Study for a methodological framework and assessment of potential financial risks associated with biodiversity loss and ecosystem degradation

Final Report

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Abstract

One of the key pillars of the European Green Deal (EGD) is set on prioritizing the preservation and enhancement of natural capital. Amidst key legislations and international commitments, the EU Sustainable Finance agenda mandates transparency, urging financial institutions to align with nature-positive strategies. Biodiversity and nature loss pose multifaceted risks, extending beyond the environmental realm, impacting essential economic activities and the overall financial system. Recognizing these risks, both public and private sectors are increasingly integrating nature and biodiversity into long-term strategies and risk assessments. This study aims to enhance the European financial sector's preparedness by providing a flexible methodological framework, drawing on existing climate and nature risk approaches. Reviewing best-practices and existing frameworks, the study covers the key definitions and steps in determining risk drivers, types, transmission channels, and exposure assessments. An assessment of the EU's sectoral exposure furthermore reveals that agriculture, real estate and construction, and healthcare sectors as most susceptible. This highlights the importance of nature's location specificity. The developed framework supports financial institutions in assessing and managing biodiversity and nature-related risks, offering practical considerations for risk identification, forward-looking scenarios, and mitigation actions. The aim is to encourage financial institutions to embark on a journey towards progressively integrating nature-related risks into their sustainability frameworks and decision-making processes.

Abstrait

L'un des principaux piliers du Green Deal européen (EGD) consiste à donner la priorité à la préservation et à l'amélioration du capital naturel. Parmi les législations clés et les engagements internationaux, l'agenda de l'UE en matière de finance durable impose la transparence, exhortant les institutions financières à s'aligner sur des stratégies favorables à la nature. La perte de biodiversité et de nature pose des risques à multiples facettes, allant au-delà du domaine environnemental et ayant un impact sur des activités économiques essentielles et sur le système financier dans son ensemble. Conscients de ces risques, les secteurs public et privé intègrent de plus en plus la nature et la biodiversité dans les stratégies à long terme et l'évaluation des risques. Cette étude vise à améliorer la préparation du secteur financier européen en fournissant un cadre méthodologique flexible, s'appuyant sur les approches existantes en matière de risques climatiques et naturels. Passant en revue les meilleures pratiques et les cadres existants, l'étude couvre les définitions et les étapes clés de la détermination des facteurs de risque, des types, des canaux de transmission et de l'évaluation de l'exposition. Une évaluation de l'exposition sectorielle de l'UE révèle en outre que les secteurs de l'agriculture, de l'immobilier et de la construction, et des soins de santé sont les plus sensibles. Cela souligne l'importance de la spécificité géographique de la nature. Le cadre élaboré aide les institutions financières à évaluer et à gérer les risques liés à la biodiversité et à la nature, en proposant des considérations pratiques pour l'identification des risques, des scénarios prospectifs et des mesures d'atténuation. L'objectif est d'encourager les institutions financières à s'engager sur la voie de l'intégration progressive des risques liés à la nature dans leurs cadres de durabilité et leurs processus décisionnels.

EXECUTIVE SUMMARY

The European Green Deal (EGD) represents an ambitious strategy aimed at ensuring a sustainable and prosperous future for Europe, while addressing climate change and environmental degradation challenges. Central to the EGD is the preservation and enhancement of natural capital to foster a sustainable, equitable and competitive economy within the European Union. Legislation and international commitments such as the Biodiversity Strategy for 2030 and the recently adopted Global Biodiversity Framework (GBF), the EU Sustainable Finance agenda, encompassing the EU Taxonomy, the Sustainable Finance Disclosure Regulation (SFDR), Corporate Sustainability Reporting Directive (CSRD) and European Green Bond Standard Regulation, compel financial institutions towards transparency and alignment with nature positive strategies and actions.

The loss of biodiversity and nature poses multifaceted risks that extend well beyond the environmental sphere, rippling deeply into essential economic activities and our overall financial system. **Many industries heavily rely on services provided by ecosystem, and the combined impacts of these dependencies are often underestimated.** In economic terms, biodiversity and nature related risks can affect different sectors and industries in a multitude of manners. Moreover, biodiversity and nature loss can have indirect but significant repercussions on financial institutions. **Acknowledging the importance of risks related to biodiversity, the public and private sector are increasingly incorporating nature and. biodiversity considerations into their long-term strategies and risk assessments.**

The primary objective of this study lies in enhancing the European financial sector's preparedness to address and manage risks emanating from environmental degradation and biodiversity loss. By critically examining the existing landscape, **this research aims to provide financial institutions with a flexible and adaptable methodological framework for measuring and quantifying these challenges and risks through the development of a specific methodological framework.** The proposed framework, which draws on existing climate and nature risk assessment framework, and was presented and discussed at an outreach workshop and during interviews with European financial stakeholders, aligns with major references such as the NGFS([1]), OECD ([2]) and TNFD ([3]) approaches.

([1]) NGFS (2021) Biodiversity and financial stability: building the case for action.

([2]) OECD (2023), "A supervisory framework for assessing nature-related financial risks: Identifying and navigating biodiversity risks", OECD Business and Finance Policy Papers, No. 33, OECD Publishing, Paris, https://doi.org/10.1787/a8e4991f-en.

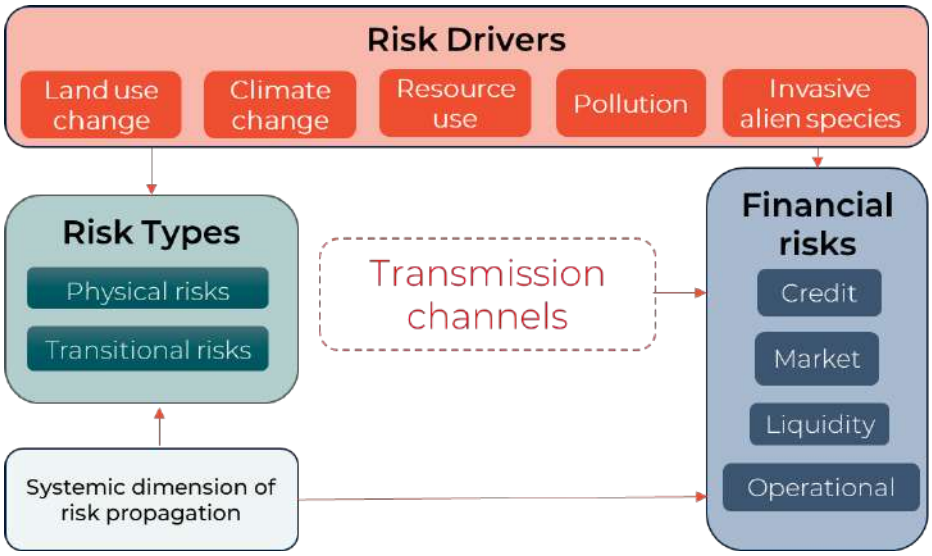
([3]) TNFD (2022) The TNFD Nature-related Risk & Opportunity Management and Disclosure Framework. Beta v0.3 Release.

The fundamentals of nature-related risk frameworks

The four fundamentals of nature-related risk frameworks (see Figure 1) – risk drivers, risk types, transmission channels and exposure/materiality assessment – find their origins in the more advanced and established climate-related risk frameworks. This framing captures how nature can affect the performance of financial institutions, and conversely, how their respective activities can impact nature, a relationship, known as 'double materiality'.

Risk drivers, the root cause of nature loss, are most commonly described based on the IPBES classification ([4]) - land use and climate change, resource use, pollution and invasive aliens' species. From these drivers, multiple **risk types** can propagate from natural or human-induced changes to ecosystems (physical risks) or through external circumstances which are often associated with a (institutional) misalignment to impacts on nature (transitional risks) ([5]) ([6]) ([7]). These two risk types can interact with the breakdown of ecosystems/ecosystem services and exacerbate a range of impacts, including amplified risks to the ecological and financial system. Hence, their consideration within a risk framework is significant.

Figure 1 - Risk categorisation of nature-related risk frameworks



Understanding the manner and the scale in which risk transmits to the financial system (**transmission channels**) can assist financial institutions in understanding the **financial risks** and impacts. These predominantly are credit risk, market risk, liquidity risk,

([4]) IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

([5]) TNFD (2022) The TNFD Nature-related Risk & Opportunity Management and Disclosure Framework. Beta v0.3 Release.

([6]) TNFD (2022) The TNFD Nature-related Risk & Opportunity Management and Disclosure Framework. Beta v0.3 Release.

([7]) NGFS (2021) Biodiversity and financial stability: building the case for action.

underwriting risk, and operational risk ([8]) ([9]). **Exposure assessments** can assist a financial institution to measure and assess their dependency and impact on nature. While advanced assessments exist with key tools such as ENCORE, IBAT and EXIOBASE, tools lag behind in the integration of key nature-related risk relational features (location-specificity, value chain interactions, time projections)**. Materiality assessments** use scenarios to translate exposure into tangible financial risk, however important data gaps due to the complexity of the relationship between nature and socio-economic systems exist. As such, the integration of nature-related risk within the decision-making processes of financial institutions, as well as the formulation of proactive mitigation approaches (e.g., due diligence, Biodiversity Action Plans, ESG integration) remain an ongoing endeavor.

Assessing sectoral exposure and understanding nature-related risks in the EU Economy

While every sector is to some degree dependent upon and has an impact on nature, some (sub)sectors or industries are more exposed to biodiversity and nature related risks than others, with implications on the financial institutions that loan, insure, or invest to entities from these sectors. The (sub)sectors that are commonly identified by relevant resources as particularly exposed to nature related risk range across primary, secondary, and tertiary sectors. The intensity of their exposure to nature related transition and physical risks, and the financial implications of these exposures, however, varies considerably. This section therefore undertook an analysis to estimate the materiality of their exposure to nature-related risks from the perspective of the EU economy, using the fundamentals of the nature-related risks introduced by the Study (Section 1). The ranking and prioritization of (sub)sectors according to the materiality of their exposure to nature-related risks can guide the implementation of the framework for assessing nature-related risks in the EU (Section 3), especially in the short term until data at the entity level becomes more available.

The assessment of the exposure of the affected sub-sectors to physical and transition risks, shown in Figure 2, highlights agriculture and farming, forestry, fishing and aquaculture, but also water and waste services, metals and mining, and construction and engineering as the most materially exposed sectors at the global level. Integrating the economic, investment and employment relevance of these affected sub-sectors to the EU, however, shifts the focus towards real estate and construction, agriculture and farming, and health care delivery as the most critical areas from the EU perspective, as shown by Figure 3. The implementation of the sectoral exposure assessment approach confirms the importance for each financial institution to consider the sectoral distribution of its financial assets. The assessment also sheds light on the important limitations that existing tools still have in terms of factoring in supply chain interlinkages and locational specificities in determining the materiality of exposure to nature related risks.

([8]) CISL (2021) Handbook for nature-related financial risks: key concepts and a framework for identification, University of Cambridge.

([9]) TNFD (2022. The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.3.

Figure 2 - (Sub)sector dependence and impact score

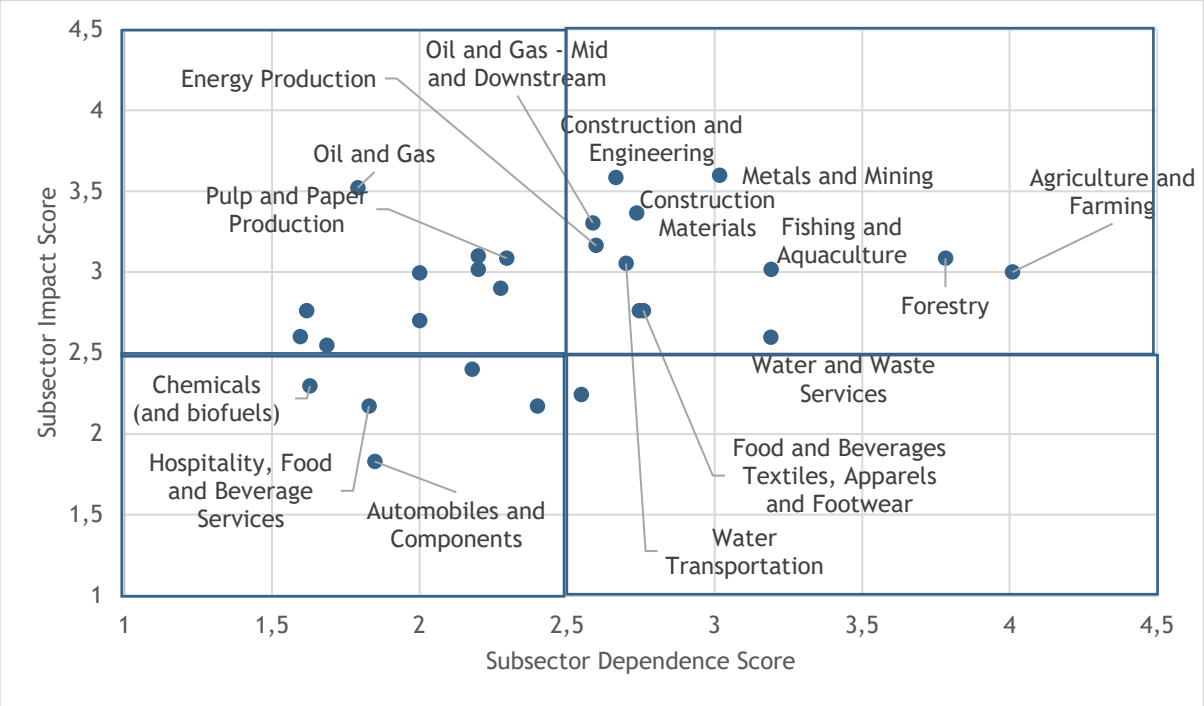
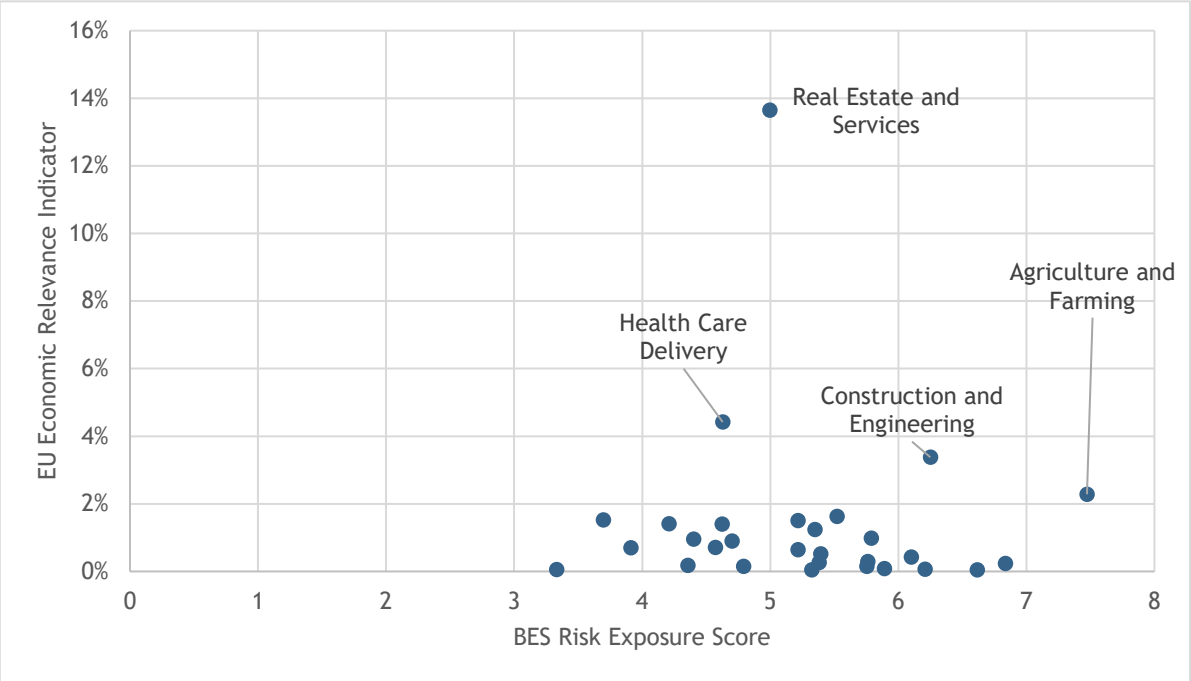


Figure 3 - Mapping BES Risk Exposure Scores and EU Economic Relevance Indicators for the affected sub-sectors



Case studies can provide a temporary solution to addressing these limitations, until existing tools make further progress to integrate relational aspects and facilitate a more comprehensive nature-risk assessment approach. The cases of real estate and construction, agro-food production and health care delivery unveil: 1) the significance of so-called "hidden risks," through biological and macroeconomic feedback loops, 2) the

substantial impact of inter-sectoral and locational linkages that can amplify risk propagation across various sectors, thereby generating more pronounced financial risks than commonly estimated, and 3) the current deficiency in comprehending transmission channels and mitigation measures at the sectoral level.

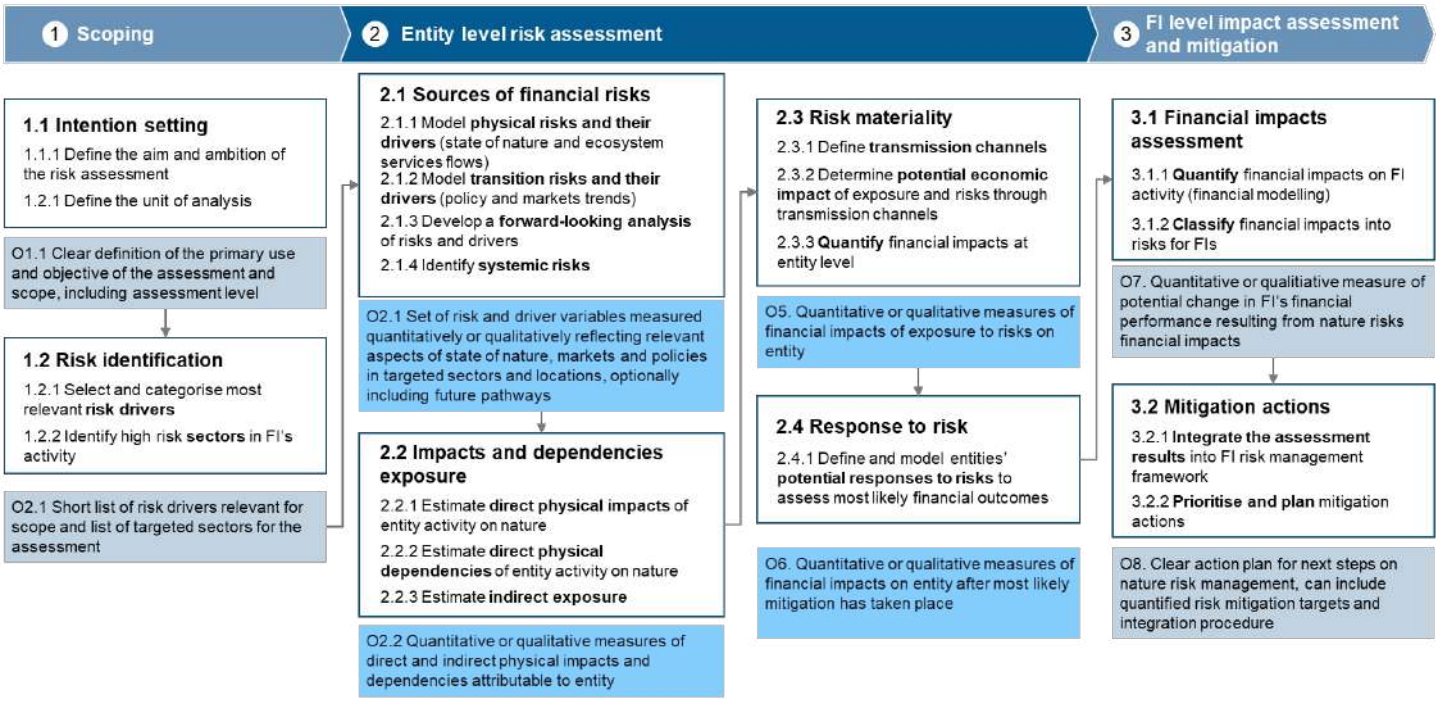
Developing a framework for assessing nature-related risks in the EU

This framework sets out an overall approach and step-by-step methodology for financial institutions to assess the financial impacts of biodiversity and nature-related risks. The framework is intended to equip financial institutions with an approach that can be applied for different use case and resource constraints, working towards best practice in a data challenged environment, with the focus on being adaptive in the context of improving data and the understanding of nature-related risks.

The framework is complementary to three existing sets of methodological guidance related to biodiversity and nature-related risk assessments in the financial sector, including the NGFS conceptual framework, the OECD supervisory framework (developed as part of the technical support project launched by the European Commission at the initiative of the central bank of Hungary) and the TNFD approach. The main steps and concepts used in this framework are aligned with these approaches but provides individual financial institutions with an additional layer of detail on practical steps required to implement a biodiversity and nature- risk assessment.

This framework is split into three stages and eight steps as shown in Figure 4. Each stage covers the key components of nature risk assessment for financial institutions from defining the appropriate assessment scope, to quantifying transition and physical risks, estimating impacts and dependencies exposure and translating exposure and risks into financial impacts at entity and institution level. For each step, the framework details how specific actions could be carried out by financial institutions. It also includes discussions around key challenges, synergies and design decisions that arise when undertaking these actions, including discussions around synergies and differences with climate risks assessment approaches and metrics.

Figure 4 - Methodological framework for assessing nature related financial risks



The framework underlines several practical considerations, that are important for financial institutions to carry out nature-related risk assessments. These include:

- Clearly setting out the intention and use of the risk assessment to inform key design choices, such as granularity of data required and whether qualitative or quantitative data is required,
- Conducting risk identification prior to a full risk assessment to understand where to invest time and resources in conducting deeper levels of assessment,
- Using forward-looking scenarios to assess future exposure to risk, particularly given the uncertainty of the development and timing of different physical and transition risks,
- Assessing when and where location-specific data is required to generate robust insights on impacts and dependencies,
- Using an approach that considers nature-related risks that occur due to value chain exposure, given that a significant amount of financial exposure in Europe is in sectors that do not directly impact or depend on nature,
- Considering the range of mitigation actions that have potential to reduce exposure to risks, both in terms of actions available for individual counterparties or portfolio companies and for financial institutions at large.

Financial institutions now have a considerable amount of methodological guidance available to begin to carry out nature-related risk assessments and assess the financial materiality of these risks. Several practical challenges remain in areas of ongoing development for individual financial institutions and the sector at large. These include:

- the **development of publicly available nature scenarios** useful for the financial sector substantially lags behind availability of comparable climate scenarios. In the short term, financial institutions will be best served by developing their own scenarios that meet their risk assessment needs or by building on existing climate scenarios to construct integrated nature and climate scenarios,
- the **consideration of the location** is central to a robust nature risk assessment. Financial institutions are likely, however, to encounter significant challenges in compiling data that is comprehensive enough to generate granular insights across the whole portfolios. Individual financial institutions can work in the short-term to prioritise and determine which risks or parts of a portfolio require very granular data, while collaboration between financial institutions, supervisors, companies, data providers and scientists can help close this gap over time,
- the **availability of value chain and supply chain data** for individual companies in the economy is limited. This is a significant barrier to generating robust, portfolio-wide risk assessments and is an area where a significant amount of innovation and work is required.

Recommendations and actionable insights:

Nature-related risk assessment is an evolving field for financial institutions. As improved capabilities, new data and regulations begin to emerge, financial institutions can already begin now to build towards best practice and explore how nature-related risk assessments can support their activities and efforts towards financing a sustainable future. This could be done in three main phases:

(i) a short-term exploratory and planning phase

Financial institutions can start implementing this framework by piloting high-level or targeted assessments (e.g. sector, region, etc.) and building up capabilities towards best practice for the various use cases, although alignment of data, metrics, and approaches to assess nature-related risks is expected to improve over time.

(ii) a medium-term deepening phase building strong capability

Financial institutions can deepen their capabilities on nature-related risks assessment by conducting more comprehensive quantitative analysis, including exploring scenario analysis. They might also want to start implementing risk management measures by engaging with clients and initiating preliminary discussions on mitigation actions and transition plans for risks they currently do not act on.

(iii) a long-term mainstreaming phase integrating nature in their frameworks, including exploring full integration with climate models

In the long-term financial institutions might work towards making nature an integrated part of their sustainability risk assessment and management, especially by integrating climate and nature models and management processes, including capital allocation strategies, lending policies, annual reporting combined with TCFD-TNFD disclosures to enable the development of comprehensive nature transition plans. Financial institutions might also consider mainstreaming nature across the organization by ensuring that

nature is included in decision frameworks at all levels and across all divisions, beyond risk teams.

Key take-away points

Despite the increasing recognition of the significance of nature and biodiversity in our collective health and economic prosperity, prevalent lack of assessments, transparent reporting and disclosure are hindering the transition from awareness to impactful and mitigative actions. Nature holds inherent value, fundamental to financial institutions and companies' success, yet its worth often remains unquantified. This lack of acknowledgment consequently results in that neither risks nor opportunities are being sufficiently considered in assessments of both financial institutions and companies.

Deeper assessment into the sectoral exposure shows that biodiversity and nature related risks can have diverse impacts across various sectors and industries, accentuating the varying degrees of exposure present in the financial landscape. Available tools represent sectoral exposure at a global level, yet context-specific information is crucial to truly understand the level of impact and dependencies that a sector has on nature at a local or regional level. Assessment specifically of the European economy's dependencies and impacts show that a wide array of sectors is heavily dependent on nature and thus exposed to associated risks in one form or another: agriculture, real estate and construction, and the healthcare sector came out as the most susceptible. Contextualizing global data to regional markets provides pivotal insights for financial institutions to evaluate their risk exposure comprehensively.

The methodological framework offers financial institutions a systematic approach to assess the financial impacts stemming from biodiversity and nature-related risks. It aims to provide a flexible approach that can be applied in diverse circumstances, considering resource limitations and evolving data accessibility**. The framework is designed to accommodate a scalable approach, allowing institutions to initiate assessments with simplicity and gradually delving into more sophisticated analysis.** This component of scalability ensures that the framework is adaptable to the needs and capacities of financial institutions as they progress in integrating nature and biodiversity considerations into their risk assessments. The framework thus provides an adaptable assessment amid a data-constrained environment.

Furthermore, the framework has also been designed in consideration of evolving environmental standards and regulations. **The framework methodology remains flexible so that it can easily be integrated into emerging framework to ensure that it remains relevant within the evolving landscape.** It thus presents a dynamic tool that can adapt and align with emerging best-practices in nature-related financial assessments.

As the financial sector navigates environmental challenges, the insights provided through the framework assessment will empower institutions to integrate nature and biodiversity considerations into risk assessments and advance their strategies towards sustainable and resilient practices.

RÉSUMÉ EXÉCUTIF

Le Pacte Vert pour l'Europe (EGD) représente une stratégie ambitieuse visant à assurer un avenir durable et prospère à l'Europe, tout en relevant les défis du changement climatique et de la dégradation de l'environnement. La préservation, le maintien et la restauration du capital naturel pour favoriser une économie durable, équitable et compétitive au sein de l'Union européenne (UE) sont au cœur de l'EGD. Dans ce contexte, la législation et les engagements internationaux tels que la Stratégie en faveur de la Biodiversité à l'horizon 2030 et le Cadre Mondial pour la biodiversité (GBF) récemment adopté, la Stratégie en matière de finance durable de l'UE, qui englobe la taxonomie européenne, le règlement sur la publication d'informations en matière de durabilité dans le secteur des services financiers (SFDR), la directive sur la publication d'informations en matière de durabilité par les entreprises (CSRD) et le règlement sur les obligations vertes européennes, obligent les institutions financières à faire preuve de transparence et à s'aligner sur des stratégies, et les incitent à développer des actions favorables à la nature.

L'appauvrissement de la biodiversité et de la nature pose des risques à multiples facettes qui dépassent largement la sphère environnementale et se répercutent profondément sur des activités économiques essentielles et sur l'ensemble de notre système financier. **De nombreuses industries dépendent fortement des services fournis par les écosystèmes, et les effets combinés de ces dépendances sont tendent à être sous-estimés.** D'un point de vue économique, les risques liés à la biodiversité et à la nature peuvent en effet affecter différents secteurs et industries de multiples façons. En outre, la perte de biodiversité et de nature peut avoir des répercussions indirectes mais significatives sur les institutions financières. **Reconnaissant l'importance des risques liés à la biodiversité, les secteurs public et privé intègrent progressivement les considérations relatives à la nature et à la biodiversité dans leurs stratégies à long terme et leur évaluation des risques.**

L'objectif principal de cette étude est d'améliorer la préparation du secteur financier européen à aborder et à gérer les risques émanant de la dégradation de l'environnement et de la perte de biodiversité. En examinant de manière critique le contexte actuel, **cette recherche vise à fournir aux institutions financières un cadre méthodologique flexible et adaptable pour mesurer et quantifier ces risques à travers le développement d'un cadre d'évaluation spécifique.** Le cadre proposé, qui s'inspire des cadres d'évaluation des risques climatiques et naturels existants, et qui a été présenté et discuté lors d'un atelier de sensibilisation et au cours d'entretiens avec des

acteurs financiers européens, s'aligne sur des références majeures telles que les approches du NGFS ([10]), de l'OCDE ([11]) et de la TNFD ([12]).

Les fondements des cadres d'évaluation des risques liés à la nature

Les quatre éléments fondamentaux des cadres d'évaluation de risques liés à la nature (voir figure 1-1) - facteurs de risque, types de risques, canaux de transmission et évaluation de l'exposition/de l'importance relative - trouvent leur origine dans les cadres d'analyse des risques liés au climat, plus avancés et mieux établis. Ces cadres permettent de comprendre comment la nature peut affecter les performances des institutions financières et, inversement, comment leurs activités respectives peuvent avoir un impact sur la nature, une relation connue sous le nom de "double matérialité".

Les facteurs de risque, qui sont la cause première de la perte de la nature, sont le plus souvent décrits sur la base de la classification IPBES ([13]), qui distingue cinq facteurs clés (changements d'usage des terres et de la mer, exploitation directe de certains organismes, changement climatique, pollution et espèces exotiques envahissantes). À partir de ces facteurs, de multiples **types de risques** peuvent se propager du fait de changements naturels ou induits par l'homme dans les écosystèmes (risques physiques), ou à travers des circonstances externes qui sont souvent associées à un décalage institutionnel par rapport aux impacts sur la nature (risques de transition) ([14]) ([15]). Ces deux types de risques peuvent interagir avec la dégradation des écosystèmes et des services écosystémiques et exacerber une série d'impacts, voire mener à des risques amplifiés pour le système économique et financier. Il est donc crucial de les prendre en compte dans tout cadre d'analyse du risque.

([10]) NGFS (2021) Biodiversity and financial stability : building the case for action.

([11]) OCDE (2023), "Un cadre de surveillance pour l'évaluation des risques financiers liés à la nature : Identifier et gérer les risques liés à la biodiversité ", Documents de politique économique et financière de l'OCDE, n° 33, Éditions de l'OCDE, Paris, https://doi.org/10.1787/a8e4991f-en.

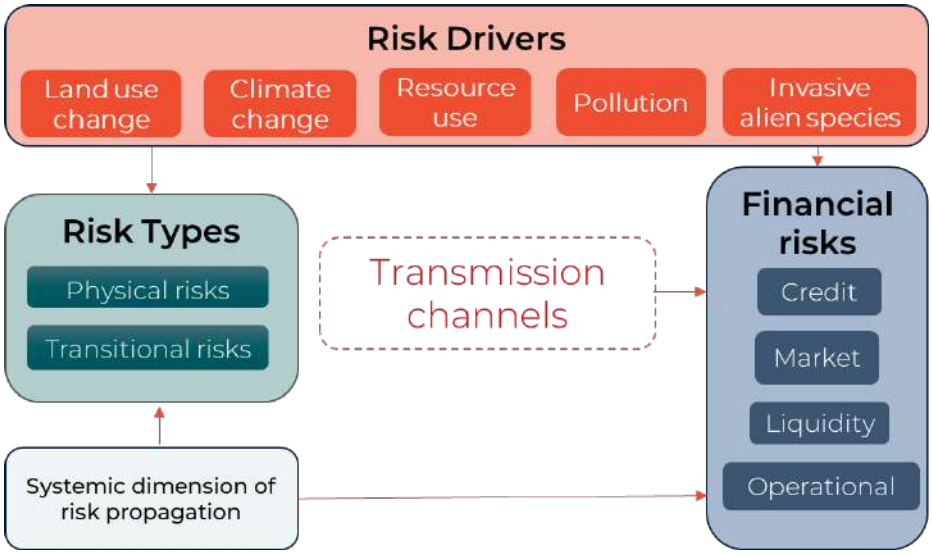
([12]) TNFD (2022) Cadre de gestion et de divulgation des risques et opportunités liés à la nature. Version Beta v0.3.

([13]) IPBES (2019) : Résumé à l'intention des décideurs du rapport d'évaluation mondiale sur la biodiversité et les services écosystémiques de la plateforme intergouvernementale scientifique et politique sur la biodiversité et les services écosystémiques.

([14]) TNFD (2022) Cadre de gestion et de divulgation des risques et opportunités liés à la nature. Version Beta v0.3.

([15]) NGFS (2021) Biodiversity and financial stability : building the case for action.

Figure 1 Catégorisation des risques dans les cadres d'évaluation des risques liés à la nature



Comprendre l'ampleur des risques et la manière dont ils se transmettent au système financier (**canaux de transmission**) peut aider les institutions financières à comprendre les **risques financiers** et leurs impacts. Il s'agit principalement du risque de crédit, du risque de marché, du risque de liquidité, du risque de souscription et du risque opérationnel ([16]) ([17]) Les **évaluations de l'exposition** peuvent aider une institution financière à mesurer et à évaluer sa dépendance et son impact sur la nature. Bien que des évaluations avancées existent et proposent des outils clés tels que ENCORE, IBAT et EXIOBASE, ces outils n'intègrent pas pleinement les principales caractéristiques des risques liés à la nature (tels que la spécificité du lieu, les interactions au sein la chaîne de valeur, ou les projections temporelles)**. Les évaluations de la matérialité** utilisent des scénarios pour traduire l'exposition aux risques financiers tangibles, mais il existe d'importantes lacunes dans les données en raison de la complexité de la relation entre la nature et les systèmes socio-économiques. Ainsi, l'intégration des risques liés à la nature dans les processus décisionnels des institutions financières, ainsi que la formulation d'approches d'atténuation proactives (par exemple, la diligence raisonnable, les plans d'action en faveur de la biodiversité, l'intégration ESG) restent à consolider.

Évaluer l'exposition sectorielle et comprendre les risques liés à la nature dans l'économie de l'UE

Si tous les secteurs dépendent dans une certaine mesure de la nature et ont un impact sur elle, certains (sous-)secteurs ou industries sont plus exposés que d'autres aux risques liés à la biodiversité et à la nature, ce qui a des répercussions sur les institutions financières qui prêtent, assurent ou investissent dans des entités de ces secteurs. Les (sous-)secteurs communément identifiés par la littérature analysée comme étant particulièrement exposés aux risques liés à la nature couvrent les secteurs primaire,

([16]) CISL (2021) Handbook for nature-related financial risks : key concepts and a framework for identification, Université de Cambridge.

([17]) TNFD (2022) Cadre de gestion et de divulgation des risques et opportunités liés à la nature. Version Beta v0.3.

secondaire et tertiaire. L'intensité de leur exposition aux risques physiques et de transition liés à la nature, ainsi que les implications financières de ces expositions, varient toutefois considérablement. Cette section a donc entrepris une estimation de l'importance de leur exposition aux risques liés à la nature du point de vue de l'économie de l'UE, en utilisant les principes fondamentaux des risques liés à la nature introduits par l'étude (section 1). Le classement qui en résulte et la hiérarchisation des (sous-)secteurs en fonction de l'importance de leur exposition aux risques liés à la nature peuvent guider la mise en œuvre du cadre d'évaluation des risques liés à la nature dans l'UE (section 3), en particulier à court terme, jusqu'à ce que les données au niveau de l'entité soient plus couramment disponibles.

L'évaluation de l'exposition des sous-secteurs concernés aux risques physiques et de transition, présentée dans la figure 1-2, met en évidence l'agriculture et l'élevage, la sylviculture, la pêche et l'aquaculture, mais aussi les services liés à l'eau et aux déchets, les métaux et les mines, ainsi que la construction et l'ingénierie, comme étant les secteurs les plus matériellement exposés au niveau mondial. Toutefois, si l'on analyse l'importance de ces sous-secteurs du point de vue de l'économie, de l'investissement et de l'emploi dans l'UE, l'immobilier et la construction, l'agriculture et l'élevage, et la prestation de soins de santé, émergent comme les domaines les plus critiques, comme le montre la figure 1-3. La mise en œuvre de l'approche d'évaluation de l'exposition sectorielle confirme l'importance pour chaque institution financière de prendre en compte la répartition sectorielle de ses actifs financiers. L'évaluation met également en lumière les limites importantes des outils existants en ce qui concerne la prise en compte des liens entre les chaînes d'approvisionnement et les spécificités locales dans la détermination de l'importance de l'exposition aux risques liés à la nature.

Figure 2 Dépendance (sous-)sectorielle et score d'impact

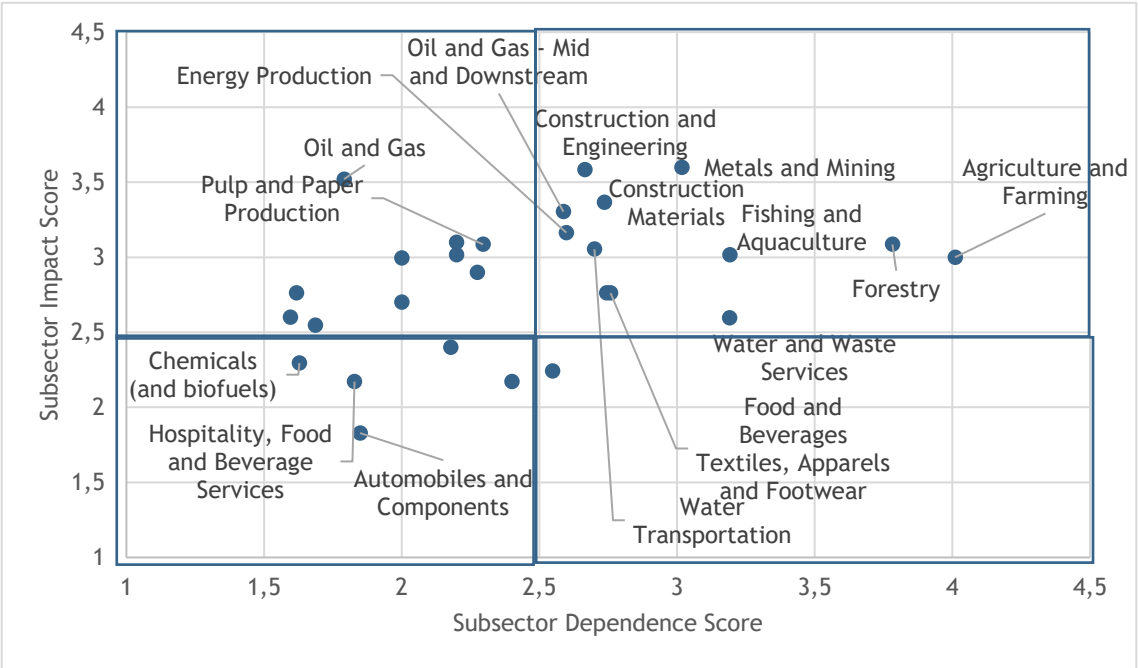
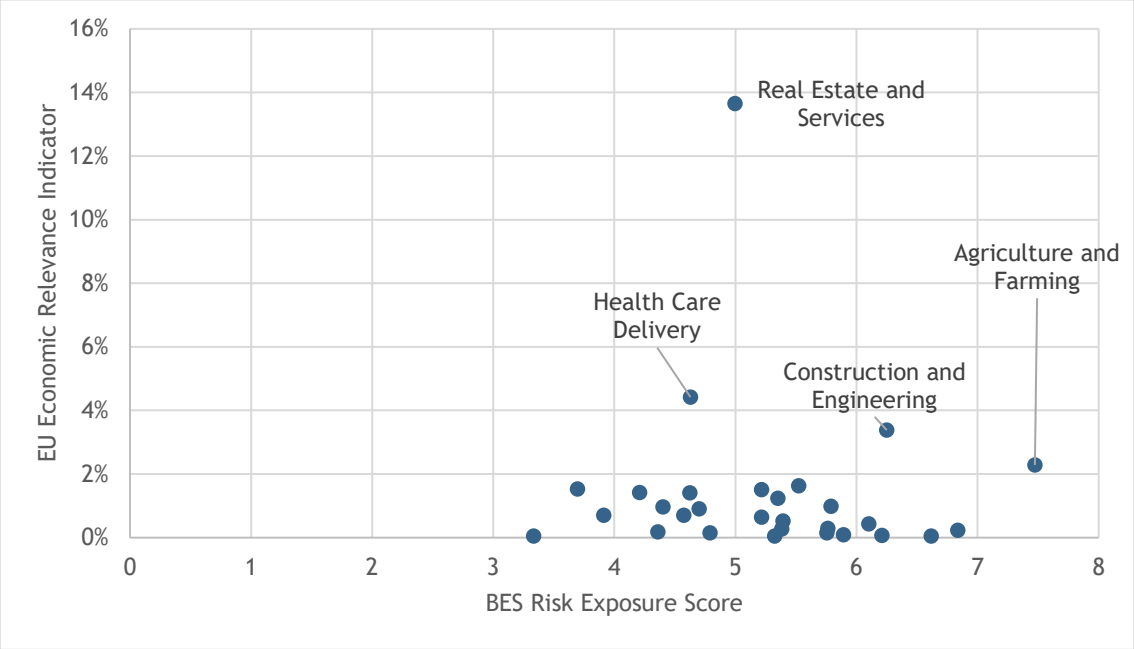


Figure 3 Mise en correspondance des scores d'exposition aux risques liés à la biodiversité et et aux écosystèmes et des indicateurs de pertinence économique de l'UE pour les sous-secteurs concernés



Les études de cas peuvent apporter une solution temporaire à ces limitations, jusqu'à ce que les outils existants progressent davantage dans leur intégration des aspects relationnels et facilitent une approche plus complète de l'évaluation des risques liés à la nature. Ainsi, et à partir des cas de l'immobilier et de la construction, de la production agroalimentaire et de la prestation de soins de santé, cette étude révèle : 1) l'importance des "risques cachés" du fait de boucles de rétroaction biologiques et macroéconomiques, 2) l'impact substantiel des liens intersectoriels et locaux qui peuvent amplifier la propagation des risques dans divers secteurs, générant ainsi des risques financiers plus prononcés que généralement estimé, et 3) les lacunes actuelles dans la compréhension des canaux de transmission et des mesures d'atténuation au niveau sectoriel.

Élaboration d'un cadre d'évaluation des risques liés à la nature dans l'UE

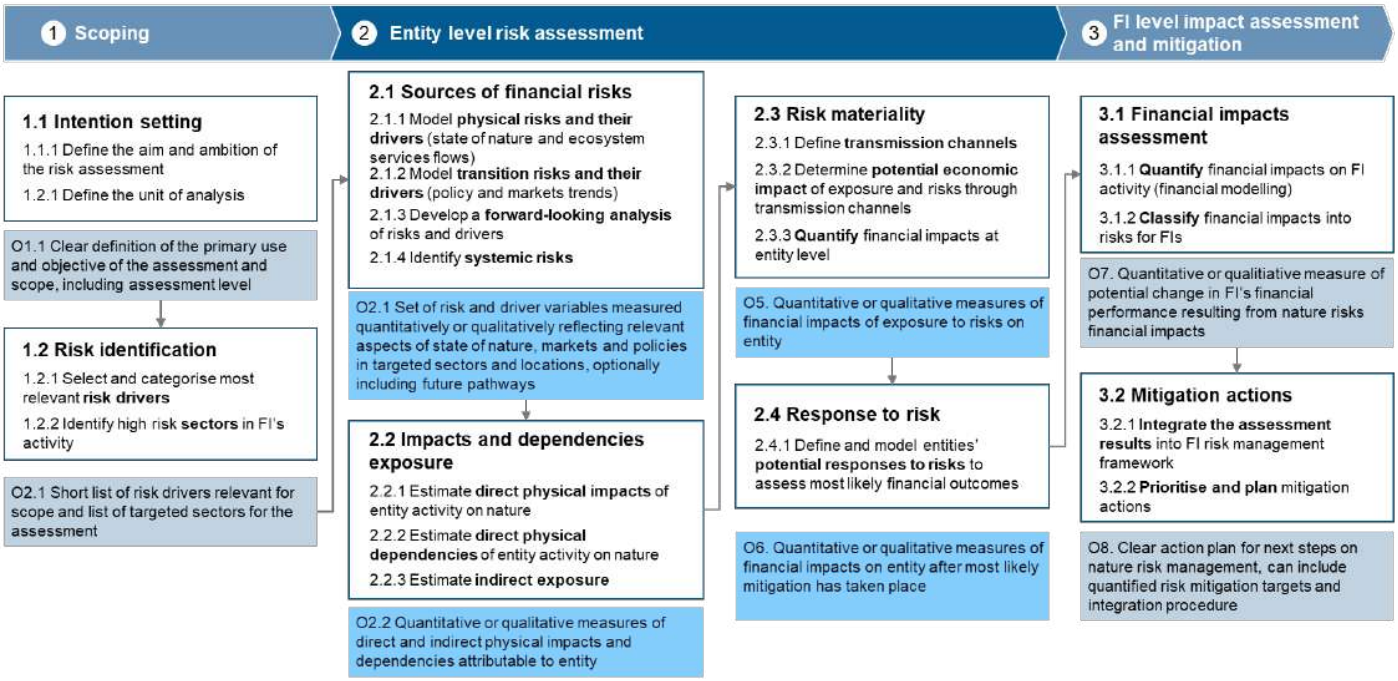
Le cadre proposé définit une approche globale et une méthodologie structurée étape par étape, permettant aux institutions financières d'évaluer les impacts financiers de la biodiversité et des risques liés à la nature. Le cadre vise à doter les institutions financières d'une approche qui peut être appliquée à différents cas et contraintes de ressources, afin de permettre l'adoption de bonnes pratiques malgré la rareté des données. L'accent a ainsi été mis sur l'adaptabilité du cadre d'évaluation, dans un contexte où la quantité et la qualité des données et la compréhension des risques liés à la biodiversité et à la nature sont en évolution constante.

Ce cadre complète trois ensembles méthodologiques existants : le cadre conceptuel du NGFS, le cadre de surveillance de l'OCDE (élaboré dans le contexte du projet de soutien technique lancé par la Commission européenne à l'initiative de la banque centrale de Hongrie) et l'approche de la TNFD. Les principales étapes et les concepts utilisés par la

présente étude sont alignés sur ces approches, tout en fournissant aux institutions financières un niveau de détail supplémentaire sur les étapes pratiques de mise en œuvre.

Le cadre résultant de cette étude est divisé en trois phases et huit étapes, comme décrit dans le schéma 1-4. Chaque étape couvre les éléments clés de l'évaluation des risques liés à la biodiversité et à la nature pour les institutions financières, balayant la définition du champ d'évaluation, la quantification des risques de transition et des risques physiques, l'estimation de l'exposition aux impacts et aux dépendances, et la traduction de l'exposition et des risques en impacts financiers pour l'institution. Pour chaque étape, le cadre d'évaluation détaille la manière dont les institutions financières peuvent mener à bien des actions spécifiques. Il comprend également des éléments de réflexion sur les principaux défis, synergies et point conceptuels qui se posent lors de la mise en œuvre de ces actions, ainsi que sur les synergies et les différences avec les approches liées aux risques climatiques.

Figure 4 Cadre méthodologique pour l'évaluation des risques financiers liés à la nature



De surcroît, le cadre souligne six considérations pratiques fondamentales pour les institutions financières qui procèdent à une évaluation des risques liés à la biodiversité et à la nature :

- Une définition claire des objectifs et de l'utilisation finale de l'évaluation est nécessaire pour éclairer les choix conceptuels qui sous-tendent l'évaluation, tels que la granularité et le type (qualitatif ou quantitatif) de données requises,
- L'identification des risques doit être réalisée préalablement à leur évaluation complète afin d'utiliser stratégiquement le temps et les ressources dédiés à l'évaluation,

- L'utilisation de scénarios prospectifs est fondamentale pour évaluer l'exposition future au risque, compte tenu de l'incertitude liée à la nature et la vitesse de l'évolution des risques physiques et de transition,
- L'utilisation de données spécifiques au lieu de réalisation des impacts et des risques est nécessaire pour obtenir des informations solides,
- La prise en compte des risques qui surviennent en raison de l'exposition de la chaîne de valeur est cruciale, dans la mesure où une part importante de l'exposition financière en Europe se situe dans des secteurs qui n'ont pas d'impact direct sur la nature ou qui n'en dépendent pas,
- L'éventail des mesures de réduction du risque doit être envisagé dans toute sa diversité, tant pour les mesures applicables aux entités bénéficiant des investissements qu'au niveau des institutions financières et de leur portefeuille.

Les institutions financières disposent désormais d'un nombre considérable d'orientations méthodologiques pour évaluer les risques liés à la biodiversité et à la nature, et à estimer leurs implications financières. Des défis pratiques subsistent néanmoins pour divers aspects en cours de développement, à la fois pour les institutions financières et le secteur financier dans son ensemble :

- L'**élaboration de scénarios liés à la nature accessibles au public** et utiles au secteur financier accuse un retard considérable par rapport à la disponibilité de scénarios climatiques. À court terme, les institutions financières bénéficieraient donc de scénarios propres, développés en interne sur la base de scénarios climatiques, et qui répondent à leurs besoins,
- La **prise en compte de la localisation** est essentielle pour une évaluation solide des risques liés à la biodiversité et à la nature. La compilation de données suffisamment complètes pour générer des informations granulaires sur l'ensemble des portefeuilles risque toutefois de générer d'importantes difficultés. À court terme, les institutions financières peuvent prioriser les risques matériels ou les portions de leur portefeuille qui nécessitent des données très granulaires. La coopération entre les institutions financières, les superviseurs, les entreprises, les fournisseurs de données et la communauté scientifique permettra par la suite de combler les lacunes restantes,
- La **disponibilité des données relatives aux chaînes de valeur et aux chaînes d'approvisionnement** est limitée. Il s'agit là d'un obstacle important à la réalisation d'évaluations solides des risques à l'échelle d'un portefeuille, et d'un point qui nécessite un travail approfondi.

Recommandations et points d'action

L'évaluation des risques financiers liés à la biodiversité et à la nature est un domaine en pleine évolution. Tandis que des connaissances renforcées, de nouvelles données et des réglementations commencent à émerger, les institutions financières peuvent dès à présent s'inspirer des bonnes pratiques existantes et explorer la manière dont les évaluations des risques liés à la nature peuvent soutenir leurs activités et leurs efforts en vue de financer un avenir durable. Dans cette optique, trois phases d'action se dégagent :

(iv) Une phase exploratoire et de planification à court terme

Les institutions financières peuvent commencer à mettre en œuvre le cadre proposé par la présente étude en pilotant des évaluations de haut niveau ou ciblées (par exemple, par secteur, région, etc.) et en renforçant leur capacité à mettre en œuvre les bonnes pratiques existantes. En parallèle, il est entendu que l'alignement des données, des mesures et des approches pour évaluer les risques liés à la nature est amené à progresser.

(v) Une phase d'approfondissement à moyen terme et le renforcement des capacités

Les institutions financières peuvent renforcer leur capacité d'évaluation des risques liés à la nature en menant des analyses quantitatives plus complètes, y compris en explorant l'analyse de scénarios. Elles pourraient également mettre en œuvre des mesures de gestion du risque en s'engageant auprès de leurs clients et en entamant des discussions préliminaires sur les mesures d'atténuation et les plans de transition pour les risques sur lesquels elles n'agissent pas actuellement.

(vi) Une phase d'intégration de la nature dans les cadres d'analyse et de décision sur le long terme, y compris à travers l'intégration dans les modèles climatiques

À long terme, les institutions financières pourraient faire de la nature une partie intégrante de leur évaluation et de leur gestion du risque de durabilité, notamment en intégrant les modèles climatiques et liés à la nature dans les processus de gestion – y compris dans les stratégies d'allocation de capital, les politiques de prêt, les rapports annuels, et les divulgations de la TCFD-TNFD. Cela permettrait par ailleurs l'élaboration de plans de transition complets. Les institutions financières pourraient également envisager d'intégrer la nature dans l'ensemble de leurs politiques, en veillant à ce qu'elle soit incluse dans les cadres de décision à tous les niveaux et dans toutes les divisions, au-delà des équipes chargées des risques.

Points clés à retenir

Malgré la reconnaissance croissante de l'importance de la nature et de la biodiversité pour notre santé collective et notre prospérité économique, le manque généralisé d'évaluations, de rapports transparents et de divulgations entrave la transformation de la prise de conscience en des mesures concrètes. La nature possède une valeur inhérente et fondamentale pour le succès des institutions financières et des entreprises, mais sa valeur reste rarement quantifiée. De ce fait, ni les risques ni les opportunités ne sont suffisamment pris en compte dans les évaluations des institutions financières et des entreprises.

Une évaluation plus approfondie de l'exposition sectorielle montre que les risques liés à la biodiversité et à la nature peuvent avoir des impacts divers dans différents secteurs et industries, ce qui accentue les différences d'exposition au sein du paysage financier. Les outils actuellement disponibles permettent bien de représentent l'exposition

sectorielle au niveau mondial, mais des informations plus spécifiques – cruciales pour comprendre réellement le niveau d'impact et les dépendances d'un secteur – sont nécessaires au niveau local ou régional. L'évaluation spécifique des dépendances et des impacts de l'économie européenne montre qu'un large éventail de secteurs est fortement dépendant de la nature et donc exposé aux risques associés sous une forme ou une autre : l'agriculture, l'immobilier et la construction, ainsi que le secteur des soins de santé sont apparus comme les plus sensibles. La contextualisation des données mondiales aux marchés régionaux fournit des informations essentielles aux institutions financières pour évaluer leur exposition aux risques de manière exhaustive.

Le cadre méthodologique proposé par cette étude offre aux institutions financières une approche systématique pour évaluer les impacts financiers découlant des risques liés à la biodiversité et à la nature. Il vise à fournir une approche flexible qui peut être appliquée dans des contextes variés, en tenant compte des limitations des ressources et de l'évolution de l'accessibilité des données**. Ce cadre est conçu pour s'adapter à une approche évolutive, permettant aux institutions d'entamer les évaluations avec simplicité et de passer progressivement à une analyse plus sophistiquée.** Cela garantit que le cadre soit adaptable aux besoins et aux capacités des institutions financières à mesure qu'elles progressent dans l'intégration des considérations relatives à la nature et à la biodiversité dans leurs évaluations des risques. Le cadre fournit donc une évaluation adaptable dans un environnement où les données sont limitées.

En outre, le cadre a été conçu en tenant compte de l'évolution des normes et des réglementations environnementales. La **méthodologie du cadre reste flexible, de sorte qu'elle peut facilement être intégrée dans un cadre émergent pour s'assurer qu'elle reste pertinente dans un paysage en évolution.** Il s'agit donc d'un outil dynamique qui peut s'adapter et s'aligner sur les bonnes pratiques émergentes.

Alors que le secteur financier est confronté à des défis environnementaux, les informations fournies par le cadre d’évaluation permettront aux institutions d'intégrer les considérations relatives à la nature et à la biodiversité dans l'évaluation des risques et de faire progresser leurs stratégies vers des pratiques durables et résilientes.

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1. Background

The European Green Deal represents an ambitious and strategic response by the European Union to tackle the pressing challenges of climate change and environmental degradation. By fostering a sustainable, equitable, and prosperous society, the Green Deal envisions a resource-efficient and competitive economy that safeguards and enhances the EU's natural capital.

Natural capital serves as the foundation of our economy and society, providing essential land and resources for economic activities and recovery from economic crises. Ecosystems play a vital role in both rural and urban areas, offering a diverse range of services, including flood control, improved air and water quality, pollination, and recreational opportunities among others. A recent analysis by PwC highlighted that 55% of the world's total GDP, is moderately or highly dependent on nature and its services, making it vulnerable to risks from biodiversity and natural capital loss ([18]), a value slightly greater than the previous assessment by the World Economic Forum ([19]). Changes in the stock and condition of natural capital alter its ability to provide the goods and services upon which businesses depend, and therefore have implications for the operations and profitability of businesses and financial institutions ([20]). Our economies are therefore clearly “embedded in nature” and not external to it. ([21]) If we consider this in our assessments of economic possibilities and risk assessments, it has profound implications on what we can legitimately expect in terms of future prosperity and economic stability ([22]).

Despite the ambitious goals set by the European Green Deal, the world still grapples with ecosystem collapse and the failure to achieve biodiversity targets by 2020 ([23]). Studies and reports continue to reveal the sustained degradation of ecosystems and the urgent need for stronger conservation efforts ([24]) ([25]). Despite mounting evidence of the critical state of biodiversity and natural capital, many institutions still perceive the environment as an externality, neglecting its true value in economic decision-making.

([18]) Evison (2023). Managing nature risks: From understanding to action. PwC Strategy and Business.

([19]) The World Economic Forum and PwC (2020) Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy

([20]) Dasgupta (2021) The Economics of Biodiversity: The Dasgupta Review Headline Messages.

([21]) Ibid

([22]) Ibid

(23) EEA (2020) State of nature in the EU, Results from reporting under the nature directives 2013-2018. EEA Report No.10//2020.

([24]) Ibid

([25]) IPBES (2018) The IPBES regional assessment report on biodiversity and ecosystem services for Europe and Central Asia

1.1. Paving the way for sustainable finance

To address this challenge, the European Union has implemented and committed to several key legislations and international commitments aimed at incentivizing the internalization of environmental considerations and promoting more sustainable market decisions, either directly though addressing financial institutions or more indirectly through the promotion of nature conservation and valuation. The new Biodiversity Strategy for 2030, which has most recently led to the adoption of a proposal for a Nature Restoration Law ([26]), which lays out targets and actions to restore and protect Europe's ecosystems and put Europe's biodiversity on a path of recovery by 2030. By setting ambitious targets and emphasizing the importance of nature restoration, these frameworks strive to steer institutions and governments towards a more responsible and nature-friendly approach. At an international level the Global Biodiversity Framework (GBF), adopted in December 2022, aims to halt global biodiversity loss and guide global action to protect biodiversity and nature. The 23 action-oriented targets developed emphasize a whole-society approach. While all targets are of relevance of financial institutions - they should align their investment, lending, underwriting and insurance activities with the goals and targets of the GBF ([27]) - particularly Target 15 calls to 'Take legal, administrative or policy measures to encourage the private sector (companies and financial institutions) to assess and disclose risks, dependences and impacts on biodiversity related to their activities'.

To drive more direct change in the financial sector the EU has formulated the Strategy for Financing the Transition to a Sustainable Economy in 2021, which outlines a comprehensive framework designed to integrate sustainability considerations across all aspects of the financial sector ([28]) to support the transition of the real economy. It encompasses a wide range of measures aimed at redirecting financial flows towards more sustainable investments and fostering responsible business practices. The strategy's core objective is to set a framework for classifying green investments and as such provide a mechanism that can mobilize private capital in support of the European Green Deal and the EU's broader sustainability agenda. In conjunction with this strategy, the recent Sustainable Finance package encompasses a number of legislative proposals and measures, including a recommendation on transition finance ([29]). These proposals focus on enhancing the transparency and disclosure of sustainable investment practices, creating a more standardized framework for defining and reporting sustainable activities, encouraging the private funding of transition projects and technologies and harmonizing sustainable finance practices across the EU's Member States.

([26]) European Commission, Nature Restoration Law. Available here: https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en

([27]) United Nations Environment Programme (2023). Stepping Up on Biodiversity: What the Kunming-Montreal Global Biodiversity Framework means for Responsible Investors. Nairobi

([28]) EC (2021). Strategy for financing the transition to a sustainable economy. COM(2021) 390 Final https://eur-lex.europa.eu/resource.html?uri=cellar:9f5e7e95-df06-11eb-895a-01aa75ed71a1.0001.02/DOC_1&format=PDF.

([29]) DG FISMA (2023). Sustainable finance package – General Publications.

The EU sustainable finance agenda relies on three pillars (i) the EU taxonomy (ii) a comprehensive disclosure regime for non-financial and financial undertakings (iii) and a set of investment tools to develop sustainable solutions. The EU Sustainable Finance Taxonomy aims to classify sustainable economic activities, providing a framework for identifying investments that contribute positively to environmental objectives including "protection and restoration of biodiversity and ecosystems' ([30]). The EU Taxonomy, together with the other disclosure and reporting specifying regulations, play pivotal roles in the sustainable finance framework. The Sustainable Finance Disclosure Regulation (SFDR) mandates financial market participants to disclose their sustainability efforts (including Environmental, Social and Governance indicators), helping to foster transparency and accountability. Financial institutions have a critical role to play in ensuring that nature and biodiversity loss can be halted, by proposing more sustainable investment options and accelerating this transformative process. In parallel, the Corporate Sustainability Reporting Directive (CSRD), replacing the Non-Financial Reporting Directive (NFRD), mandates a large array of companies within the EU to report on a similar set of comprehensive ESG indicators. Complementing the CSRD, the Europeans Sustainability Reporting Standards (ESRS) provides a roadmap for how companies should report sustainability information to comply with the directive itself. Within these standards, standard E4 is specifically focused on biodiversity and ecosystems, focusing on how actions affect nature and biodiversity, what mitigation measures are taken and the need for assessing risks and opportunities ([31]).

Additionally, the European Green Bond Standard Regulation establishes a legal framework for issuers choosing this standard, ensuring that the funds raised are directed towards projects with positive environmental impacts, including those focused on biodiversity and nature preservation ([32]).

In recent years, there has been growing awareness of the significant macroeconomic and financial risks that biodiversity and nature loss can pose ([33]). There have been efforts, from the private and public sector, to understand the links between nature and biodiversity loss, and the possible risks that they could pose to the financial system, as well as understanding the impacts of their investments and lending on biodiversity and ecosystem degradation. Financial authorities globally have recognized the importance of understanding the extent to which biodiversity risks could pose a threat to financial stability. Furthermore, an increasingly substantial body of literature highlights the heightened interest among financial institutions in comprehending biodiversity-related risks and their implications across the economic and financial landscapes. Central banks and supervisors have been frontrunners in investigating biodiversity and nature risks,

([30]) EC (2020). Establishment of a framework to facilitate sustainable investment, amending Regulation (EU) 2019/2088.

([31]) EFRAG (2022). ESRS E4 Draft: Biodiversity and Ecosystems.

([32]) European Parliament (2023) adoption of Regulation (EU) 2023/... of the European Parliament and of the Council of European Green Bonds and optional disclosures for bonds markets as environmentally sustainable and for sustainability-linked bonds.

([33]) Dasgupta (2021) The Economics of Biodiversity: The Dasgupta Review Headline Messages.

and the transmission channels that connect them to the financial system ([34]) ([35]) ([36]) and in their supervisory framework. Most recently, the European Central Bank (ECB) conducted an in-depth assessment of the risk exposure within euro area banks held portfolios: the findings showed that 72% of non-financial corporations are highly dependent on at least one ecosystem service and that 75% of corporate bank loans in the euro area are granted to corporations with a high dependency on nature services ([37]). The study investigates in detail key transmission channels as well as conducting sensitivity analyses to gain a deeper understanding on different environmental scenarios impacts. In addition, the ECB has set the addressing of climate and biodiversity risks within their supervisory priorities for 2022 – 2024 ([38]).

In parallel, a number of new international principles for more sustainable investment and decision making are evolving at the moment. The Principles for Responsible Banking (PRB) encourage banks to align their strategies with the Sustainable Development Goals (SDGs), including those related to biodiversity protection ([39]). The UN Principles for Responsible Investments set guidelines to encourage investors to incorporate environmental, social and governance (ESG) factors into their investment decisions ([40]). However, need for further awareness and understanding of individual risk exposure, transmission channels and mitigation opportunities is increasingly being recognized by financial institutions ([41]) ([42]) ([43]).

1.2. Evolving risk assessment landscapes: adding nature to climate

Prior to 2014, financial institutions did not consider climate change impacts in their business decisions – by 2020 every major institution is using climate change predictions in their forward-looking approaches and integration of climate-risk assessments into

([34]) Svartzman et la (2021). A silent spring for the financial system? Exploring biodiversity-related financial risks. Banque de France: https://publications.banque-france.fr/en/silent-spring-financial-system-exploring-biodiversity-related-financial-risks-france.

([35]) Elderson (2023). The economy and banks need nature to survive. Available here: https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230608~5cffb7c349.en.html

([36]) DNB - The Sustainable Finance Platform (2020). Biodiversity opportunities and risk for the financial sector. Platform voor Duurzame Financiering. Available at: https://www.dnb.nl/media/cy2p51gx/biodiversity-opportunities-risks-for-the-financial-sector.pdf

([37]) ECB (2023). Occasional Paper Series: living in a world of disappearing nature: physical risk and the implications for financial stability. Available at: https://www.dnb.nl/media/cy2p51gx/biodiversity-opportunities-risks-for-the-financial-sector.pdf

([38]) ECB (2022) Banking Supervision – Supervisory priorities for 2022-2024. Available at: https://www.bankingsupervision.europa.eu/banking/priorities/html/ssm.supervisory_priorities2022~0f890c6b70.en.htmll

([39]) UNEP-FI (2022). Principles of Responsible Banking Guidance.

([40]) UN PRI. Available here: https://www.unpri.org/about-us/what-are-the-principles-for-responsible-investment

([41]) AXA (2023). AXA IM Stewardship Report 2022.

([42]) BNP Paribas Asset Management (2022). Sustainable by Nature Sequel: Our portfolio biodiversity footprint.

([43]) Cherief et al (2022). The Market Effect of Acute Biodiversity Risk: The Case of Corporate Bonds. Available at SSRN

financial institution's decision making is standard, exemplified by the work of the Network for Greening the Financial System (NGFS) and the Task Force on Climate-related Financial Disclosures (TCFD). The NGFS has been spearheading the integration of climate and environmental risks into banking supervisory, with numerous publications that cover guidelines for banks to take actions as well as informative climate scenario assessments that provide insights into macroeconomic and financial stability ([44]). The TCFD has been adopted by the Financial Stability Board (FSB) as their industry standard, which has helped propel the common implementation of the framework. Despite the initial efforts by the NGFS ,and the growing acknowledgment of the importance of nature loss to the investment portfolios and assets of financial institutions, nature-related financial risks assessment approaches have only recently gained the attention from the financial sector. ([45]) It is therefore, that climate change risk assessment approaches are often used as a basis to develop the nature-related ones. This can be seen in the Taskforce of Nature-related Financial Disclosure (TNFD) framework, which currently sets the gold-standard for nature-related risk assessments for financial institutions. The TNFD has taken the approach to categorising nature and biodiversity risks has been to frame them in, and by building on, the terminology used for risks related to climate change. However, differences and conflicting interests between nature and climate risks remain, which challenge the one-to-one transfer of the climate risk-framework to nature equivalents.

However, it is important to enhance our understanding of the interaction between climate change and nature loss as they are interconnected and mutually reinforcing challenges. Climate change stands as one of the five primary drivers of biodiversity loss and is projected to exert an even stronger influence in the future. The climate-biodiversity nexus is based on complex interlinkages with possible negative trade-offs, with major implications on ecosystem and climate-system functions. For example, while solar and wind power are considered climate friendly, the construction of these large-scale farms can have negative impacts on local ecosystems and wildlife ([46]). While some climate adaptation and mitigation measures can harm nature, other climate mitigation (i.e. carbon sequestration) and adaptation (i.e. flood protection) measures have the potential to contribute to restoring nature ([47]). Hence, biodiversity and climate related risks directly interact and affect the associated financial risks that are addressed under each realm ([48]), It is therefore important that we move towards a comprehensive approach that can encompass the relation between biodiversity and climate risk, and present a holistic overview of the potential risks, their interactions and ultimately the full extent of their impact.

([44]) NGFS (2020). Guide for Supervisors: integrating climate-related and environmental risks into prudential supervision.

([45]) Finance for Biodiversity (2021). The ClimateNature Nexus Implications for the Financial Sector

([46]) Dhar et al. (2020). Perspectives on environmental impacts and a land reclamation strategy for solar and wind energy systems. Science of the total Environment, 718.

([47]) IPCC (2022). Sixth Assessment Report: Climate change – Impacts, Adaptation and Vulnerabilities.

([48]) NGFS and INSPIRE (2022). Occasional paper: Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability.

In light of these linkages, the approach taken in this report is to develop a methodological framework which leverages and builds on current best practice and existing framework regarding climate risk assessment used in the financial sector, while augmenting these with specific considerations and additional elements required to robustly assess financial risks from biodiversity loss. Climate risk frameworks and guidance are an advantage starting point for developing a framework adaptable to biodiversity and nature for several reasons. For example, risk categorizations (e.g., physical and transition risks) are broadly consistent across climate and nature. Additionally, as discussed above, there are multiple interactions between climate and nature that require an integrated approach to the climate and nature transition. Finally, financial institutions have already established risk management processes for climate. Therefore, constructing a framework familiar to financial institutions will make it easier for these institutions to integrate biodiversity and nature assessments into existing processes.

1.3. Assessing nature related risks for diverse financial institutions

Understanding the crucial role of natural capital in driving economic growth and recovery, this study delves into the financial risks associated with biodiversity loss and ecosystem degradation. Given the increasing interdependencies between nature and the economy, the financial sector plays a pivotal role in supporting the Green Deal's objectives and the EU's ambitions to a sustainable economy and society. As the bedrock of our economy, natural capital requires diligent protection to mitigate risks and foster sustainable growth. Building upon the EU's sustainable finance framework, this study sets out to assess and understand the potential financial consequences of biodiversity loss and ecosystem degradation.

At present, while strides have been made in identifying and managing climate-related financial risks, a comprehensive approach to biodiversity and ecosystem-related financial risks is still in its nascent stages. However, throughout the course of this study the rate at which new research publications are released – at institutional as well as international organizational level – indicate that the momentum for considering and incorporating nature and biodiversity risks in financial decision making is continuously increasing. This study aims to contribute to ongoing endeavors to bridge the knowledge gap by evaluating existing practices for risk identification, measurement, and management by financial institutions, market participants, and supervisors and **developing a framework for assessing financial risks from nature and biodiversity that is applicable to a broad range of financial institutions.**

This requires an understanding of how different types of financial institutions might affect the nature-related risks to which they could be exposed. The following section focuses on how factors such as the size, operations and types of assets affect the nature-related risks to which they could be exposed. This informs specific recommendations for different types of financial institutions, as well as the design of the overall framework.

This study focuses on nature-related risks faced by four main types of private financial institutions. The institutions are defined below:

1. **Banks** – financial institutions licensed to receive deposits and make loans ([49]).
2. **Asset managers** – financial institutions that manage the assets of their clients, making investment decisions based on each client's investment strategy, risk tolerance and financial situation. ([50])
3. **Asset owners** – financial institutions that manage investments on behalf of participants, beneficiaries, or the organisation itself. Asset owners include pension funds, endowments and sovereign wealth funds. ([51])
4. **Insurers** – financial institutions that agree to compensate people, companies or other organisations for specific financial losses ([52])

Differentiation in how these institutions may be exposed to potential risks from nature and biodiversity are driven by six factors. These factors are core determinants of the extent to which physical or transition risks may affect these organisations in the EU. These include:

- Core function/Business model
- Geographic exposure
- Company size and industry concentration
- Types of assets held
- Sectoral diversification
- Time horizon considered

In the following sections, we explore how these factors influence the nature-related risks faced by various types of financial institutions.

The EU financial sector is a concentrated industry, implying institutions may be exposed to similar levels of nature-related risk. The insurance market is dominated by a few large multinational companies ([53]), whilst the asset management industry is

([49]) Adapted from Investopedia (2023). How Banking Works, Types of Banks, and How To Choose the Best Bank for You. Available at: https://www.investopedia.com/terms/b/bank.asp

([50]) AssetMetrix. What is Asset Management? Available at: https://www.asset-metrix.com/en/asset-management-definition/

([51]) CFA. GIPS Standards for Asset Owners. Available at: https://www.gipsstandards.org/standards/gips-standards-for-asset-owners/

([52]) Adapted from Insuranceopedia (2016). What Does Insurer Mean? Available at: https://www.insuranceopedia.com/definition/384/insurer#:~:text=What%20Does%20Insurer%20Mean%3F,organizations%20for%20specific%20financial%20losses.

([53]) Yahoo Finance (2023). 15 Biggest European Insurance Companies. Available at: https://finance.yahoo.com/news/15-biggest-european-insurance-companies-194251672.html#:~:text=According%20to%20PwC%2C%20the%20insurance,in%20the%20past%20four%20years.

becoming increasingly concentrated. ([54]) Furthermore, small and medium-sized banks represent less than 20% of the euro area banking sector in terms of assets. ([55]) Large multinational financial institutions (across types) are therefore likely to share exposure to some of the same nature-related risks, as they are interconnected and serve similar sectors and clients. However, there are exceptions, with small and medium banks (2,400 as of 2020) existing across the EU ([56]). The high concentration of financial institutions highlights the need to consider the interconnectedness of institutions, and to examine risks in sectors where many institutions have high levels of exposure.

All four types of financial institutions are likely to be exposed to international nature-related risks, due to their global reach. European banks account for half of global banking assets and typically have internationally diverse lending portfolios. ([57]) Similarly, European reinsurers account for 50% of the world's reinsurance. ([58]) Asset managers and asset owners typically have portfolios consisting of debt and equity in large multinationals and, in cases where risk appetite is higher, may hold assets in developing countries. The geographic diversity of financial institutions' exposure implies most EU financial institutions face potential exposure to nature-related risks outside the EU. Some institutions, local or national banks, which sometimes have a history of lending to specific sectors (like agriculture) may have exposure concentrated in nature-related risk within the EU.

Banks are primarily exposed to nature-related credit risk and reputational risk primarily due to their corporate lending portfolio. One of the core functions of a bank is to provide loans to businesses, exposing them to credit risk through financing industries dependent on nature - the ECB estimates that 75% of bank loans within the EU are to firms that depend on ecosystem services ([59]). Banks with greater exposure to industries which heavily impact or depend on nature, such as mining and agriculture, are likely to face the highest risk. For example, companies in the mining sector may face higher litigation risk and relocation costs as a result of laws introduced to protect biodiversity, such as protected area legislation, which in turn could lead to higher loan default rates. Additionally, the financing of companies or industries associated with negative impacts on nature can create reputational risk for banks, which may affect their funding, both through deposits and capital markets.

([54]) Banking hub by zeb (2020). Asset Management 2020 – insights into the European Asset Management Study. Available at: https://www.bankinghub.eu/research-markets/asset-management-2020-study

([55]) ECB (2020). Taking the pulse of small and medium-sized banks in Europe. Available at: https://www.bankingsupervision.europa.eu/press/publications/newsletter/2020/html/ssm.nl200212_4.en.html

([56]) ECB (2020). Taking the pulse of small and medium-sized banks in Europe. Available at: https://www.bankingsupervision.europa.eu/press/publications/newsletter/2020/html/ssm.nl200212_4.en.html

([57]) EBRD (2014). Europe's banking union in the global financial system: constructing open and inclusive institutions. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3121082

([58]) Insurance Europe. Statistics. Available at: https://www.insuranceeurope.eu/statistics

([59]) ECB (2023). Occasional Paper Series: living in a world of disappearing nature: physical risk and the implications for financial stability. Available at: https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op333~1b97e436be.en.pdf?90e7aaae4ef927f887a787587a22adba , https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230608~5cffb7c349.en.html

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Asset managers and asset owners tend to be globally and sectorally diversified, which may limit potential exposure. These financial institutions hold a variety of corporate bonds and listed equities, with European asset managers holding €7.0 trillion and €6.6 trillion in debt securities and listed equities, respectively. ([60]) These institutions will be primarily affected by nature-related risks that affect the valuations of assets they invest in. For example, policy and legal risks may increase the cost of complying with regulation designed to protect nature and biodiversity, leading to lower actual or projected profits for exposed companies. This may in turn lead to a drop in the price of equities or corporate debt. Asset managers and asset owners will face risks in sectors directly exposed to specific nature-related (like agriculture), but could also be particularly exposed to the impact of risks in supply chains, which affect a broader set of downstream companies where they have significant exposure, like consumer goods companies. For instance, if prices of raw materials and goods increase as a result of an acute physical risk, such as crop losses due to pest outbreak, the effects of nature-related risks could be felt by a much wider set of financial institutions.

Insurance companies may be particularly exposed to the impact of physical risks, in addition to litigation risks. As providers of insurance against hazards, including physical hazards, insurance companies are exposed to the impact of acute and chronic physical risks. For example, agricultural insurance payments may increase due to a long-term decline in agricultural productivity (due to factors such as soil erosion and the loss of pollination services[61]) and the impact of increased frequency of extreme weather events on crop losses. ([62]) Additionally, insurers that underwrite certain types of liability risks may be exposed to damages paid by insured entities failing to comply with nature-related legislation. These risks could stem from both within and outside of the EU, highlighting the need for an understanding of nature-related risks internationally and how these risks can be transferred across border through value chains. Potential losses in the value of financial assets as a result of nature-related risks could also affect insurers. Insurers invest their technical reserves in financial assets at risk and could experience reduced ability to face indemnification requests.

In this report, we provide a comprehensive overview of the current frameworks for biodiversity and ecosystem risk identification, measurement and management of these, and existing gaps. Thereafter, we delve deeper into industry and business sectoral sensitivity. We provide an overview of all main sectors at risk, contextualizing it to the EU financial market and provide an overview of the main drivers and channels of transmission. These outputs provide the basis for the first draft outline of the methodological framework for financial institutions to assess their biodiversity related risks (Task 3).

The ultimate aim of this study is to contribute to increasing the resilience of the European financial sector against the challenges posed by environmental degradation and biodiversity loss. By undertaking this comprehensive analysis, the

([60]) EFAMA (2022). EFAMA Asset Management Report 2022. Available at: https://www.efama.org/newsroom/news/efama-asset-management-report-2022

[61] IEEP (2022). Environmental degradation: impacts on agricultural production. Available at: https://ieep.eu/wp-content/uploads/2022/12/Policy-brief_Environmental-degradation.-Impacts-on-agricultural-production_IEEP-2022.pdf

([62]) European Parliament (2023). The impact of extreme climate events on agricultural production in the EU. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2023/733115/IPOL_STU(2023)733115_EN.pdf

study seeks to contribute to the establishment of a sustainable and resilient financial sector that proactively addresses the risks posed by environmental degradation and biodiversity loss.

This study differs from, but remains complementary to, a recent OECD study ([63]) since it focuses on a broader range of financial institutions. The OECD framework is "a four-step approach to help central banks, financial supervisors, as well as commercial banks, identify and prioritise, conceptualise and assess nature-related financial risks." This study provides a framework designed to be applicable to a broader range of private financial institutions, including also asset managers, asset owners and insurers.

(63) OECD (forthcoming). A methodological supervisory framework for financial risks stemming from biodiversity-related losses: A prudent approach to nature

2. Task 1 - Understanding the types of risks associated to ecosystem/biodiversity loss

2.1. Introduction

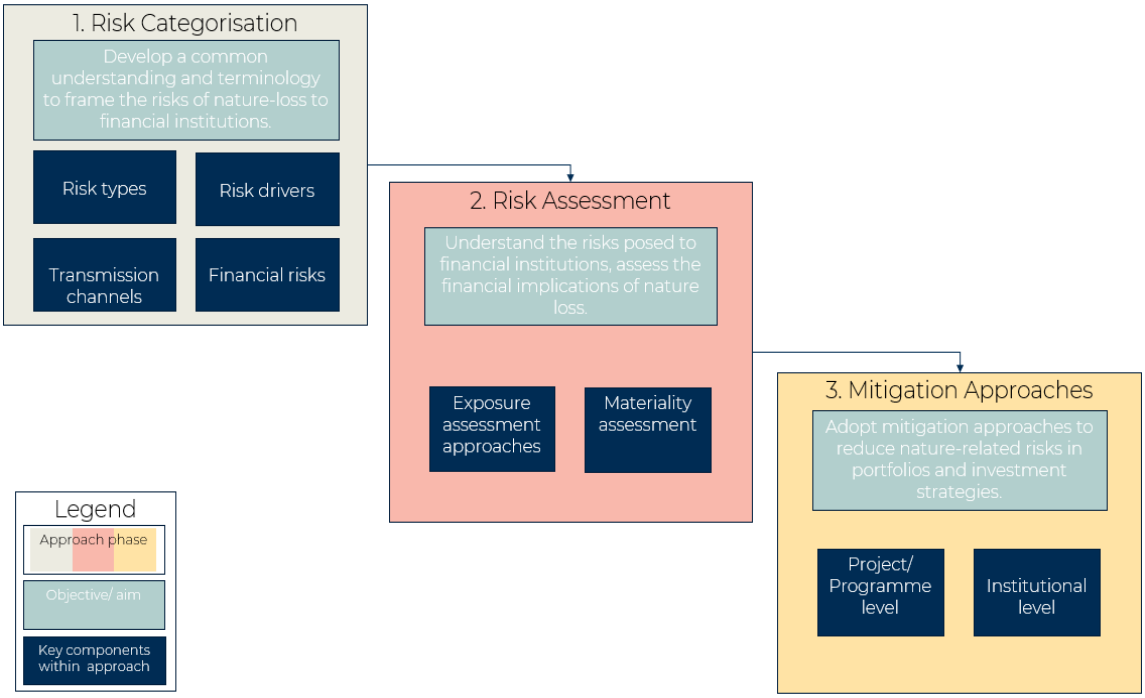
Chapter 2.1 establishes the key definitions, understandings and methodological approaches that shape the development of Task 1 overall. Before diving into each methodological phase, which financial institutions are required to undertake to understand nature-related risks posed to their portfolios/assets, this chapter presents an overview of what these methodological phases are, their objectives, and the key components within each approach. Figure highlights these phases, which can be used as a reference point for the remainder of Task 1.

As the global financial landscape evolves, the imperative of comprehending and addressing environmental risks becomes increasingly evident. Task 1 of this report serves as the cornerstone for exploring nature-related risks within the financial sector: it seeks to create a common language and understanding of nature-related risks to financial institutions, leaning on the myriad of terms currently in use to depict the types of risks present, what drives these, and how these risks transmit into financial risks for these institutions. The aim is to gain a comprehensive understanding of the financial risks relevant to financial institutions and their stakeholders. By establishing a common understanding and terminology, this chapter provides the essential groundwork for subsequent risk frameworks.

The chapter begins with establishing common terminology and concepts which underpin these sequential steps from risk to financial impacts. An overview of the methodological approach to arrive at a common language and risk framework is presented. Central to the endeavors of Task 1 is to decipher the multifaceted pathways through which nature-related risks translate into financial impacts. The intricate web of dependencies between nature, biodiversity, and financial institutions necessitates a methodological approach that is both comprehensive and adaptable. This chapter offers an overview of the methodological foundations, guiding readers through the process of dissecting the intricate layers of risk and impact. Furthermore, the holistic exploration of nature-related risks extends beyond mere identification to proactive risk mitigation strategies. Task 1 delves into the array of tools, data sources, and considerations that are instrumental in comprehending the intricate relationships between financial institutions and the natural world.

In essence, Task 1 serves as the bedrock upon which the subsequent tasks are built. It underscores the importance of establishing a baseline understanding of nature-related risks within the broader financial risk framework.

Figure 2-1 The broad methodological phases outlined in Chapter 2, the objectives of each phase, and the key components within each phase



2.1.1. Key definitions

A number of aspects are required to be clarified for the purpose of this study prior to presenting the analysis in the sections below. The study focusses on **nature-related** risks rather than *biodiversity-related risks* in order to encompass ecosystem structure and functioning in addition to the living organisms within these systems (i.e. biodiversity). ([64]) Specifically, nature-related *risks* are defined as the potential threats posed to financed activity linked to its dependencies and wider society's dependencies on nature and nature impacts. ([65])

This study focusses in particular on nature-related risks posed to financial institutions. A key concept in this regard is **materiality.** This outlines how nature can affect the financial performance of such institutions, and vice-versa how their respective activities can impact nature ('double materiality'). In simple terms, this outlines the **impacts** and **dependencies** on and of nature. Linked to this terminology, **natural capital** and **ecosystem services** can be used as terms to frame the stock of renewable and non-renewable natural resources ([66]) and flow of benefits which stem from these stocks, ([67])

([64]) IPBES (n.d.) 'nature' and 'biodiversity'. Available at: https://www.ipbes.net/glossary/nature; and, https://www.ipbes.net/glossary/biodiversity

([65]) TNFD (2022) The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.3 Annex 3.1 Guidance on the Assess Phase of LEAP. ; this report acknowledges that mitigating negative impacts on nature from activities, or conducting nature-positive activities are acknowledged as creating potential opportunities for actors

([66]) Capitals Coalition (2016) Natural Capital Protocol

([67]) IPBES (n.d.)'Ecosystem services'. Available at: https://www.ipbes.net/glossary/ecosystem-services

respectively. Here, it is key to also introduce the theory of **tipping points**. This refers to a set of (ecological or social) conditions where further distress will cause rapid change and prevent the system from returning to its former state. ([68]) It is imperative for financial institutions to understand how their investments impact nature, particularly with much of global biodiversity currently on a trajectory to reach many of these tipping points in the near future.

Numerous key terms and concepts are used repeatedly throughout this study, yet below captures the predominant aspects which are important to outline from the outset:

Ecosystem condition- The quality of an ecosystem measured by its abiotic and biotic characteristics. Condition is assessed by an ecosystem's composition, structure and function which, in turn, underpins the ecological integrity of the ecosystem, and supports its capacity to supply ecosystem services on an ongoing basis. ([69])

Ecosystem function- The flow of energy and materials through the biotic and abiotic components of an ecosystem. This includes many processes such as biomass production, trophic transfer through plants and animals, nutrient cycling, water dynamics and heat transfer. ([70])

Nature-positive- a future state of nature which is greater than the current state, ([71]) or whereby actions are undertaken at scale to reduce and remove the drivers and pressures fueling the degradation of nature, actively improving the state of nature (natural capital) and the ecosystem services it provides. ([72])

Nature-related opportunities- when financial institutions/ organisations avoid, reduce, mitigate or manage nature-related risks, or strategically transform their business models, products, services, markets and investments that actively work to reverse the loss of nature. ([73])

Nature-related risk- Potential threats posed to an organisation linked to its and other organisations' impacts and dependencies on nature. These can derive from physical and transition risks. ([74])

([68]) IPBES (n.d.) 'Tipping point'. Available at: https://www.ipbes.net/glossary/tipping-point

([69]) UN SEEA (2021) System of Environmental-Economic Accounting - Ecosystem Accounting: Final Draft

([70]) IPBES (2019) The global assessment report on biodiversity and ecosystem services

([71]) See TNFD (2023) Glossary of key terms. Available at: https://framework.tnfd.global/appendix/glossary-of-key-terms/

([72]) University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification

([73]) TNFD (2023) Glossary of key terms. Available at: https://framework.tnfd.global/appendix/glossary-of-key-terms/

([74]) CDSB (2021) Framework application guidance for biodiversity-related disclosures

2.1.2. Methodology outline

In order to develop the risk typology formulated in this report, two predominant methodological steps were undertaken: 1) a comprehensive literature review, and 2) stakeholder consultations. Each are described in detail below.

The literature review, as a first step, sought to identify documentation of relevance to the project- with a focus on biodiversity (financial) risk, assessment approaches, risk typologies and frameworks, and nature-related impacts and dependencies measurement approaches. In doing so, approximately **100 sources** were located.

Each of the sources were briefly scanned, with an abstract/summary of the source developed. From the initial brief-scan, it became apparent that few documents were commonly cross-referenced in terms of the formulation of nature-related risk frameworks. In particular, the TNFD typology was identified as being at the forefront of biodiversity financial risk framing. ([75])As such, the typology of risks from the TNFD was used as a 'baseline'.

The 'baseline' was used to frame the literature review analysis- providing a comparison point whilst also facilitating the categorization of data found within documentation. The baseline is further introduced in Chapter 2.2 below.

With the framework and baseline developed, literature was inserted into an excel tool. The tool was developed with a primary purpose of identifying which literature significantly differed in the framing/categorizing of nature-related risks. This identification would then be used for further analysis- so that the baseline could be continually assessed, differentiation noted, and any changes in the baseline then made. Variations in categorization/definitions were ranked- to allow easy identification of which publications offered contrasting interpretations. Using the tool, summaries of the main divergence points were developed, which could then be used as building blocks for the analysis presented in Chapter 2.2.

Complementing this approach, a series of interviews with **key stakeholders** were undertaken. 'Key stakeholders', for the purpose of this study, were organisations/institutions/entities involved in the development and/or implementation of nature-related risk frameworks or methodologies to understand risks. This included central banks, NGOs, industry (associations), asset owners, and others (including partnerships, such as: the Taskforce on Nature-related Financial Disclosures (TNFD), United Nations Environment Programme Finance Initiative (UNEP FI), and intergovernmental organisations such as the Organisation for Economic Co-operation and Development (OECD)). As outlined, these organizations represented a diverse range of stakeholder types, but they were also chosen based upon their involvement in recent key documents which aligned to the objectives of this study.

Consultations focused on several key discussion points:

([75]) Consultations outlined that the TNFD is a consolidation of multiple frameworks and terminologies used in a range of other documentation and is therefore seen as the most comprehensively aligned typology

- Sources of information which informed the development of frameworks/terminology to define and understand the financial risks posed by nature loss;
- Views on the risk categorisation formed in this study's analysis;
- Approaches and methodologies undertaken to identify, understand and quantify these risks;
- Data sources and metrics used to inform risk assessments (and identification of any significant data gaps);
- Approaches by organisations/institutions/entities to mitigate identified nature-related financial risks.

The outputs from interviews were documented and then used to refine the synthesis of information presented in Chapter 2.2 below.

2.2. Risk categorization

This chapter aims to systematically categorize and define key components of risk and set a common understanding regarding terminology surrounding nature-related risks.

Four key risk-related definitions were identified within literature and through consultations: risk type, risk driver, transmission channels, and financial risks. Each of these components contain various sub-components, which are assessed and defined, allowing the reader to finish Chapter 2.2 with a clear understanding of the terminologies and categorization of nature-related risks and how they propagate to potentially impact financial institutions.

Our assessment indicates that many of the nature-related risk terminologies and frameworks build upon those already developed for climate-related risk. Through the literature sources identified and reviewed, very few points of deviation occur when framing nature-related risk terminology. However, one key consideration, which is treated differently in literature, is the notion of *systemic risk*. This factor is often not included due to the lack of data/agreed upon methodological approaches to understand the complexity of such issues. We follow this approach and do not propose to include systemic risk as a self-standing risk type. However, we suggest to take account of the systemic dimension of risk propagation in the actual implementation of the risk framework through a forward-looking analysis of risks and drivers, as well as to continue research work on methodological approaches to be able to capture systemic risks in the future

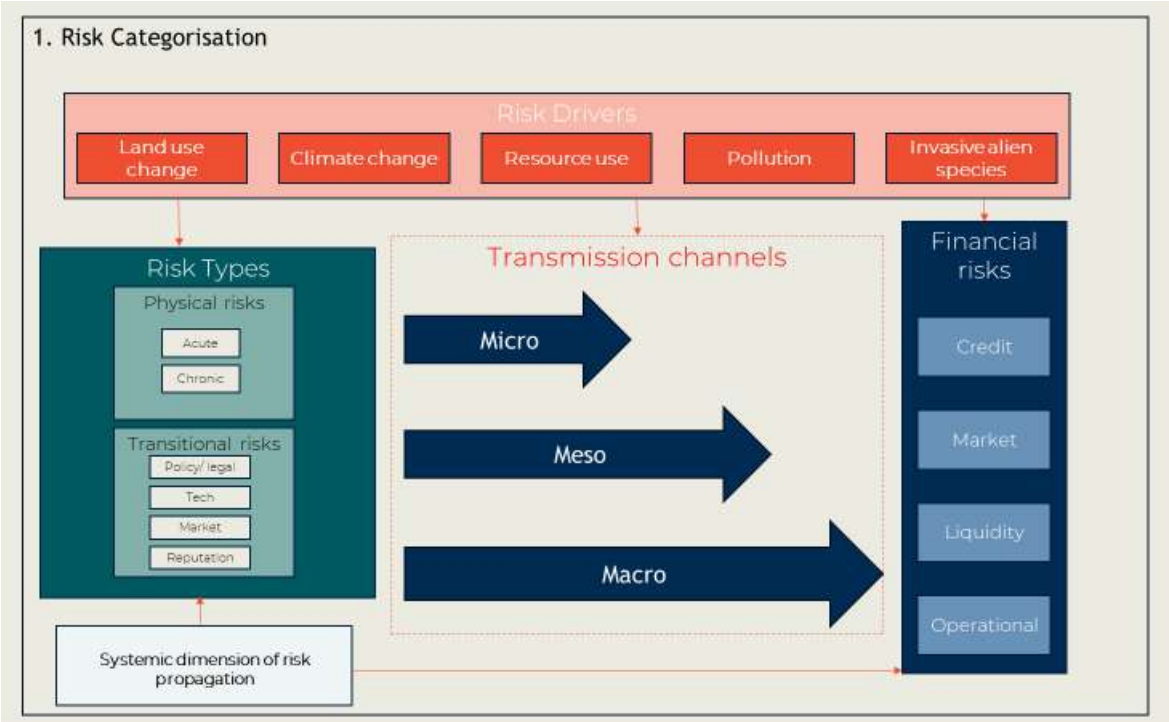
As noted in the methodology outline above, a key point of origin for the risk categorization was the formulation of a baseline. The baseline was used as a comparison point-allowing for an assessment to be made of the key similarities and departure points found within literature on how nature-related risk is categorized. A starting point for this formulation was the development of a **framework.** The overall framework was developed by this study, through the synthesis of key documentation identified during the literature review. As captured in Figure below, a series of key **elements** of a nature-related risk typology are shown. Here, the baseline was used as to frame each of these elements.

The exercise categorized the following baseline elements of the nature-related risk typology:

1. **Risk driver**- depicting the direct factors which are (negatively) influencing nature and causing changes to biodiversity and ecosystems (i.e. pressures).
2. **Risk type**- noting the forms of potential risk posed to organisations and institutions, stemming from their impacts and dependencies on nature.
3. **Risk category**- further breaking down 'risk types' into sub-categories to outline the specific manner in which potential risks can negatively threaten organisations/institutions.
4. **Transmission channels-** categorizing the manner in which nature-related dependencies and impacts transmit to impact the organization or financial institution. These channels outline the causal linkage between risk drivers and financial risks. Such channels can be micro (organization/entity level), meso (sectoral) or macro (system-wide).
5. **Financial risk-** outlining the broad range of risks stemming from impacts on earnings and cashflow due to nature loss.

A key focal point of the figure are the transmission channels, which intersects financial institutions impacts and dependencies on nature, with real financial impacts. Many of these channels create feedback loops between nature, the economy and financial systems which are significantly challenging to understand and quantify, and can impact at various magnitudes. As such, given this complexity, and rather nascent stage of understanding, Chapter 2.3 highlights some of the challenges faced, the assessment approaches possible to use, and the key gaps/needs.

Figure 2-2 Overview of nature-related risk framework



2.2.1. Risk drivers

Risk drivers categorise the key drivers of nature loss, both natural and human-induced. Such drivers, in-turn, impact the benefits we obtain from nature (ecosystem services), which can ultimately impact people, society and the economy. ([76])

Literature shows a divergent picture when it comes to classifying risk drivers. While early publications only refer to singular (e.g. physical depletion, climate change) or a low number of risk drivers (e.g. climate change and land use change), there has been greater convergence around the five direct drivers as defined in the IPBES Global Assessment Report on Biodiversity and Ecosystem Services that unequivocally influence biodiversity and ecosystem processes: land use change, climate change, pollution, nature resource use and exploitation, and invasive species ([77]). Some publications also capture opportunities, as well as risks, include the contrapositives replenishment, pollution removal and IAS removal.

Within the context of this report, we would classify the risk drivers ([78]) into the categories land use change, climate change, pollution, resource use and invasive alien species, which also align with the five drivers highlighted in the EU's Biodiversity Strategy, and coincide with the EEA's findings in its 2020 State of Nature report ([79]) (see figure below). Risk drivers are interconnected and the presence of several exacerbate negative effects on biodiversity, which can be demonstrated by water use as an example: resource use in itself can lead to water scarcity, aggravated through increased temperatures and droughts caused by climate change, or modified water courses through the expansion of urban areas.

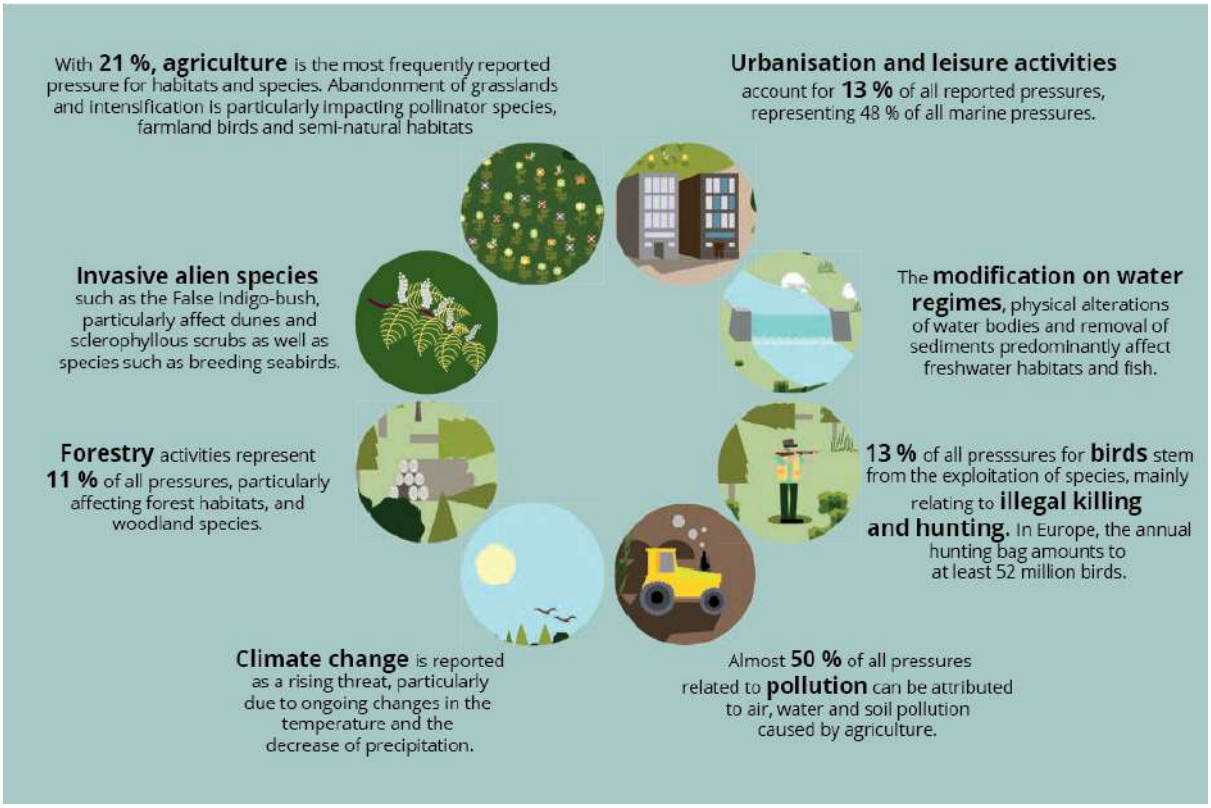
([76]) IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

([77]) IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

([78]) This report only focuses on risks and not opportunities, hence resource replenishment, pollution removal and IAS removal have not been further considered.

([79]) EEA (2020) State of Nature in the EU. Report No. 10/2020. European Environment Agency.

Figure 2-3 - Causes of biodiversity loss: land use change (urbanisation, agriculture, modification on water regimes), climate change, pollution, resource use (agriculture, forestry, exploitation of species), invasive alien species



Source: EEA State of Nature 2020 report

Risk driver 1: Land use change (terrestrial and marine/aquatic)

The IPBES report summarises land use change as the major human influence on habitats which can include the conversion of land cover (e.g. deforestation or mining), changes in the management of the ecosystem or agro-ecosystem (e.g. through the intensification of agricultural management or forest harvesting, or through expansion of economic activities into protected areas) or changes in the spatial configuration of the landscape (e.g. fragmentation of habitats). Land use change has hence been a major driver for loss of biodiversity and ecosystem services in the last half century, in particular for terrestrial and freshwater ecosystems.

Risk driver 2: Climate change

Temperature changes and more frequent extreme weather events caused by climate change have a major effect on biodiversity, and can be the reason for the migration of species and of entire ecosystem, and even for species extinction. The IPCC in its most

recent synthesis report ([80]) warns from biodiversity loss in land, freshwater and ocean ecosystems, and a decrease in food production in some regions associated with climate hazards in the near-term. Species extinction or irreversible biodiversity loss is in particular expected in forests, coral reefs and in Arctic regions.

Risk driver 3: Resource use

Overexploitation of natural resources leads to the extinction of species (affecting in particular marine species), and to biodiversity loss at a major scale such as through deforestation. Deforestation in turn negatively impacts the capacity of the planet to absorb CO_2, aggravating further the impacts of climate change. However, natural resources are an input factor for many production processes, such as agriculture, fisheries and mining. Hence resource depletion is a driver that can deprive important economic sectors of their input and can even lead to the full breakdown of the sector.

Risk driver 4: Pollution

Pollution is a key driver of biodiversity loss and has a harmful impact on our health and environment. It is caused through the release of nutrients, chemical pesticides, pharmaceuticals, hazardous chemicals, urban and industrial wastewater, and other waste including litter and plastics. Significantly, nitrogen deposition is one of the most important threats, even at global level ([81]), causing through eutrophication 'dead zones' where no aquatic life is no longer possible.

Risk driver 5: Invasive alien species

'Invasive alien species' means an alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services. Like highlighted in the EU Biodiversity Strategy, many such species also facilitate the outbreak and spread of infectious diseases. Of the 1,872 species now considered threatened in Europe, 354 are under threat from invasive alien species.

2.2.2. Risk types

A range of risks are posed to financial institutions from nature loss. The majority of literature reviewed converges on the view of categorizing risk as either a ***physical risk*** or a ***transition risk***. Further differentiations exist but are few. Literature that focuses on legal or reputational risk would for example include further, sometimes separate

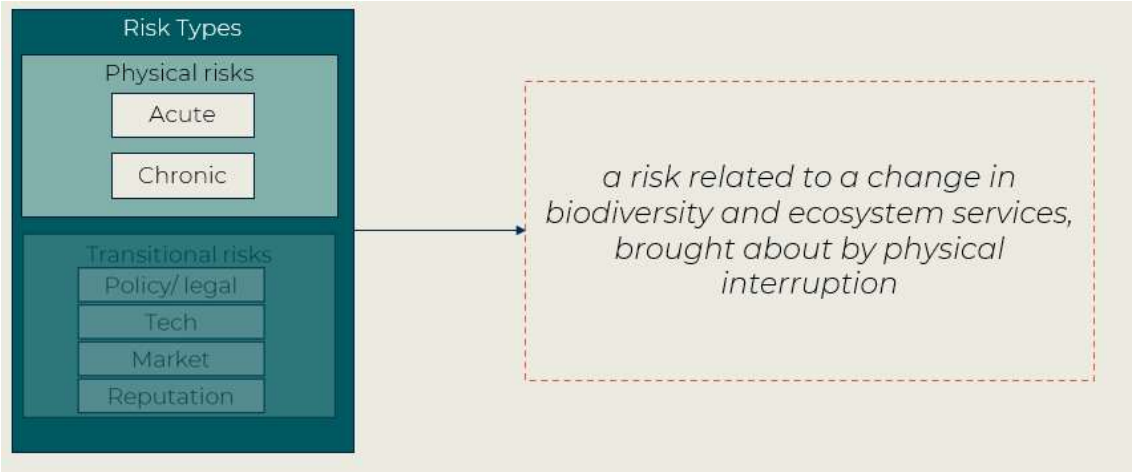
([80]) IPCC (2023) Synthesis report of the IPCC sixth assessment report (AR6). Summary for Policy Makers. Available at: https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_SPM.pdf

([81]) IPBES (n.d.) Models of drivers of biodiversity and ecosystem change. Available at: https://www.ipbes.net/models-drivers-biodiversity-ecosystem-change

categories such as liability or litigation risk ([82]) ([83]) ([84]). However, this report considers this as a sub-category within transition risks.

Below is thus a full description of the suggested classification and related examples:

Figure 2-4 Definition of physical risk ([85])



Physical risks can arise due to natural events/changes (climatic- such as weather extremes, geologic- such as seismic events) ([86]) or human-induced conditions, ([87]) causing ecosystem equilibria to be damaged and degrading ecosystem services. ([88]) This type of risk affects in particular sectors that are highly dependent on biodiversity assets as input to their production processes, for example agriculture. But also other sectors can suddenly be at risk, such as real estate development in an area devastated by a land slide as a consequence of soil degradation and erosion. Physical risks can be further sub-categorised as *acute* or *chronic*. ([89]) Acute physical risk describe event-driven impacts which result in sudden consequences (e.g. an earthquake or the spread of a disease due to invasive species). ([90]) Chronic physical risk describes a situation

([82]) Commonwealth Climate and Law Initiative (2020). The emergence of foreseeable biodiversity-related liability risks for financial institutions: A gathering storm?

([83]) NGFS - INSPIRE (2022). Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability.

([84]) OECD (2023). Assessing biodiversity-related financial risks: Navigating the landscape of existing approaches.

([85]) For example: DNB (2020) Indebted to nature. De Nederlandsche Bank; OECD (2023). Assessing biodiversity related financial risks: Navigating the landscape of existing approaches; WWF (2023) WWF Biodiversity Risk Filter Methodology Documentation

([86]) University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification.

([87]) WWF (2023) WWF Biodiversity Risk Filter Methodology Documentation

([88]) University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification

([89]) For example: NGFS - INSPIRE (2022). Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability; Global Canopy and Vivid Economics (2020) The Case for a Task Force on Nature-related Financial Disclosures; University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification.

([90]) University of Cambridge Institute for Sustainability Leadership (CISL, 2021). Handbook for nature-related financial risks: key concepts and a framework for identification. OECD (2023). Assessing biodiversity related financial risks: Navigating the landscape of existing approaches.

where such interruptions happen over time with its effect slowly accumulating (e.g. chemical pollution through wastewater discharges).

Figure 2-5 Definition of transition risk ([91])

Transition risk describes a risk related to changing (external) circumstances. Such changes could be due to new **or emerging policies, legislation** or **technology**, but also stemming from changes in (consumer) **demand** or from an alteration in **public perception** for certain products. As such, transition risks are mainly a reaction to an entities impact on nature. These numerous transition risks are often intrinsically interlinked, and can also link to the aforementioned physical risks. As an example- the introduction of stringent regulation to tackle land use changes (for example, which negatively impact biodiversity and physical assets reliant on a functioning ecosystem) can not only impact a commodity provider through restrictions on their production processes, but also through changes in consumer demand due to negative connotations on the products provided by organisations. ([92]) Often economic activities which are highly dependent upon fully-functioning, intact nature are likely to be exposed to greater physical risks. In turn, the greater expected risks become, a stronger need for changes in policy/legislation/technology/demand becomes- ultimately causing increased transition risks. ([93])

Public policy is hence a key determining factor for assessing potential future transition risks, and whether or not public policy would disrupt traditional production processes. The EU Green Deal for example has been instrumental in redirecting the EU's policies and legislation towards the objectives of climate neutrality and biodiversity conservation in an accelerated manner. This has benefitted sectors that have already been heading into this direction, but has also put pressure on those which are not aligned to these ambitions. The introduction of new policies which place stricter restrictions upon

([91]) NGFS (2021) Biodiversity and financial stability: building the case for action

([92]) Chatham House (2016) Managing the Risk of Stranded Assets in Agriculture and Forestry

([93]) EIOPA (2023) EIOPA Staff paper on nature related risks and impacts for insurance

economic activities which negatively impact nature can also increase the risk of stranded assets- whereby activities which do not abide to new restrictions (for example, through upgrading technologies) can be prohibited from proceeding with their activities. For example, in the Netherlands, regulations and measures to tackle the ongoing nitrogen crisis- whereby nitrogen disposition in Natura 2000 areas surpassed thresholds - were imposed to comply with EU nature legislation, resulting in significant delay/revoking of permits for construction. This has resulted on the one hand in wide-spread and still ongoing resistance among the farmer community; on the other, there are also farmers that are transitioning to technologies which assist in reducing nitrogen application- such as precision farming practices and sustainable land use practices. ([94])

Technological changes can often be in response to policy/regulatory, but also in response to market changes. ([95]) For example, the use of mycelium-based construction materials has shown promise in replacing more conventional materials. With further regulation implemented globally to restrict deforestation and limit emissions, the use of concrete and wood could be foreseen to be placed under strain- with other materials sought to align with policy goals and consumer needs.

Multiple examples of consumer preferences (in-turn leading to fluctuations in demands for certain products) exist, which can be influenced by the transition risks outlined above. Within the EU, the Green Deal and push towards enhanced sustainability is projected to shift consumer demand for meat products- reducing per capita consumption from 69.8kg in 2018 to 67kg by 2031. ([96]) Such shifts in behaviour can be expected to place enhanced demand on protein substitutes to fulfil dietary needs, which in-turn could pose nature-related risks.

It is key to note that in the context of financial systems a further risk type has been identified with systemic risk that can be defined as “the potential for a threat or hazard to propagate disruptions or losses to multiple nested or otherwise connected parts of a complex system” ([97]). Parallels (albeit with important caveats) can be drawn to financial risks associated with biodiversity loss, as the aforementioned physical and transition risks can interact with the breakdown of ecosystems/ecosystem services and exacerbate a range of impacts, resulting in systems rendered unable to recover their equilibrium. ([98]) Such **systemic dimensions,** through three augmentations, can present risk through indirect causal chains listed below. For financial institutions, the pathways or reactions taken to address these issues can present further risks in itself- through amplifying stress

([94]) DNB (2020) Biodiversity Opportunities and Risks for the Financial Sector

([95]) See, for example: OECD (2023) Assessing biodiversity related financial risks: Navigating the landscape of existing approaches; CISL (2021), Handbook for nature-related financial risks: key concepts and a framework for identification;

([96]) EC (2021) EU agricultural outlook 2021-31: consumer behaviour to influence meat and dairy markets. Available at: https://agriculture.ec.europa.eu/news/eu-agricultural-outlook-2021-31-consumer-behaviour-influence-meat-and-dairy-markets-2021-12-09_en

([97]) Hynes, W., M. Lees and J. Müller (eds.) (2020), Systemic Thinking for Policy Making: The Potential of Systems Analysis for Addressing Global Policy Challenges in the 21st Century, New Approaches to Economic Challenges, OECD Publishing, Paris, https://doi.org/10.1787/879c4f7a-en.

([98]) TNFD (2021) The TNFD Nature-related Risk & Opportunity Management and Disclosure Framework. Beta v0.1 Release.

placed on the ecological and financial system. 1) compounding effects- whereby the collapse of an ecosystem or ecosystem service could result in the degradation or a collapse of others. ([99]) An example of this kelp forests decline associated with the extinction of sea otters in the Alaskan Aleutian Islands ([100]). 2) Cascading effects- whereby physical and/or transitional risks can cascade and amplify through value chains, resulting in 'tipping points' where damage to biodiversity and ecosystem functioning becomes irreversible. When such points are crossed, they can produce 'large failures and cascading interactions of physical and transition risks, one loss triggers a chain of others and stops systems from recovering their equilibrium after a shock.' ([101]) One way of depicting tipping points is through the Planetary Boundaries model conceived in 2009 by Johan Rockström et. al. Scientists at that time set quantitative planetary boundaries within humanity would be save to operate without risking irreversible environmental changes. Since 2009, the model has been updated several times, and in January 2022 it was found that another planetary boundary related to environmental pollutants and other novel entities including plastics has been exceeded ([102]). In a further advancement of the model together with others and integrating earth system resilience and human well-being, Rockström et. al established in 2023 quantified safe and just Earth system boundaries (ESBs) for climate, the biosphere, water and nutrient cycles, as well as aerosols at subglobal level, finding that seven of eight that were defined as "globally quantified safe and just" ESBs are already exceeded (including phosphorus, nitrogen, water and ecosystems) ([103]).

([99]) NGFS (2023) Nature-related Financial Risks: a Conceptual Framework to guide Action by Central Banks and Supervisors. Network for Greening the Financial System.

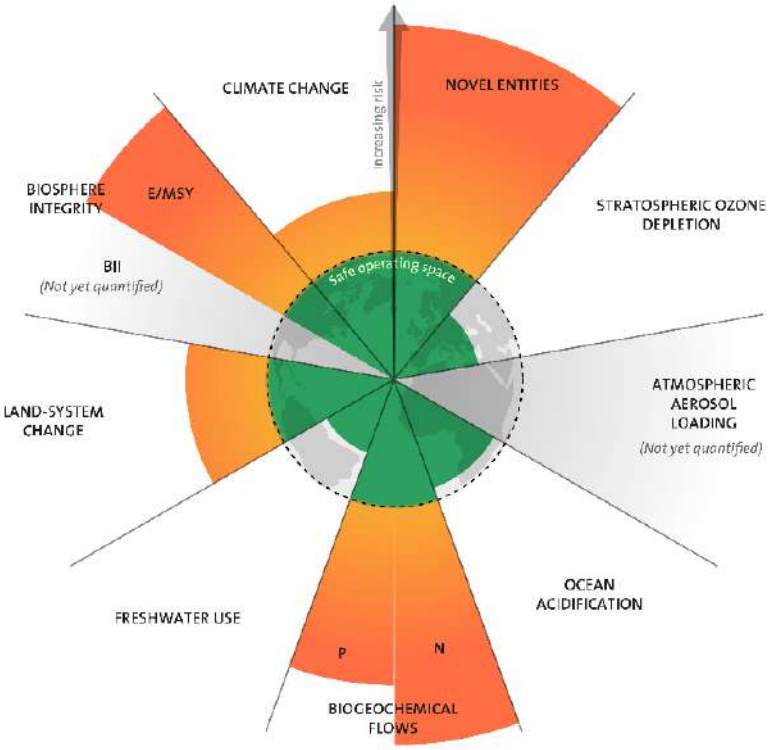
([100]) WWF, Deloitte (2022). Nature is Next. Integrating nature-related risks into the Dutch Financial Sector.

([101]) TNFD (2023). Glossary of key terms. Available at: https://framework.tnfd.global/appendix/glossary-of-key-terms/

([102]) Persson et al., (2022). Outside the safe operating space of the planetary boundary for novel entities.

([103]) Rockström, J., Gupta, J., Qin, D. et al. (2023). Safe and just Earth system boundaries. Nature 619, 102–111. https://doi.org/10.1038/s41586-023-06083-8

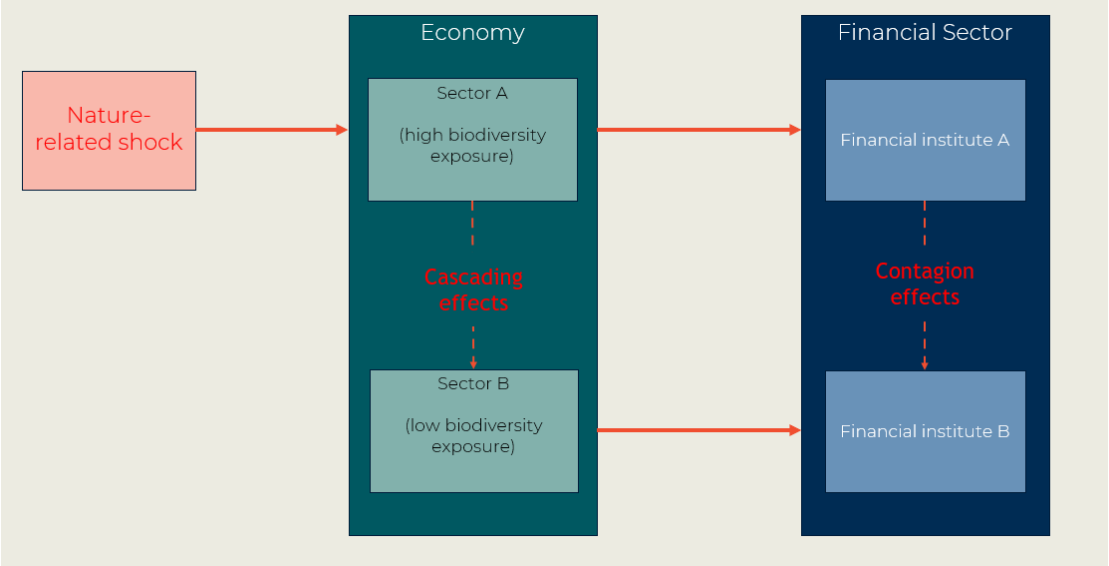
Figure 2-6 – Planetary Boundaries; Azote for Stockholm Resilience Centre, based on analysis in Persson et al 2022 and Steffen et al 2015



Finally, through 3) contagion effects- these depict the impacts of physical or transitional risks on individual financial institutions which can in-turn spread throughout the entirety of the financial system, potentially impacting the economy as a whole. ([104]) The figure below captures a simplified view of how systemic risks can impact financial institutions.

([104]) NGFS (2023) Nature-related Financial Risks: a Conceptual Framework to guide Action by Central Banks and Supervisors. Network for Greening the Financial System.

Figure 2-7 – Interaction of cascading effects and contagion effects with the financial system. Adapted from OECD (2023) ([105])



While the TNFD for example includes systemic risk as an individual risk type, such risks are often not included in frameworks as methodologies to further understand the details of these risks are still nascent in their development ([106]) ([107]). While it might be difficult to incorporate systemic risk as a self-standing risk type in a nature-related risk typology (challenges in identifying tipping point thresholds, methodological and capacity challenges in identifying and assess the dimensions and impacts of systemic risks), it is highly relevant to consider these types of most extreme risk manifestations in risk assessment framework, through a forward-looking analysis of risks and drivers. We therefore regard systemic risk as a transversal risk that can appear in various forms throughout the assessment framework, that need to be considered and accounted for as such.

2.2.3. Transmission channels

The risks outlined in the above sections can transmit and manifest to the economy in various forms- to organizations (micro-impacts), sectors (meso-impacts), or financial institutions who invest in these sectors and organisations (macro-impacts). Interviewees confirmed that transmission channels are important to capture supply chain effects and intersectoral connectivity. This information is required to capture the macroeconomic impacts. Each of these **transmission channels** can be presented with specific

([105]) OECD (2023). Assessing biodiversity-related financial risks: Navigating the landscape of existing approaches.

([106]) Banque de France (2021). A "Silent Spring" for the Financial System? https://publications.banque-france.fr/en/silent-spring-financial-system-exploring-biodiversity-related-financial-risks-france - Exploring Biodiversity-Related Financial Risks in France.

([107]) OECD (2023). Assessing biodiversity related financial risks: Navigating the landscape of existing approaches.

economic risks related to nature loss. For example, micro-/meso-economic transmission channels affect the organisations/sectors who conduct business with financial institutions, directly and indirectly- whereby nature loss could disrupt their operations which in-turn impacts the assets financed by financial institutions. Nature-related risk drivers can impact factors such as inflation, labour productivity and the overall economy in which financial institutions operate through macroeconomic transmission channels. These factors can not only be grouped based upon their scale (micro, meso, macro-), but also upon the manner in which they can propagate to specific financial impacts:

- Changing demand
- Raw material price volatility
- Asset value
- Change in profitability/increased litigation
- Disruption of activities/value chains

It should be noted here that each of the risks depicted above can be transmitted to physical, financial and societal assets- as these are often interlinked with each other. ([108]) However, the focus of this study is predominantly on the financial risks associated with nature-loss, as highlighted in the next section. Furthermore, it is important to consider that the various transmission channels can lead to drivers of biodiversity loss being exacerbated through **endogenous risk**, whereby financed activities can exacerbate, such as can be observed in specific agricultural finance transactions ([109]).

2.2.4. Financial risk

A final stage in the risk framework outlines how nature-related risks manifest to impact financial systems. These **financial risks** can stem from multiple risk drivers simultaneously, transmit at varying scales can generally be categorized as five distinctive types: credit risk, market risk, liquidity risk, underwriting risk and operational risk. ([110]) Each of these are introduced below along with examples of how these risks can impact financial institutions.

Credit risk relates to the deterioration of credit quality of fixed income holdings ([111]), whereby an issuer, borrower or counterparty is not able to fulfil its obligations due to

([108]) Chatham House (2016) Managing the Risk of Stranded Assets in Agriculture and Forestry

([109]) NGFS-INSPIRE (2022) Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability.

([110]) See, for example, CISL, 2021, Handbook for nature-related financial risks: key concepts and a framework for identification, University of Cambridge Institute for Sustainability Leadership; TNFD (2022) The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework.

([111]) Sustainable Insurance Forum (2021) Nature-related risks in the global insurance sector

defaulting. ([112]) As such, this financial risk can impact households, businesses/organisations, sectors, or sovereign wealth. Through physical drivers, credit risk can be impacted through the damage/destruction of assets- which can decrease its related value, or negatively impact cash flows to these damaged/destroyed assets. ([113]) Transition risks can also impact credit through increasing credit costs in polluting industries following the implementation of legislation which seeks to tackle, for example, greenhouse gases (which could lead to stranded assets). At a macroeconomic level, the loss of nature and subsequent increased sovereign risk through reduced economic performance ([114]) will make it more challenging for countries to service debt, resulting in strained government budgets. ([115]) Businesses can also be exposed to credit risk through, for example, overextraction of/ failure to protect regulating services provided by nature such as flood control, storm protection or wildfire protection due to loss of forested areas, mangroves or due to incorrect land management practices.

Market risks stem from changes in market prices. A decline in the market value of an investment can occur if biodiversity tipping points are encountered which negatively impact the values of shares/bonds, or production processes. ([116]) In turn, these (adverse) changes in market prices risk losses to company/financial institutions' balance sheets. Beyond the depicted physical risks posed by nature loss, markets can also be intrinsically linked to some of the risks outlined in section 0. For example, consumer preferences for goods/services which are not deemed environmentally damaging can result in shifts in the supply/demand of such products. Furthermore, environmental disasters such as oil spills can impact social sentiment, which can translate to negative stock market reactions.

Liquidity risk can be posed to financial institutions by their necessity to draw down deposits and/or credit lines in order to meet current and future cash flow and collateral needs. Changes in these current and future needs can be resultant of volatile markets, the need to withdraw money to finance damage repairs or due to non-compliance with regulations. For example, the ongoing drought witnessed in southern Europe (May 2023) has negatively impacted crop yields in large areas. This is likely to result in price increases of crops impacted by drought due to decreased harvesting, which can ultimately impact the liquidity of crop commodity markets due to challenges in predicting harvest volumes moving forward. In the event of an activity causing environmental damage, an organisation's license to operate may be withdrawn- such as the (temporary) shut down of the 3M plant in Belgium due to environmental regulators banning the

([112]) Cambridge Centre for Sustainable Finance (2016) Environmental risk analysis by financial institutions: a review of global practice.

([113])Bank for International Settlements (2021) Climate-related risk drivers and their transmission channels

([114]) Bank for International Settlements (2021) Climate-related risk drivers and their transmission channels

([115]) Bennett Institute for Public Policy, Cambridge (2022) Nature Loss and Sovereign Credit Ratings.

([116]) The Sustainable Finance Platform (2020) Biodiversity Opportunities and Risks for the Financial Sector; CISL, (2021), Handbook for nature-related financial risks: key concepts and a framework for identification, University of Cambridge Institute for Sustainability Leadership; NGFS-INSPIRE (2022) Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability.

emission of PFAS chemicals. In turn, this can be expected to impact the ability of such organisations to refinance debt.

Underwriting risks can also stem from nature loss, particularly in relation to insurance lines such as flood, agriculture, life and health. These risks can lead to mispricing and/or increasing claims. ([117]) For example, deforestation could result to increased flooding events in a region, which causes physical damage to (insured) assets, whilst pollinator extinction, water scarcity or soil erosion could negatively impact crop yields- causing higher insurance risks. Similarly, the condition of ecosystems and their intrinsic link to human health, could result in higher mortality and morbidity rates amongst the population if ecosystems continue to be degraded- substantially increasing health costs and subsequently health insurers.

Finally, **operational risks-** the changes to the operations of financial institutions or businesses due to nature-related loss, present complex interlinkages with to the risks outlined in section 0. Operational constraints can be encountered during resource over-extraction (for example, when not aligning with sustainable forest management practices) which could impact the financial viability of a business, or alternatively, if an investor is connected to a major negative environmental effect (for example, deforestation in previously pristine areas), this could result in the withdrawal of deposits or negative impacts to share values. Such operational risks can also lead to broader, strategic issues for organisations- who may require to change their business models in order to address these operational issues.

Each of these outlined financial risks present potential feedback loops to the risk types outlined in section 2.2.2, which in turn can lead to and/or exacerbate the aforementioned systemic dimensions.

([117]) EIOPA (2023) EIOPA Staff paper on nature related risks and impacts for insurance. European Insurance and Occupational Pensions Authority.

2.3. Approaches to identify, assess and mitigate risk

The aim of this chapter is to assess the approaches that currently exist to identify, understand and mitigate nature-related risks. The assessment builds upon terminology and concepts determined in the during the risk categorization, while also delving deeper into methods for evaluating exposure to nature-related risks and the resulting financial impacts across different risk types.

Exposure assessments provide insights into a financial institution's vulnerability to nature-related impacts and dependencies, while materiality assessments inform about the extent of financial implications stemming from these impacts and dependencies. Our assessment found that sources of variability (like geographical heterogeneity, amplifiers and mitigants) are important factors that can influence the likelihood and severity of the impacts and dependencies, but are at this stage not commonly incorporated into assessment frameworks due to their complexity. Both exposure and materiality assessment tools are difficult to develop and apply due to the multidimensional and overly specific nature of biodiversity loss's financial risks and the associated data limitations. However, materiality assessments, as they draw closer to quantifying nature-related financial risks, present significant challenges. Consequently, alternative methods such as heatmaps, asset tagging, and scenario analysis are often employed to gauge the magnitude of financial risks.

Finally, we found that risk mitigation approaches at individual company and across financial institutions are important, to reduce impact of nature and biodiversity loss related risks. Mitigating risks involves strategies at both project/program and institutional levels. However, current risk mitigation practices, based on limited risk assessments, mostly address direct impacts and dependencies, overlooking a holistic understanding of risks. This limitation points to a need for institutional transformation to better integrate information into decision-making processes.

In the preceding sections, we introduced how nature-related physical and transition risks can affect the economy at micro-, meso- and macro levels, and subsequently can affect a financial institution (see also

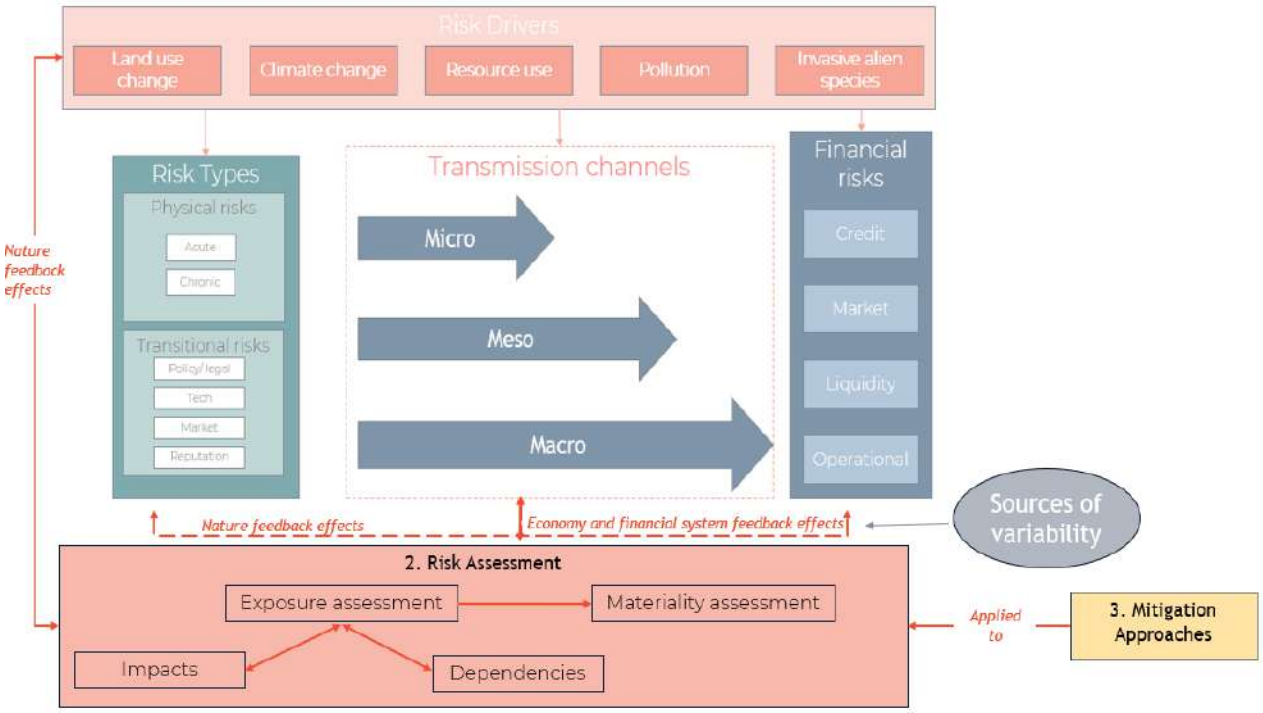
Figure 2-8). In this chapter, we delve into the approaches that currently exist to identify, understand and mitigate these nature-related risks and financial consequences.

To effectively evaluate and mitigate nature-related financial risks, risk assessment tools including models and scenarios, are required to capture the interlinkages and transmission channels between nature, the economy, and the financial sector. Nature risk assessment tools help financial institutions to assess the impacts and dependencies of their finance activities on biodiversity and ecosystem services and inform about the magnitude of the financial implications. In line with the TNFD, we identify two steps in assessing nature-related financial risks ([118]):

1. Exposure assessments to identify the financial institution’s impacts and dependencies on nature.
2. Materiality assessments to assess the (extent of) financial implications

(118) TNFD (2022). The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.3.

Figure 2-8 Overview of nature-related risk framework, including approaches to assess, materialise and mitigate risks



2.3.1. Exposure assessment approaches

A financial institution's exposure to nature-related financial risks is determined by its impacts and dependencies on nature.

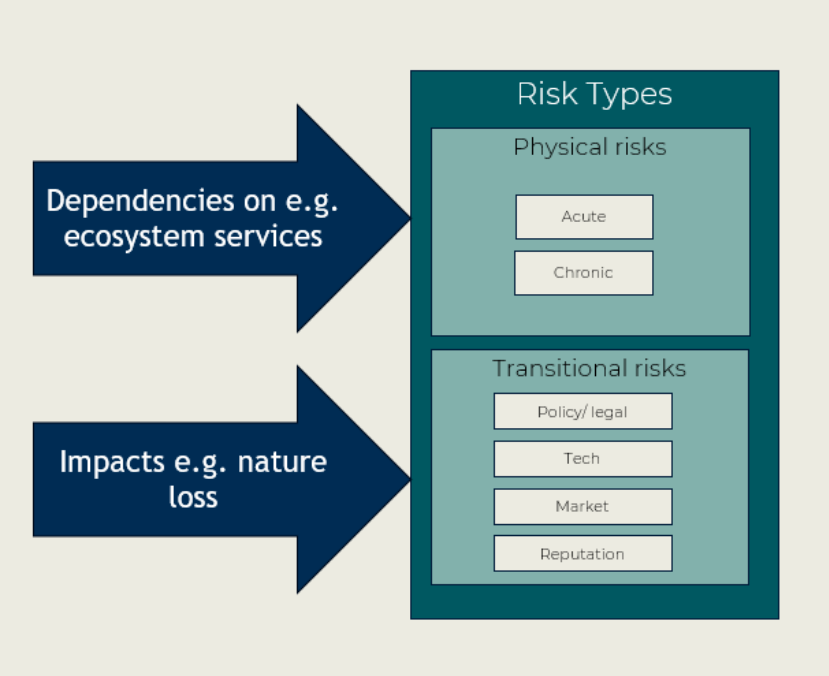
2.3.1.1. Impacts

Under impact, it is considered what impact a financial institution's investment activities may have on nature. The TNFD present the following definition of impact by Science Based Target Network (SBTN) on their website: 'Changes in the state of nature, which may result in changes to the capacity of nature to provide social and economic functions. Impacts can be positive or negative, direct, indirect or cumulative ([119]). In the context of this study, we refer mainly to **negative impacts** as those are related to transition (including reputational) risks, and more indirectly to physical risks. Tools that capture the negative impacts are often referred to as footprint tools. These tools encompass various

([119]) SBTN (2022) Working Definitions [unpublished], CDSB (2021) Framework application guidance for biodiversity-related disclosures.

drivers (e.g., emissions, resource use) and associated biodiversity impacts throughout the entire value chain, including both upstream and downstream aspects. ([120])

Figure 2-9 Relation between dependencies & impacts risks types



Investment activities may also have a **positive impact** on nature, often referred to as nature-positive activities. Clear examples of such activities are investments in nature conservation and restoration. Nature-positive activities are part of the nature-related opportunities in the TNFD framework, as it is the ultimate aim to shift global financial flows away from nature-negative outcomes and toward nature-positive outcomes. The concept of nature-positive investment is still being discussed internationally ([121]), and there is to date no shared definition ([122]). Among others, it is discussed if the concept of 'net positive impact' can lead to greenwashing when offsetting is allowed to derive a net positive impact (Figure 2-10). Another discussion point concerns the inclusion of biodiversity mainstreaming and/or co-benefits activities and how those activities should be treated in the tracking and reporting process.

2.3.1.2. Dependencies

Financed activities often depend on nature and its ecosystem services (e.g., pollination and clean air and water). If nature and ecosystem services are vulnerable, it could pose a risk to the activity or operations that rely on those services. This risk is mostly linked

([120]) Finance for Biodiversity Foundation (2022). Act Now! The why and how of biodiversity integration by financial institutions. Available here: https://www.financeforbiodiversity.org/wp-content/uploads/FfB-Foundation_Act-now_Guide-on-biodiversity-integration.pdf

([121]) Partnership for Biodiversity Accounting Financials (2022). Taking biodiversity into account. PBAF Standard v 2022 Biodiversity impact assessment - Overview of approaches

([122]) Trinomics et al. (2022). Options for considering nature-positive finance tracking and taxonomy.

with physical risk, and can be measured by a tool that translates the impact of direct drivers (e.g. land use change or overexploitation) on species and habitats (e.g., local extinctions of insects), and translates these impacts into consequences caused by declines in ecosystem services (e.g., loss of pollination services leading to declines of fruit harvesting or reduced fish stocks). ([123])

Note that on a global scale, dependency and impacts are two sides of the same coin as one company's or project's harm to nature can lead to financial loss for another company or project due to its dependence on that nature. ([124])

2.3.1.3. Exposure assessment tools

To date, there are several exposure assessment tools available, as well as helpful studies reviewing these tools to understand their applicability ([125]) ([126]) ([127]) ([128]). Despite the progress made in the last years, the development and application of those tools are relatively new.

In the Table 2-1 we give an overview of the several well-known and used exposure assessment tools, their underpinning economic models and biodiversity indicators. The table tracks the assessment tool's inclusion of impacts and dependencies, temporal (i.e. use of scenarios) and spatial (i.e. use of location-specific data), as well as intersectorality (inclusion of interaction between sectors e.g. along the value chain). A long list of the assessment tools and related models and databases is presented in Annex A. Most of the tools analysed in Table 2-1 are free and open to the public.

The review of the assessment tools is based on the reports by Finance for Biodiversity Initiative (2020) ([129]) and Business @ Biodiversity Platform (2022) ([130]), as well as the authors' judgement. For a full list of available assessment tools, we refer to the report by the European Commission and EU Business @ Biodiversity Platform (2022). ([131]) This report also offers the biodiversity Navigation Wheel which can be used to select the right assessment approach, depending on one's needs and available data.

([123]) Finance for Biodiversity Initiative (2022). Guide on biodiversity measurement approaches. Second Edition.

([124]) Ibid.

([125]) EU Business @ Biodiversity Platform (2022). Assessment of Biodiversity Measurement Approaches for Business and Financial Institutions

([126]) Finance for Biodiversity Pledge (2022). Guide on biodiversity measurement approaches

([127]) Almeida, E., C. Senni Colesanti and N. Dunz (2023), INSPIRE Sustainable Central Banking Toolbox Policy Briefing Paper

([128]) NGFS - INSPIRE (2022), Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability

([129]) Finance for Biodiversity Initiative (2020). Aligning Development Finance with Nature's Needs. Protecting Nature's Development Dividend

([130]) Business @ Biodiversity Platform (2022) Assessment of Biodiversity Measurement Approaches for Business and Financial Institutions

([131]) See Assessment of Biodiversity Measurement Approaches for Businesses and Financial Institutions: Update Report 3

2.3.1.4. Unfolding the assessment tools

Exposure assessments can be done at investment portfolio, sector, company or activity level. Moreover, the focus can be on direct operations or upstream and/or downstream in the value chain. The exposure assessment tools, often include primary data (e.g. IUCN red list of threatened species, protected areas) and secondary data (e.g., published and peer-reviewed data), and modelled data (applying modelling techniques).

Methodologies for assessing negative impacts are most progressed, whereas assessments of dependencies and positive impacts are emerging. ([132])

Most assessment tools aim to translate the drivers of biodiversity loss of IPBES into impacts and dependencies. While some tools – like ENCORE – include all drivers, others focus on a few drivers. At this stage, the coverage of overexploitation and invasive alien species has not been widely applied. Some models such as GLOBIO are used as underpinning models for nature-related risk assessment assessments. At the same time, there are also ecosystem service models and assessment tools, which translate the state of ecosystem services into ecosystem service flows ([133]). An example is InVEST, which also assesses the economic impact (in GDP) of nature loss.

Apart from ENCORE, most of these assessment tools focus on the assessment of companies' (negative) impacts on biodiversity but do not cover target setting or providing a scoring of the identified risks per economic sector or industry.

The tools specifically mentioned in the interviews were ENCORE & IBAT. In addition, EXIOBASE was often mentioned in the interviews as a tool deployed to describe supply chain dependencies. However, it was also mentioned that banks do not select one tool, but rather base the selection of various tools on the specific needs of the assessment.

The multidimensionality and over-specificity of the issue of financial risks of biodiversity loss are the main limiting factors to the development of a comprehensive framework, as it requires a lot of location-specific data per company and to track value chains which are often limited available. In addition, it required complex modelling approaches to capture the non-linearity of biodiversity loss, ecosystems degradation, and feedback loops with climate change. Given the complexity, non-linearity and location-specific nature of biodiversity and ecosystem data, nature risk assessment tools often provide a simplified overview of impacts and dependency. This makes it important to consider the challenges and limitations of applying these tools when interpreting the results. This cautious approach was further underscored during the interviews. Whether utilizing an MSA or PDF approach, the varying assumptions can lead to distinct outcomes. And although the footprint number may appear precise, it's important to acknowledge the underlying assumptions that influence its calculation.

([132]) Finance for Biodiversity Foundation (2022). Act Now! The why and how of biodiversity integration by financial institutions. Available here: https://www.financeforbiodiversity.org/wp-content/uploads/FfB-Foundation_Act-now_Guide-on-biodiversity-integration.pdf

([133]) NGFS - INSPIRE (2022), Central banking and supervision in the biosphere: An agenda for action on biodiversity loss, financial risk and system stability

Table 2-1 Overview of nature-related risk assessment approaches

Tool	Description	Temporal	Spatial	Intersectorality	Impact	Dependencies
Exposure assessment tools						
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE) ([134])	A tool and database to help users better understand and visualise the impact and dependencies of environmental change on the economy. By focusing on the goods and services that nature provides to enable economic production, it guides users in understanding how businesses across all sectors of the economy potentially depend and impact on nature, and how these potential dependencies and impacts might represent a business risk using qualitative materiality ratings.	X	X	X	✓	✓
Biodiversity Footprint for Financial Institutions Methodology (BFFI) ([135])	The tool provides a biodiversity footprint of the economic activities in which a financial institution invests and hence can be used as an investment criterion or monitoring progress. The methodology is based on Life Cycle Assessments and allows the calculation of the environmental pressures and the biodiversity impact of investments within an investment portfolio, an asset class, a company, or a project. The BFFI combines a quantitative footprint calculation (e.g. the number of ha where biodiversity loss occurs) and a qualitative analysis. In the absence of company-specific data, the environmental data in the EXIOBASE input/output database (see further below) is applied for the assessment of land use, water use, emissions, etc. (pressures). EXIOBASE takes into account worldwide trade flows between countries and between sectors. ([136])	X	X	✓	✓	✓
Integrated Biodiversity Assessment Tool (IBAT) ([137])	IBAT offers visual geolocated data on global biodiversity by offering access to biodiversity datasets on 1) key biodiversity areas 2) protected areas and 3) distribution maps for IUCN Red List species. If the location of an investment activity is known, IBAT data can be helpful to inform the early-stage biodiversity risk screening and due diligence process. Ultimately, it can help to avoid investing in harmful activities in high biodiversity areas.	X	✓	✓	✓	X
Global Biodiversity Score for Financial	The tool is based on the GBS® and hence provides information on the measured by the Mean Species Abundance. In summary, the GBSFI provides an overall and synthetic vision of the biodiversity footprint of financial assets (e.g., listed equity) considering the full value chain of underlying economic activities (associated companies and businesses).	X	✓ ([139])	✓	✓	✓

([134]) ENCORE is developed by the Natural Capital Finance Alliance in partnership with UNEP-WCMC and was financed by the Swiss State Secretariat for Economic Affairs (SECO) and the MAVA Foundation.

([135]) Developed together with ASN Bank, PRé and CREM

([136]) Finance for Biodiversity Pledge (2022). Guide on biodiversity measurement approaches

([137]) IBAT is developed by BirdLife International, Conservation International, IUCN and UNEP-WCMC.

([139]) Indirect via Globio model

Institutions (GBSFI) ([138])						
The Biodiversity Risk Filter ([140])	The Biodiversity Risk Filter is a tool that enables companies and financial institutions to Inform (i.e. providing an overview of the industry-specific dependencies and impacts on biodiversity), Explore (i.e. collection of spatially explicit maps of the importance and local integrity of biodiversity), Assess (i.e. physical and reputational risks description), and Respond (identifying suitable actions to respond to the identified risks (under development)) to biodiversity risks. ([141])	X	✓	✓	✓	✓
Underpinning environmental and economic models						
GLOBIO Model ([142])	GLOBIO is a model used to simulate the impact of different human pressure scenarios on biodiversity, in the form of the Mean Species Abundance (MSA). It also has derivations: GLOBIO-Aquatic, GLOBIO-Species and GLOBIO-ES. All these were designed to inform and support decision-makers by quantifying global human impacts on biodiversity. The various anthropogenic pressures included are infrastructure, hunting, nitrogen deposition, habitat fragmentation, land use and climate change. The GLOBIO model calculated changes in MSA due to increasing environmental pressures over time which can be attributed to different responsible economic sectors. The model is closely connected to PBL's IMAGE model: an integrated assessment model that simulates the global environmental consequences of human activities by assessing the impacts on Impacts on climate change, land-use change, biodiversity loss, modified nutrient cycles, and water scarcity. Globio assesses the consequences of three of the Shared Socio-economic Pathways (SSPs) for terrestrial biodiversity intactness. ([143])	✓	✓	Image: energy & agriculture	✓	X
Exiobase ([144])	EXIOBASE is a global, detailed Multi-Regional Environmentally Extended Supply-Use Table (MR-SUT) and Input-Output Table (MR-IOT). It was developed by harmonizing and detailing supply-use tables for a large number of countries, estimating emissions and resource extractions by industry. The MR-IOT can be used for the analysis of the environmental impacts associated with the final consumption of product groups. E.g. BFFI applies the environmental data in the EXIOBASE input/output database to assess what land use, water use, emissions, etc. (pressures) are linked to the economic activities unless more accurate data (like company data) is available. EXIOBASE takes into account worldwide trade flows between countries and between sectors.	X	X	✓	X	✓
Biodiversity Metrices and Indexes						

([138]) Developed by CDC Biodiversité

([140]) The BRF is developed by WWF

([141]) WWF (2023) Tackling Biodiversity Risk – A biodiversity risk assessment guide for companies and financial institutions, WWF Switzerland and WWF Germany in cooperation with Climate & Company, January 2023.

([142]) The GLOBIO model was developed by PBL Netherlands Environmental Assessment Agency.

([143]) See GLOBIO

([144]) See https://www.exiobase.eu/index.php/about-exiobase

Species Threat Abatement and Restoration (STAR) Metric ([145])	The (STAR) Metric allows quantification of the potential contributions that species threat abatement and restoration activities offer towards reducing extinction risk across the world (drawing from the IUCN Red List of Threatened Species). As such, STAR helps identify actions that have the potential to bring benefits for threatened species, and it supports the establishment of science-based targets for species biodiversity, and commitments relevant to the post-2020 biodiversity framework. STAR is one of the derived data layers in IBAT.	n/a	✓	X	Positive impact	X
Mean Species Abundance (MSA)	The Mean Species Abundance (MSA) metric is an indicator of local biodiversity intactness. The MSA values range from 0% to 100%, where 100% represents an undisturbed pristine ecosystem. (ratio between the observed biodiversity and the biodiversity in its pristine state). ([146]) The MSA is applied in the GLOBIO Model.	n/a	✓	X	✓	X
Potentially Disappeared Fraction of Species (PDF)	The Potentially Disappeared Fraction (PDF) metric quantifies the proportion of species richness that may face loss or extinction as a result of various environmental pressures, including land use changes, climate change, and other factors. The PDF can have a max value of 1 (or 100%), and all species disappeared or zero, meaning that all species are still there. Loss of species is calculated in a certain terrestrial area (hence m2) or marine/freshwater area (hence m3), during a certain time (hence the addition of years). ([147]) PDF is applied in the ReCipe model.	✓	✓	X	✓	X

([145]) STAR is developed by BirdLife International, Conservation International, IUCN and UNEP-WCMC.

([146]) GLOBIO

([147]) https://pre-sustainability.com/articles/biodiversity-one-our-impact-on-biodiversity/

2.3.1.5. Applying exposure assessments tools

The TNFD introduces the use of **heatmaps** as one of three risk assessment methods, in particular, to identify (potential) exposure per sector. Heatmaps are used to apply a rating, often from low, medium to high impact or dependency on nature. For instance, research by World Economic Forum (and updated by PWC) suggests that more than half of the world's total GDP, amounting to approximately US$ 58 trillion, depends moderately or highly on nature and its ecosystem services. ([148]) In 3.3.2 we share the findings of our sector materiality assessment based on the publicly available ENCORE tool. Other tools like the WWF Biodiversity Risk Filter (see Table above) are also used by financial institutions to allocate a qualitative rating to each sector concerning various nature-related categories, similar to the SBTN Materiality Matrix. ([149]) In their estimations, banks can define and apply a threshold to determine what can be regarded as 'high risk' (stakeholder consultation).

Despite the practical applicability of heatmaps, it is important to note that existing heatmaps remain a static tool to express exposure rather than financial implications. Moreover, they do not consider any forward-looking aspects as there is no scenario modelling involved and they often provide a simplistic view of sectors and omit any nuance about unconventional sectors and subsectors. ([150])

To complement heatmaps approach, financial institutions often include other methods like **asset tagging** and **scenario-based risks method**, the remaining two methods for assessing nature-related risks as per the TNFD. The scenario-based risks approach is introduced in the materiality assessment section 2.3.2, as it a dynamic approach to quantify the financial risks, whereas heatmaps and asset tagging are more static approaches, introducing an order of magnitude.

Asset tagging adds specific company or asset information to the heat-mapping exercise, allowing it to move from the sector level to the portfolio or asset level. It leads to the use of detailed quantitative or qualitative data (at the process, product, geography and/ or physical asset level), providing a more granular and specific understanding of (the magnitude of the) risk. In 2020, it was the Dutch Central Bank (De Nederlandsche Bank, DNB) that for the first time quantified the extent to which the financial institution was exposed to the risks of biodiversity loss at the portfolio level (DNB, 2020). DNB found that 36% of assets held by the Dutch financial system were highly or very highly dependent on one or more ecosystem services ([151]). In addition, the European Central Bank recently (2023) assessed dependence on the nature of more than 4.2 million

([148]) Updated numbers by PwC (2023). 'Managing nature risks: from Understand to action', based on the work of the World Economic Forum (2020). Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy, conducted in collaboration with PwC

([149]) See: https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/09/SBTN-initial-guidance-for-business.pdf

([150]) TNFD (2023). Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.4. Annex 4.6 Guidance on LEAP: Methods for assessing nature-related risk

([151]) Van Toor, J., Piljic, D., Schellekens, G., van Oorschot, M., & Kok, M. (2020). Indebted to nature Exploring biodiversity risks for the Dutch financial sector. De Nederlandsche Bank (DNB) and Planbureau voor de Leefomgeving (PBL). https://www.pbl.nl/en/publications/indebted-to-nature.

individual companies accounting for over €4.2 trillion in corporate loans. Based on this bottom-up approach, they found that nearly 75 per cent of all bank loans in the euro area are to companies that are highly dependent on at least one ecosystem service. ([152])

The **EU Taxonomy** ([153]) can inform the asset tagging assessment tools, as assets (or investments in economic activities) aligned with the Taxonomy and the associated criteria should have a limited negative impact on biodiversity and, consequently, a low nature-related transition risk. With the Environmental Delegated Act ([154]), assets in economic activities aligned with these technical screening criteria would make a significant contribution to biodiversity.

While the asset tagging approach is rather flexible and has been used by financial institutions in various ways (see two examples above), there are also some drawbacks as data availability limits the specificity of the assessments. Due to a lack of (location) specific data on companies, many reports from banks apply sector averages to portfolio companies. This can be improved as corporate disclosure practices improve (stakeholder consultation). To address the variety of companies within the sector (locations and sustainability of operations) banks often assume that on the portfolio level, there will be a representative average. One can also differentiate between companies through the use of case studies (stakeholder consultation).

2.3.1.6. Sources of variability

The likelihood and severity of the climate- and nature-related financial risks can be affected by various factors, also called 'sources of variability'. ([155]) The Bank for International Settlement (BIS, 2021) identifies three types of variables: geographical heterogeneity, amplifiers and mitigants. In addition, the type of sector influences the likelihood and severity of the manifestation of nature-related risks. Sector sensitivity to nature-related risks is explained and discussed in detail in Chapter 3 of this report.

Geographic heterogeneity: The geographical location determines to what extent direct risk drivers are affecting the state of nature and biodiversity, and hence the exposure of financial institutions to those risks. It depends per location to what extent e.g. climate change results in increased and intensified drought events. Moreover, the jurisdiction is important as there can be structural differences in regulations, technological innovations, and public opinion, as well as differences in economies and financial systems that affect the likelihood of risks and the relative importance of various transmission channels.

Risk can be amplified through interactions and interdependencies between risk types (e.g., physical and transition) risk drivers (e.g. climate change and land use change),

([152]) ECB (2023). Interview with the Financial Times (8 June 2023). Why is the ECB concerned about the risks of biodiversity loss.

([153]) See: https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

([154]) European Commission (2023). Commission Delegated Regulation,,,,. SWD(2023) 239 final. Available here: https://finance.ec.europa.eu/system/files/2023-06/taxonomy-regulation-delegated-act-2022-environmental_en_0.pdf

([155]) Bank for International Settlements (2021). Climate-related risk drivers and their transmission channels

feedback loops between the transmission channels (e.g., interaction between micro and macroeconomic channels) and the financial impacts ([156]). Behavioural actions within the financial system and its interaction with the real economy can further exacerbate risks, leading to additional financial losses. Insurers often need to reduce their coverage or increase the prices after the materialisation of physical risks, which further amplifies the costs as well as the availability of getting new loans approved e.g. farmers.

In addition, financial Institutions' mitigation measures may reduce the financial risks, which in turn affect the severity and likelihood of the financial risk to materialise. Pro-active measures like disinvestments in controversial sectors or diversification of investments, as well as reactive measures using financial products to transfer climate risk, are examples of mitigation strategies. Mitigation measures are further discussed in Chapter 2.3.3.

The sources of variability drive the exposure and vulnerability of financial institutions to be impacted by nature-related risks and the likelihood of this these risks to materialize.

Scenario analysis (discussed further below) is a useful tool in projecting the likelihood of financial risks materializing, considering one or multiple sources of variability against a baseline in various future scenarios.

2.3.2. Materiality assessment

While most of the risk assessment approaches discussed in the previous section aim to inform and increase understanding about the exposure of a financial institution's investment portfolio or assets to biodiversity loss, these assessments often do not include information on how this exposure manifests itself in terms of financial and economic risks. This exercise of translating exposure (both impact and dependencies) into financial risks is also referred to as materiality assessment. Materiality assessments help a financial institution to assess how and to what extent certain impacts and dependencies are important to a financial institution. As such, materiality assessment informs about the magnitude of nature-related dependencies and impacts and can be a helpful tool to prioritise nature-related risks.

The concept of materiality is applied in a wide variety of contexts (e.g., accounting, reporting, etc.), but becoming increasingly important in the context of sustainability standards and disclosure. *([157])* TNFD recommends that 'organisations should disclose not just how nature may (positively or negatively) impact the organisation's immediate financial performance ("outside in"), but also how the organisation (positively or negatively) impacts nature ("inside out"). ([158]) This is also referred to as **double materiality**, a concept often used in the European disclosure policy. The EU Corporate Sustainability Reporting Directive (CSRD) applies a double materiality approach so that

([156]) Bank for International Settlements (2021). Climate-related risk drivers and their transmission channels

([157]) WWF (2023). Tackling Biodiversity Risk – A biodiversity risk assessment guide for companies and financial institutions, WWF Switzerland and WWF Germany in cooperation with Climate & Company, January 2023.

([158]) TNFD (2022). The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.3 November 2022.

companies have to report how sustainability issues might create financial risks for the company (financial materiality), but also on the company's impacts on people and the environment (impact materiality). ([159])

The quantification of the financial risks can be assessed through scenario analysis. This approach aims to translate the findings of the previous approaches (exposure at sector-, company- or asset level), introduced in section 2.3.1) into financial implications for financial institutions. To do so, several data inputs are required and the TNFD summarizes the inputs as follows:

1) Economic and financial costs of nature-related risks, by means of the following indicators:
    a. Profitability to understand the impact on financial institutions;
    b. Probability of default to assess the effect on financial stability (important for central and national Banks);
    c. Gross Domestic Product (GDP) to understand the impact on the economy as a whole.
2) Modelling of changes in dependencies and impacts to allow conversion to and estimation of, changes in costs and revenues;
3) More comprehensive scenario analysis to project how changes in specific drivers of physical and transition risk could impact transmission channels through which costs and revenues could be affected.

Macroeconomic ([160]) and Microeconomic ([161]) Assessment Approaches are important tools to translate the biodiversity and nature impacts and dependencies into economic and ultimately financial risks at Marco- (e.g., national or global level) and micro level (i.e., company-level) respectively. The use of these models is further discussed in Chapter 4 as part of Task 3.

Beyond the limitations mentioned for the heat mapping and asset tagging approaches, we have identified the following limitation for scenario-based approaches, based on literature review and stakeholder consultation:

1) Difficulty to develop scenarios due to the complexity of biodiversity, limited available data and limited legally binding targets to predict potential changes to nature policy and technologies (transition risks) ([162]). While scenario-based

([159]) EU DG – FISMA (2022.) Newsroom – Sustainable finance. 26/07/2022

([160]) Such as Integrated Assessment Models (IAMs) developed by the International Institute for Applied Systems Analysis (IIASA), provide policy-relevant insights by offering quantitative descriptions of the interactions between physical earth systems and human or economic system. The modelling approach is integrated, including information from both the biophysical and the economic systems. It is a partial-equilibrium model which represents the primary land-use sectors, including agriculture and forestry.

([161]) Such as the UN System of Environmental Economic Accounting (SEEA) Ecosystem Accounting (EA) that offers an integrated and comprehensive statistical framework for organizing data about habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity

([162]) Compared to the climate change targets (e.g. limiting global warming to 1.5°C above pre-industrial levels).

methodologies are already employed to address climate-related risks, they have not yet fully encompassed broader nature-related risks. The readily available scenario of 'IPR Forecast Policy Scenario + Nature ([163])', focuses on transition risk; despite the challenges associated with the development of scenarios reflecting biodiversity and ecosystems degradation risk, there does not seem to be an alternative approach providing tractable inputs for the related financial risk assessment;

2) Another challenge is to capture the climate–nature interactions in scenarios. Understanding dependencies and (climate) feedback loops in ecosystems is crucial for assessing their impact on the global economy. While estimations of the impact of the collapse of a single ecosystem service, such as pollination, are possible, the existence of cascading effects and interconnections with other ecosystems, like the Brazilian forest's climate effects, makes isolated estimation impractical. Incorporating trade-offs and synergies (e.g. nature-based solution) with climate change into risk assessment tools is challenging. This is due to complexity of these interactions and calls for a more comprehensive and holistic approach to risk assessment and policy-making.
3) On the financial risk side, it is the modelling that presents challenges, particularly in terms of substitution within a CGE (computable general equilibrium) framework. The substitution can occur between ecosystems or between natural capital and produced capital. Additionally, there could be a third dimension of substitution involving consumer choices, like shifting between products, which can impact risk assessments.

To address the challenges, interviewees promote a mix of quantitative and qualitative approaches, using available data for quantification and exploring qualitative methods to fill in the information gaps. In addition, it is important to improve data quality and connect assessments with reporting data, so that legislation on disclosure may accelerate the collection of relevant data.

2.3.3. Mitigation approaches

As environmental risks become increasingly apparent, various mitigation approaches to reduce the impact of nature related risks have been adopted. The majority of the approaches outlined in this section apply to organisations, yet a disaggregation of approaches is offered: from organization- to financial institute-level.

A proactive approach to risk management has emerged as a guiding principle, emphasizing the importance of anticipating and addressing potential risks before they escalate. EU legislation, such as the EU Sustainable Finance Taxonomy identifies environmentally sustainable activities, but it does not prescribe exact mitigation strategies for biodiversity and nature loss. It defines criteria that economic activities must meet to be considered environmentally sustainable, leaving it up to financial institutions to align their investments accordingly. Similarly, the Sustainable Finance Disclosure Regulation (SFDR) mandates disclosure of sustainability risks, but it does not dictate

([163]) See https://www.unpri.org/inevitable-policy-response/ipr-forecast-policy-scenario--nature/10966.article

precise mitigation measures. Financial market participants are required to disclose how they integrate sustainability risks, but the exact strategies are left to their discretion. While the EU legislations lay the foundation for sustainable finance practices, the specific implementation of mitigation strategies is often left to financial institutions.

Risk mitigation is a critical component of risk management, and links directly to associated risk opportunities. Organisation's risk management needs to combine both nature related risks and opportunities into existing processes and understand how these tie together and can affect investment decisions ([164]). Risk mitigation itself can be multifaceted, and financial institutions can approach it from different angles. We identify two levels at which various mitigation action can be taken: project/programme level and institutional level.

On the one hand, risk mitigation can be approaches at a project or programme level where specific measures are taken to address risks associated with individual investments or initiatives. This approach focuses on identifying and managing risks within each project to minimize potential negative impacts on nature and biodiversity at a more focused level. Here, financial institutions work directly with investees to reduce their risks.

On the other hand, financial institutions can also work on creating a more resilient environment, adopting strategies and establishing frameworks that promote sustainable practices throughout the institution's operations. This broader approach goes beyond solely considering nature and biodiversity-related risks and encompasses a more comprehensive sustainability agenda. The institutional approach focuses on building a more resilient and sustainable foundation within the financial institution and can in fact go beyond pure nature and biodiversity related risks. By embedding sustainability principles within their structures, financial institutions can better safeguard their portfolios against a wide range of risks, including those related to climate change, social issues, and governance. Such a proactive and resilient setup ensures that the institution is better equipped to handle various challenges and uncertainties in the long run.

2.3.3.1. At Project/Programme level

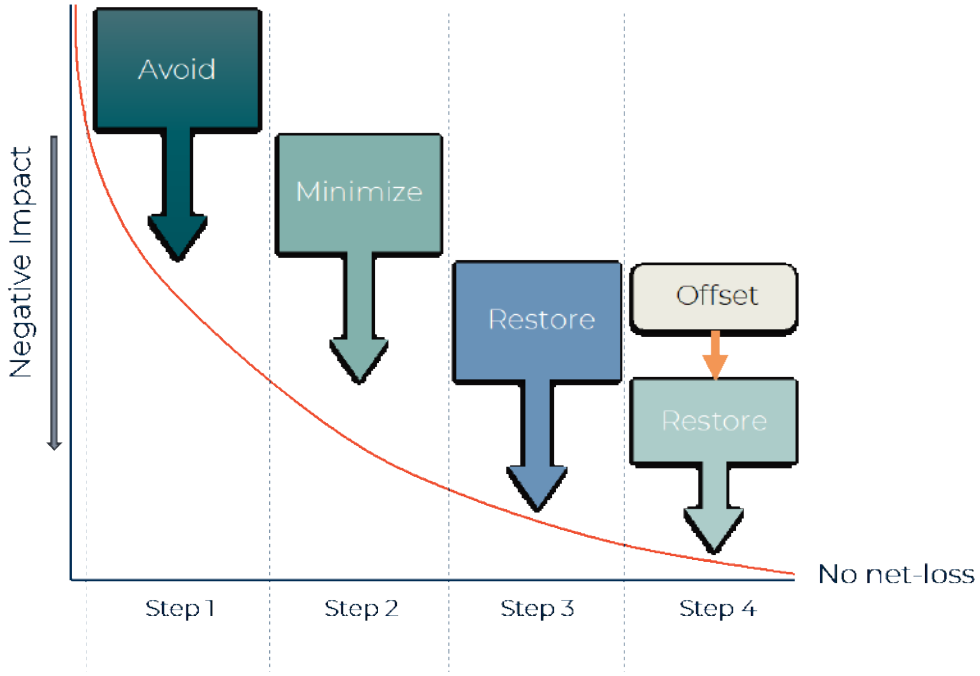
There have been plenty of efforts to introduce practice guidelines to operationalize mitigation at company. Most of the existing guidance on mitigation hierarchy models lean on the Mitigation and Conservation Hierarchy as its core ([165]), and follow the same basic principles of avoid, reduce impact, restore and regenerate (Figure 2-10). The concept of mitigation hierarchy has been introduced, elaborated and further developed by various international institutions in order to promote mitigation at project level: the Cross-Sector

([164]) TNFD (2023). Nature related risk and opportunity management and disclosure framework. Beta v0.3 Annex 3.1 Guidance on the Assess Phase of LEAP.

([165]) https://conservationhierarchy.org/

Biodiversity Initiative ([166]), SBTN AR^{3}T ([167]) which sets out the International Financial Corporation's (IFC) Performance Standards (#6) ([168]), and the TNFD all include mitigation measures as a key component to avoid impacts on biodiversity and nature. The Commission has also released guidance documents on integrating ecosystem and their services into decision making ([169]), which clearly delineate the mitigation hierarchy model as key step. These frameworks allow companies to plan for and address their impacts on biodiversity at a project level, and thus can be directly beneficial to financial institutions when making investment decisions. Some frameworks include offsetting within their recommended mitigation strategies. However, as discussed in section 1.5.1 offsetting is a controversial practice that has over the years received a lot of criticism for enabling greenwashing ([170]). Nonetheless, we discuss offsetting as a form of mitigation strategy as we see potential positive impacts if conducted transparently and correctly.

Figure 2-10 Schematic overview of the mitigation hierarchy mitigate and the transition to net-positive



The first stage represents a business-as-usual scenario, whereby no actions are taken to reduce impacts on nature and biodiversity. As such, all economic developments remain at a net-negative impact on nature which would over time exponentially increase the associated risks and transmissions to financial institutions. The following stages

([166]) The Biodiversity Consultancy (2015). A cross-sector guide for implementing the mitigation hierarchy. Available at: http://www.csbi.org.uk/our-work/mitigation-hierarchy-guide/

([167]) Science-based Target for Nature (2020) Initial Guidance for Business. Available at: https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/09/SBTN-initial-guidance-for-business.pdf

([168]) International Finance Corporations (2012). Biodiversity Conservation and Sustainable Management of Living Natural Resources. Available at: https://zeroextinction.org/wp-content/uploads/2018/05/Performance-Standard-6_English_2012.pdf

([169]) EC (2023). EU guidance on integrating ecosystems and their services into decision making. SWD (2019) 305 final.

([170]) Kotiaho (2022). Analysis: Environmental degradation and its offsetting, or ecological compensation. Green European Foundation. Available at: https://ajatuspajavisio.fi/wp-content/uploads/2022/07/GEF_Environmental-degradation.pdf

gradually present mitigation actions that together and cumulatively can lead to an overall no-net-loss of biodiversity and nature:

- Avoid: prevents impacts from happening in the first place. This eliminates the impact entirely and is the most cost-efficient and effective form of mitigation
- Minimize: reduces the overall impact, but without necessarily eliminating them entirely.
- Restore: is focused on recovery of the ecosystem with respect to its health, integrity and ecosystem services and values generation. Restoration actions are designed to regenerate and recover the ecological productivity of an ecosystem, or specific components
- Offset: introducing and encouraging offsetting, increases the investments into conservation and restoration finance, thus providing development support for nature restoration and recreation.

Offsetting can be a valuable tool for promoting environmental restoration and conservation, but its effectiveness hinges on its proper application within a broader hierarchy of actions. It is essential that companies prioritize avoidance and minimization of environmental impacts as the initial steps in their sustainability efforts. Only then should they consider offsetting as a lever to invest in the restoration and recreation of ecosystems. Using offsetting as a last step ensures that companies are genuinely committed to reducing their ecological footprint and invest in the actual increase of nature and biodiversity. It should not be used as a mere excuse to continue business as usual while attempting to create an illusion of green practices. This approach undermines the true potential of offsetting and fails to achieve the desired no-net-loss goal. To yield meaningful results, offsetting must be considered in conjunction with precautionary approaches and within the context of restoration.

Financial institutions can drive companies towards taking actions across the spectrum of the hierarchy and ensure that the borrowers prioritize avoidance and minimization. Minimization can be encouraged through the incorporation and investment into, for example, nature-based solutions ([171]) ([172]). In addition, financial institutions can leverage restoration investments, where offsetting efforts can be included, in order to reduce the overall net-negative impact of the investee.

The European Bank for Reconstruction and Development (EBRD) has developed a Performance Requirement #6 that sets an example on how financial institutions can adapt their policies (see institutional operations) to ensure that new projects take a precautionary approach to biodiversity conservation and oblige investees to take

([171]) IPBES. (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. https://ipbes.net/global-assessment

([172]) Science-based Target for Nature (2020) Initial Guidance for Business. Available at: https://sciencebasedtargetsnetwork.org/wp-content/uploads/2020/09/SBTN-initial-guidance-for-business.pdf

appropriate actions to mitigate their impacts ([173]). In order to be able to avoid, minimize and take mitigation actions, an environmental appraisal process in implemented in which clients are required to identify and characterize the potential impacts on nature and biodiversity and associated risks. The EBRD applies additional requirements to development proposals affecting protected areas, involve the management of living natural resources, and/or have supply chains that may adversely impact biodiversity and ecosystem services. Similarly, the European Investment Bank (EIB) has implemented the Environment and Social Sustainability Framework (ESSF) which acts as a critical tool to ensure environmental, climate and social risks are integrated into aspects of EIB-financed projects. As other institutions, the ESSF relies on the mitigation hierarchy, providing an implementing framework for the different phases of the project investment cycle, access-to-information requirements, and different forms of guidance to the clients ([174])

To effectively implement the steps of avoidance, minimization, and restoration in addressing biodiversity and nature-related risks, companies must first gain a comprehensive understanding of their impacts and dependencies on nature. This entails a thorough mapping of risks to develop a robust risk management plan. At this crucial juncture, engagement activities with clients become pivotal for financial institutions. Engagement programmes have emerged as a powerful method for financial institutions to actively manage and reduce the financial risks, in particular in their existing investment portfolios. Stakeholder interviews revealed that due to the number of underlying assumptions that risk assessments currently make, institutions feel that the most efficient approach at this stage was to raise awareness with clients. Through engaging with investee companies, financial institutions can exert influence and drive positive changes in risk management practices, thereby promoting sustainability and long-term value creation. Financial institutions can initiate broader communication and feedback activities with clients within their portfolios, in order to assess targeted risks and together establish how to best manage these. As part of their programmes, institutions can engage through direct dialogue, discussion forums and conferences, and questionnaires to gain insights on company's impacts and risks and give tailored recommendations of needed improvements ([175]).

Based on findings and outcomes from engagement activities, financial institutions can take various actions and request additional measures from their investees in order to better comprehend environmental (and social) aspects of their clients' operations, assist in identifying risks and opportunities, and ultimately enables the institutions to offer tailored solutions and guidance. Examples include:

- **Due Diligence and environmental impact assessments (EIA**): financial institutions can require companies and project they invest in to conduct EIAs to

([173]) EBRD (2022). EBRD Performance Requirement 6: Biodiversity conservation and sustainable management of living natural resources – Guidance Note.

([174]) European Investment Bank (EIB) (2022). The EIB Environment Framework. Accessible at: https://www.eib.org/attachments/lucalli/20220213_eib_environment_framework_en.pdf

([175]) AXA (2021). Active ownership and stewardship Report -Highlights. Available at: https://www.axa-im.nl/document/3569/view

assess potential biodiversity risks and impacts, informing the institutions investment decisions. The scope of the EIA can be defined on a case-by-case basis depending on the business model and context of the asset, as well as the data needs of the institution. However, it should be acknowledged that EIAs are often rather complex, comprehensive and costly processes- and are therefore more appropriately applied at larger-scale physical investments, when required by law.

— **Biodiversity Action plans (BAP):** financial institutions can encourage or even mandate companies to develop and implement BAPs as part of their sustainability commitments. This helps ensure that biodiversity protection measures are in place.

— **ESG integration, data disclosure and enhanced reporting requirements:** Financial institutions can require investee companies to improve their ESG reporting with a particular focus on biodiversity and nature impacts and request further disclosure of nature related impacts. This increases transparency and enables better risk assessment and decision-making.

— **Incentives and rewards:** Financial institutions can provide incentive structures that reward investee companies for achieving specific biodiversity and nature-related goals, or showing efforts to avoid or minimize, thus financing a nature positive path. This can include access to additional capital for companies demonstrating strong environmental performance ([176]).

— **Formalize and integrate new strategies and policies:** Financial institutions can request that investees formalize and introduce climate, biodiversity and nature strategies and policies at various levels of the organization. This helps bring about operational transformations within individual businesses.

The power of engagement lies in its ability to foster collaborative efforts towards a shared commitment to sustainability. Financial institutions can actively partner with clients in developing innovative strategies that not only address biodiversity and nature-related risks but also unlock new business opportunities. This collaborative approach drives positive change and contributes to a more resilient and sustainable financial ecosystem. By taking these steps, financial institutions can support companies in significantly reducing their risk profiles, enhancing their creditworthiness/insurability and prospects for lending.

2.3.3.2. At Institutional level

At an institutional level, the financial sector can implement various measures to effectively mitigate some of their risks. In this context, three main areas for mitigation actions are particularly relevant: operational transformation, risk assessment, and finance-focused mitigation.

([176]) European Banking Federation (2019). Encouraging and rewarding sustainability – accelerating sustainable finance in the banking sector. Available at: https://www.ebf.eu/wp-content/uploads/2019/12/ENCOURAGING-AND-REWARDING-SUSTAINABILITY-Accelerating-sustainable-finance-in-the-banking-sector.pdf

Finance-focused mitigation involves leveraging financial mechanisms and tools to encourage investments in sustainable practices that support biodiversity conservation, as well as reducing the institutions own portfolio risk. Financial institutions can create and promote nature-positive financial products that direct capital towards projects with tangible biodiversity benefits ([177]). By channeling funds into activities that protect and restore ecosystems, financial institutions play a pivotal role in driving positive change and supporting sustainable development (e.g. green bonds ([178]), impact investment ([179]) or nature positive financing[180]). Finance-focused mitigation therefore directly link on the one hand to having impact at a project/programme level, and on the other hand to new investment opportunities. Green bonds for climate resilience are already well established and integrated into the market. HSBC utilizes green bonds dedicated to climate-positive finance and is planning to expand their fund operations to a broader range of natural capital ([181]). The Nature Conservancy's 'Green Bonds' provides the same accessibility but focused on ecosystem restoration, in particular reforestation and land-use change recovery ([182]).

The Natural Capital Finance Alliance (NCFA) aims to support financial institutions in incorporating finance-focused mitigation, by integrating natural capital considerations into their decision-making process ([183]). Examples of financial institutions current application of these mitigation measures include the Land Degradation Neutrality (LDN) Fund Mirova, a subsidiary of Natixis Investment Managers, created the fund in partnership with the Secretariat of the UN Convention to Combat Desertification (UNCCD) to promote sustainable land use practices that result in positive biodiversity and socio-economic impacts and financial returns through a blended finance model ([184]).

Operational transformation is another critical approach to risk reduction. This involves integrating environmental, social, and governance (ESG) considerations into the core operations of financial institutions. This may include reducing resource consumption, implementing eco-friendly infrastructure, and actively supporting biodiversity conservation efforts on the institution's premises. In addition, by adhering to voluntary reporting, disclosure, and target setting in line with international initiatives such as the Principles of Responsible Investment, The Principles of Sustainable Investment, Green Bond Principles, and Natural Capital Declarations, Corporate Social Responsibilities, Task Force on Nature-related Financial Disclosures (TNFD), financial institutions demonstrate their commitment to sustainability and biodiversity conservation. By

([177]) Triodos Bank (2022). Beyond the risk and return: The role of finance in preserving and fostering biodiversity.

([178]) OECD (). Green Bonds: utilizing the debt capital markets for a low-carbon transition.

([179]) NatureVest (2014). Investing in conservation: a landscape assessment of an emerging market.

[180] UNEPFI (2021). Nature positive finance guidance.

([181]) HSBC (2022). Green Bond Insights. Available at: https://www.research.hsbc.com/C/1/1/320/KHPkbSm

([182]) TNC (2023).Green Bonds Annual Impact Report. Available at: https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_Green_Bond_Impact_Report_2023.pdf

([183]) NCFA (2020). Beyond 'Business as Usual': Biodiversity targets and finance. Available at: https://naturalcapital.finance/wp-content/uploads/2020/06/Beyond-Business-As-Usual-Full-Report.pdf

([184]) Natixis (2020). First investment for the Land Degradation Neutrality fund. Available at: https:// http://www.natixis.com/natixis/jcms/rpaz5_74454/en/ first-investment-for-the-land-degradation-neutrality-fund.

participating in these initiatives, financial institutions commit to transparently disclosing their environmental and sustainability-related performance. This transparency not only demonstrates their dedication to biodiversity conservation but also fosters accountability and builds trust with stakeholders. Transformation of day-to-day operations has also been considered as a crucial step in the TNFDs adaptation of the mitigation hierarchy, whereby businesses must transform the way they see and value nature, and thus their relationship with it ([185]). Our stakeholder interviews, in particular with national banks, revealed that major financial institutions have already taken steps to set and adhere voluntarily to various ESG related targets, and are actively participating in discussions on how best to integrate nature into their risk assessments, contributing to developments of the TNFD. Operational transformations are therefore already underway especially in the largest players on the market. Operational transformation thus directly influences an institution's impacts at a project/programme level and can further help achieve net-positive nature impacts.

As part of the operational transformations, risk assessments are essential tools for financial institutions to identify and manage their exposure to biodiversity and nature-related risks (see section 2.4.1). These assessments involve analyzing the potential impact of biodiversity loss and ecosystem degradation on the institution's portfolio and operations. By conducting stress tests and scenario modeling, financial institutions can better understand the vulnerabilities they face and develop proactive risk management strategies. Integrating biodiversity risk assessments into their decision-making processes ensures that these institutions are better prepared to navigate potential challenges arising from nature-related risk.

As financial institutions embrace operational transformations to mitigate biodiversity and nature-related risks, risk assessments emerge as indispensable tools in their arsenal. These assessments play a crucial role in helping financial institutions identify and manage their exposure to the potential impacts of biodiversity loss and ecosystem degradation. Through risk assessments, financial institutions conduct in-depth analyses of how biodiversity and nature-related risks may affect their portfolios and investment strategies, in the short and long-term. By using stress tests and scenario modeling, they simulate various scenarios to gauge the vulnerabilities they may face in terms of nature-related risks.

A number of European institutions have begun integrating risk assessments. Front-runners include Banque du France ([186]), the DNB and the ECB ([187]) who have conducted a risk assessment across different scaled portfolios , which we discuss in detail in later sections (2.4.1, 2.4.2). Interviews with stakeholders revealed that while there are active efforts to implement biodiversity risk assessments, limitations in the current tools are hindering foresight and a deeper understanding of intersectoral connectivity.

([185]) TNFD (2023). Nature related risk and opportunity management and disclosure framework. Beta v0.3 Annex 3.1 Guidance on the Assess Phase of LEAP.

([186]) Svartzman et la (2021). A silent spring for the financial system? Exploring biodiversity-related financial risks. Banque du France.

([187]) Elderson (2023). The economy and banks need nature to survive. Available here: https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230608~5cffb7c349.en.html

Stakeholders also noted that, as stated above, due to the underlying assumptions made during risk assessments, instead of concrete actions the most common mitigation approach taken is that of engagement with clients. In addition, interviewed stakeholders noted that they struggle with questions from clients on how they can effectively manage the identified risks in particular when bound to EU policies, which remain challenging to answer when data is insufficient to properly inform impacts of specific actions. Hence the focus remains with actually developing robust risk assessments, improving the available data and integrating it, rather than on mitigation steps per se.

Integrating biodiversity risk assessments into decision-making processes enables financial institutions to proactively manage potential challenges and uncertainties. By understanding their exposure to nature-related risks, they can develop risk management strategies that take into account the complexities of biodiversity loss and ecosystem degradation. This proactive approach empowers financial institutions to align their investments and operations with sustainable practices and leverage new investment opportunities that contribute to biodiversity conservation and resilience.

2.4. Key conclusions and data gaps

2.4.1. Identifying risks

Proper categorization and definition of risks is important, as it not only serves as a tool for alignment in understanding and terminology, but also for increasing awareness. However, our research found that this can sometimes fall short due to the intricate nature of biodiversity-related challenges leading to oversimplification. For instance, the intricate interplay of impacts and dependencies might not be adequately captured, as well as systemic dimensions of risk propagation, potentially leading to misconceptions about the genuine extent of impacts, dependencies, and the corresponding mitigation strategies. Furthermore, our research found that the usage of terminology can vary is often characterized by nuances. The terminology for specific aspects can vary, encompassing slightly broader or narrower scopes, thereby influencing the understanding and the manner in which risks are evaluated or subsequently addressed. In the future, the Commission will continue to dedicate resources to building up this knowledge, for example through the Horizon Europe Framework Programme call topic ‘Biodiversity, economics and finance: Understanding macro-financial risks associated with biodiversity loss’ ([188]).

2.4.2. Conducting risk assessment

Within the domain of biodiversity risk assessment, a landscape characterized by a multitude of international frameworks and tools exists; however, a standardized

(188) Under the call HORIZON-CL6-2024-BIODIV-01-4; https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl6-2024-biodiv-01-4

approach is notably absent. Although the Taxonomy proves valuable in appraising the sustainability of activities, it is primarily not intended to assist in conducting nature-related risk assessments. Initiatives like the TNFD provide essential conceptual frameworks, yet the lack of quantitative tools and especially data hampers a comprehensive assessment of risks, particularly concerning interdependencies and interconnectedness, essentially creating difficulties in fully capturing double-materiality.

The current landscape of risk assessment leans heavily on tools such as ENCORE, which predominantly assess direct exposure to dependencies and impacts. However, these tools fail to support the materiality assessment, informing about the (magnitude) of financial implications. In addition, these tools reveal significant gaps when it comes to evaluating sectoral interconnectedness essentially creating difficulties in fully capturing double-materiality. Stakeholder interviews have underscored the need to utilize a range of tools to overcome varied limitations; for instance, employing IBAT for location-specific risks and considering the Global Biodiversity Framework for transition risks that tie into regulatory dynamics. This complexity underscores the current intricate nature of risk assessments.

The complexity of this risk assessment landscape therefore also requires a solid grasp of tools and methodologies, but interviews with stakeholders reveal additional hurdles such as data accessibility and resources. Notably, smaller banks, constrained by limited resources, encounter barriers such as paywall data for assessments and data procurement. In addition, an absence of location data, vital for gauging dependencies and impacts, emerges as a significant gap during interviews. The dimension of consumer choice, which is not captured quantitatively at this stage within existing tools, further complicates comprehensive risk assessments.

To address these multifaceted challenges requires a blended quantitative and qualitative approach, leveraging available data for quantification while embracing qualitative methods to bridge information gaps, report stakeholders. The overall risk assessment landscape is also hindered by general data gaps, which is directly linked with a lack of corporate reporting currently. Literature and stakeholder interviews reveal that best-practices in reporting of related risks is still only occurring in larger, international financial institutions and companies, but even here the data on supply-chain transmission risk remains sparse. Capturing transmission channels is of utmost importance, particularly to comprehend supply chain effects and intersectorability, crucial for macroeconomic assessments. So far, these macro-level approach have mainly found traction among National and Central Banks, although sector-specific transmission channels remain relatively underexplored.

An integrated approach emerges as paramount in interviews and literature reviews, stressing the interplay between nature-related and climate-related risks. This synergy underscores the need for seamless collaboration between nature risk assessment and established climate risk evaluations, facilitating a comprehensive risk management approach that maximizes risk mitigation efforts.

2.4.3. Mitigation approaches

Risk mitigation practices based on risk assessments are currently limited in their application. This is primarily due to the current level of risk assessment, which tends to focus on direct impacts and dependencies, while overlooking a more comprehensive understanding of risks.

The prevailing nature-related risk mitigation strategy for financial institutions centers around institutional transformations. This involves reshaping governance structures, enhancing reporting mechanisms, and promoting greater disclosure. Engagement activities are key to achieving a general risk reduction in financial institutions portfolios, and is often a more feasible approach than divestment. Furthermore engagement activities also ensure that transformation changes are happening at individual company level. Hence mitigation steps are focused on establishing better understanding of risks, through reporting, disclosing and first steps in risk assessments. These initial steps are crucial for gaining a deeper insight into the true extent of nature and biodiversity risks faced by financial institutions and individual companies.

Nevertheless, the practical implementation of on-the-ground mitigation measures remains deficient. This is particularly evident when examining the hierarchical approach to risk mitigation, where limited evidence suggests significant emphasis on avoidance and proactive mitigation strategies. While offsetting is a prevalent approach, as previously highlighted, its efficacy hinges on the preceding measures taken to avert degradation. In the absence of such pre-emptive actions, the attainment of a net-positive impact becomes improbable.

Consequently, the progression of mitigation efforts seems to be situated within a phase of institutional transformation. At this stage, the integration of information into decision-making processes is still an ongoing endeavor, primarily contributing to the increase of data collection practices.

3. Task 2 - Industry/business sector sensitivity to biodiversity loss and ecosystem degradation risks

3.1. Introduction

This chapter develops a systematic approach towards integrating sectoral sensitivity analysis in the financial institutions' nature (including biodiversity) related risk assessment and management approaches, to address some of the key gaps and needs identified through Task 1 and highlighted at the end of Chapter 2. The introduction therefore sets out with a brief explanation of how and why sectoral approaches can help financial institutions assess and manage nature related risks more effectively and efficiently. It then introduces the main outcomes and methodology of a sectoral sensitivity analysis that was carried out within the framework of the study to illustrate the steps that financial institutions could take to do their own analysis. Figure identifies the key methodological steps and their respective outcomes that underpin the structure of the remaining part of Chapter 3.

While every sector is to some degree dependent upon and has an impact on nature, **some (sub)sectors or industries are more exposed to biodiversity and nature related risks than others**, with implications on the financial institutions that loan, insure, or invests to entities from these sectors. Agriculture, food and beverage manufacturing, and construction are, for example much more exposed to nature-related risks such as deforestation, than other sub-sectors. Investments in or loans offered to entities from these sectors can then translate into risks to financial institutions as well, as the materialization of nature related risks could interfere with the ability of businesses from these sectors to generate returns or service debt-repayments. Deforestation is, however, only one of the drivers that exposes some sectors and industries to greater dependence and/or impact risk than others, and several stakeholders interviewed for this study highlight the complexity of accurately assessing and prioritizing (sub)sectors that are more exposed to BES related risks.

Nonetheless, financial institutions will have to adopt a more systematic approach to address the significant source of variation in exposure to biodiversity and nature related risks across (sub)sectors by continuously monitoring sectors/industries that are especially sensitive to it, assessing the materiality/financial implications of these exposure, and by integrating this information into their risk management approaches. This is especially important at the current stage where relevant micro level is often lacking, as confirmed by all stakeholders interviewed, and more accurate risk assessment is not feasible, even when significant financial and personal resources could be mobilized by financial institutions. With the increased use of nature related financial risk assessment and disclosure frameworks like the TNFD or through the implementation of the EU Corporate Sustainability Reporting Directive, a more bottom-up approach to effective biodiversity and nature related financial risk assessment and mitigation measures might become attainable, as reliable, and comparable micro-level data on biodiversity-related risks becomes more available. In the meanwhile, the integration of

sectoral considerations can play a particularly important role to ensure that exposure to biodiversity and nature related risks is properly assessed, their transmission to financial institutions is adequately considered and the effective mitigation measures are adopted.

This chapter contributes to the development of a systematic approach towards integrating sectoral aspects in the assessment and management of biodiversity and nature related risks related risk to financial institutions, that will be the primary focus of Chapter 4, in three important ways, that are explained in sub-section 3.1.1 (Key contributions). These seek to address at least some of the gaps in current risk assessment approaches identified through Task 1 and highlighted in section 2.3.4 (Key gaps/needs). The methodological approach, outlined in sub-section 3.1.2., also relies heavily on Task 1, in two important ways. Firstly, it expands the review of the same sources and uses the same interviews, to identify how sectoral sensitive approaches are generally approached in relevant references. Secondly, it is also informed by the risk typology, materiality assessment, transmission channels and mitigation approaches analysis from Chapter 2.

3.1.1. Key contributions

Firstly, it **identifies (sub)sectors that are exposed to biodiversity and nature related risk types** identified in Chapter 2 (essentially physical and transition risk). This part of the analysis, however, does not simply list the exposed (sub)sectors and industries, but also sheds light on how this identification is currently used by relevant risk assessment and management approaches. Additionally, it also examines the methodological approaches they relied on to identify the exposed (sub)sectors, that could then inform the recommendations given to financial institutions to assess their own exposure. In this study, the terminologies of (sub)sectors and industries are used interchangeably to refer to economic activities at more disaggregated levels of sectoral classification in general.

Secondly, based on the overview of methodological assessment, the study also develops and implements an **approach to assess the significance of exposure to biodiversity and nature related risk and prioritize (sub)sectors** accordingly, from the perspective of the EU economy. The analysis provides a general understanding of which (sub)sectors are most exposed to biodiversity and nature risk in the EU context. As such, the (sub)sectoral prioritization carried out in this step also aims to inform the sectoral considerations of the methodological framework that is developed as part of Chapter 4. Instead of providing a deterministic prioritization list, it also aims to exemplify a methodological approach that could be used as a starting point by financial institutions to evaluate the exposure of their business activities and portfolios, with additional adjustments that are necessary for that purpose. The list of EU-relevant materially exposed (sub)sectors might also change as technologies and value chains evolve, and as we are able to acquire further detail about exposure of various sectors. The emphasis is therefore more on the illustrative role of the materiality assessment.

Thirdly, the analysis examines how these risks in significantly exposed (sub)sectors are transmitted to financial institutions, and what approaches can be adopted to mitigate them. Transmission channels and mitigation measures are generally discussed at a high

level of abstraction and constitutes a key gap in existing nature-related risk assessment frameworks. ([189]) The emphasis in this chapter is therefore on providing some empirical insights into how these manifests in key sectors and industries that are particularly relevant from the European perspective, that can provide the basis for some general guidelines for all sectors and types of financial institutions.

3.1.2. Methodological outline

Addressing these key objectives was based on a three-step approach, that also underpins the structure of the chapter, and is summarized by Figure 3-1.

Figure 3-1 Methodological outline for analyzing industry sensitivity to biodiversity loss and ecosystem degradation risk

In ***Step 1***, a **systematic overview of relevant frameworks, tools and reports** was carried out to assess exposure of (sub)sectors to physical, transition (and systemic dimensions), continuing and expanding on literature review from Task 1. Through this comprehensive review, it was sought to:

- Acquire an initial understanding of (sub)sectors that are exposed to nature related risks (long-list of subsectors and relevant classification to use) that will provide the starting point for a prioritization based on the materiality of their exposures (the focus of Step 2).
- Analyse key patterns in their relevance and methodologies used for their identification, to highlight key weaknesses in terms of risks considered, levels of analysis, and methods used that is also relevant for the guidelines provided to EU financial institutions.

Step 2 consisted of the further refinement and implementation of **a quantitative analysis of the materiality of exposures of various (sub)sectors** from the perspective of the EU economy. This was done by assessing the significance of materiality of exposure to biodiversity and nature related risks of the exposed (sub)sectors identified in Step 1, as well as evaluating the severity of their potential economic/financial implications on the EU. The prioritization was based on a multiplicative assessment score indicating the significance of exposure to biodiversity and nature related economic risk, focusing on (sub)sectors in the top quartile. The analysis relied on the use of a

([189]) See also OECD study, but confirmed by our own analysis as well. OECD (forthcoming). A methodological supervisory framework for financial risks stemming from biodiversity-related losses: A prudent approach to nature

common nature-related risk assessment tool, ENCORE, and of secondary statistics on investments, value added and employments at (sub)sectoral levels obtained from Eurostat.

Finally, ***step 3*** consisted of **a series of industry case studies** to analyse the transmission channels of these risks to financial institutions and of the mitigation approaches that can be adopted to address them. This part of the analysis focused on three (sub) sectors identified to be most materially exposed to biodiversity and nature risk through Step 2, while also addressing some of its methodological limitations. More specifically, in this part of the analysis greater consideration will be given to inter-sectoral (value chain) linkages and locational aspects that are currently not factored in a systematic manner by most biodiversity and nature risk exposure assessment methodologies. Additionally, to the extent possible, this part of the analysis also seeks an improved understanding of how exposure to biodiversity and nature risks translates into financial risks and of mitigation measures that can be adopted, thus addressing another key gap identified through Step 1.

The subsequent sections are organized around these three key parts of the analysis, as illustrated also by Figure 3-1, but further methodological details and considerations that are relevant for the understanding of key results will be provided at the beginning of each section. The chapter concludes with some final considerations of key gaps and limitations of sectoral approaches in the assessment of biodiversity and nature related financial risk assessment and management.

3.2. Identification of (sub)sectors exposed to biodiversity and nature related risks

Consistent with the methodological outline introduced, this section proceeds with an analysis of sectoral sensitivity approaches used by relevant references and with the identification of a long list of exposed (sub)sectors identified by the reviewed sources. As such, this section:

- Explains how the literature review initiated as part of Task 1 was expanded upon for this purpose: a) the types of references considered, b) key dimensions of evaluation, and c) the benchmark used (the TNFD and some extent TCFD) to identify key differences and similarities.
- presents the 30 sub-sectors that the reviewed sources identify as exposed to biodiversity and nature risk. These sub-sectors, as can be seen in Table 3-2, span across primary, secondary, and even tertiary sectors, including agriculture, mining, manufacturing, utilities, construction, real estate, and other services.
- Examines how sectoral exposure is assessed across relevant references and integrated in nature-related risk management approaches of financial institutions.

This section presents some of the key findings of a comprehensive analysis of studies/reports, frameworks and tools that are relevant for the identification of sector exposure and transmission channels, complemented by some additional insights obtained through the interviews with stakeholders.

Overall, the systematic overview of these various resources available reveal some differences in terms of which sectors/industries are identified as being exposed to biodiversity and nature risk and sectoral classifications used, the methodologies they relied on to assess exposure to biodiversity and nature risk, and the way that these sectoral differences are integrated into their approaches. The channels through which these exposures translate into financial risk and mitigation measures that could be used to address them are considered by a relatively few sources.

Before exploring further these differences and similarities, to eventually allow us to draw some conclusions regarding the relevance of sectoral considerations for the final framework, key strengths, and weaknesses that the recommendations should factor in, the next subsection first presents the methodology used to conduct this overview. It then proceeds with the key findings regarding how sectoral considerations were used by the different resources reviewed, and the methodologies that they relied on to identify highly exposed sectors.

3.2.1. Methodology

The overview of the resources that are relevant for the assessment of sectoral exposure to biodiversity and nature risk and their transmission into financial risks considered several types of materials. While these were based primarily on the literature review conducted for the first part of the analysis (Chapter 2), the identification of relevant resources to be included within the scope of the analysis was also informed by the sectoral-sensitivity assessment methodologies used by the Taskforces on Climate and Nature Related Financial Disclosures (TCFD/TNFD). As such, the analysis considered the following types of resources ([190]):

- **Authoritative reports** – Reports published by intergovernmental, governmental, or other international organizations, which although do not provide a comprehensive framework, they discuss and analyse the issue of financial risks from biodiversity loss. An example in this regard is the Global Assessment Report on Biodiversity and Ecosystem Services published by the Intergovernmental Platform for Biodiversity and Ecosystem Services.
- **NGO and industry reports** – i.e. Reports published by NGOs and other industry-specific organisations. These refer to various reports published by the United Nations Environment Programme, World Wildlife Fund, United Nations Development Programme, OECD, World Economic Forum, Sustainable Finance

([190]) For a full list of the references reviewed and their classification, please consult the Tool that accompanies this Interim Report.

Platform (Biodiversity Working Group), but also industry associations like Finance for Biodiversity Foundation, EU Business and Biodiversity Platform, etc.

- **Risk management and disclosure frameworks** – i.e. frameworks that provide guidance to companies and financial institutions on the disclosure of their biodiversity impacts, dependencies, and their financial implications. The primary focus of the study was on the disclosure frameworks with a strong focus on financial risk and/or dedicated to financial institutions, especially the recommendations of the Taskforce on Nature-Related Financial Disclosures (TNFD). The overview also considered the guidelines of the Taskforce on Climate-related Financial Disclosures (TCFD), that the TNFD also builds on, ([191]) and of the Sustainability Accounting Standards Board (SASB) that is now integrated into the International Sustainability Standards Board (ISSB). Additionally, the analysis also reviewed other global and EU specific sustainability frameworks with broader materiality approach and/or for broader audience, such as the Global Reporting Initiative (GRI), as well as the European Sustainability Reporting Standards (ESRS) and the Corporate Sustainability Reporting Directive (CSRD).
- **Risk assessment approaches** – i.e. Comprehensive frameworks developed by or for financial institutions to assess their risk to ecosystem degradation and biodiversity loss. A significant part of these frameworks in our literature review were developed by central banks, such as the pioneering work of the Bank of the Netherlands, the Bank of France, the Central Banks of Brazil and Malaysia. But it also includes guidelines developed specifically for financial institutions by international organizations such as the Natural Capital Finance Alliance, Finance for Biodiversity Initiative, Cambridge Institute for Sustainability Leadership (CISL), etc.
- **Assessment tools and databases** – i.e. assessment tools referenced by the financial risk assessment and disclosure frameworks for companies to assess their biodiversity loss and ecosystem degradation related impacts, dependencies and risk exposure. Some examples in this regard include the Science-Based Targets Network sector materiality matrix, ENCORE tool, EXIOBASE input-output datasets, the Integrated Biodiversity Assessment Tool (IBAT), etc.

The content of the different types of resources included within the scope of the literature review were then evaluated across **a set of dimensions** considered relevant for the assessment and identification of sectoral exposure and materiality to biodiversity and nature and related financial risks. These dimensions were organized around three main areas including: 1) sectoral sensitivity aspects considered, 2) sectoral sensitivity assessment methodology, and 3) sectoral aspects of the transmission channels and mitigation measures.

The dimensions included under sectoral aspects covered areas such as exposed (sub)sectors identified, sectoral classification used, and the relevance/role of the identification of the exposed (sub)sectors. The second area, focused on methodological considerations, has examined the extent to which methodological clarifications are

([191]) The long-term objective is to have an integrated sustainability disclosure framework that covers both climate and nature.

provided within the resource, the risk drivers considered for the assessment, the type of risks factored in, the overall assessment approach including information about the extent to which inter-sectoral (value chain) linkages, locational aspects and scenario analysis were used, and the metrics used to assess the significance of biodiversity and nature risk exposure. Finally, under the third area, the reviewed references were evaluated in terms of including any relevant content with respect to channels through exposure to biodiversity and nature risk at the sectoral level affected financial results, the types of financial risks considered, metrics of quantifying financial risks, and any mitigation measures identified to address them, at the (sub)sectoral level.

An overview of the scope and dimensions of the literature review methodology is provided in Table 3-1. For most of the dimensions examined, the evaluation used **as a point of reference the comparable content provided by the TNFD** and to some extent TCFD frameworks. This is primarily due to the key relevance of the TNFD and TCFD as these two important international initiatives to assess and disclose exposure to nature (and climate) related financial risks and opportunities, that also serves as a starting point for the development of the guidelines, that will be discussed in Chapter 4.

Table 3-1 Key aspects of the literature review methodology

Types of references considered	Dimensions evaluated		
	Sectoral sensitivity aspects	Assessment methodology	Transmission and mitigation

• Authoritative reports
• NGO and industry reports
• Risk assessment approaches
• Disclosure frameworks
• Assessment tools
	• Prioritized sectors
	• Sectoral classification used
	• Sectoral sensitivity/exposure relevance
		• Risk drivers
		• Types of risks
		• Assessment approach
		  ○ Inter-sectorality
		  ○ Locational aspects
		  ○ Scenario analysis
		• Metrics of quantification
			Transmission mechanisms
			Types of financial risks
			Metrics of quantification
			Mitigation measures

The following sub-sections discuss key findings regarding the exposed (sub)sectors that were identified through the literature review (section 3.2.2.), an analysis regarding their relevance for biodiversity and nature related financial risk approaches (section 3.23.), and the methodological approaches used to identify them (section 3.2.4). Most of the reviewed sources provide very limited and merely very general information regarding key transmission channels and mitigation measures. These issues will therefore be approached under Section 3.4. with an empirical focus on the EU economy's most exposed (sub)sectors.

3.2.2. Exposed (sub)sectors

The sub-sectors/industries that are commonly identified as exposed to biodiversity and nature related risk in the relevant literature are summarized in Table 3-2. These **approximately thirty industries** were identified by consulting several references, that often relied on different sectoral classification systems. The sectoral/industry prioritization is sometimes based on the Global or Sustainable Industry Classification, but most often the classification system is not specified. As can be seen from the list, the industries are not limited only to primary sectors, but expand beyond it, as a significant part of these references also considered inter-sectoral (value chain) linkages, at least in an ad-hoc manner. These industries cover the entire agriculture, forestry, and fishing sector, but also include several industries from manufacturing, energy, transportation, construction and even services.

This list is relatively consistent with the sectors and industries identified prioritized by the TNFD and TCFD frameworks, illustrated by Table 3-3.

Table 3-2 Industries exposed to biodiversity and nature risk by reviewed references

Industries Exposed to Biodiversity Loss and Ecosystem Degradation Risk					
	Agriculture and Farming		Electronics		Water and Waste Services / Water Utilities
	Forestry		Food and Beverages		Construction and Engineering
	Fishing and Aquaculture		Machinery and Equipment		Retail Sale
	Metals and Mining		Medical Equipment and Supplies		Air Transportation
	Oil and Gas		Metals Processing		Water Transportation
	Automobile and Components		Oil and Gas - Mid and Downstream		Hospitality, Food and Beverage Services
	Biotechnology and Pharmaceuticals		Pulp and Paper Production		Hotels and Lodging / Accommodation
	Chemicals (and Biofuels)		Textiles, Apparels, Footwear and Accessories		Media and Communication / Digital Communication
	Household and Personal Products		Energy Production		Real Estate Services
	Construction Materials		Energy Transmission and Distribution		Health Care Delivery

Source: Trinomics, based on comprehensive review of relevant references addressing nature-related risk

As can be seen from Table 3-3, there is a significant convergence across the TCFD and TNFD in terms of the financial sectors that they focus on, including banks, insurance companies, asset managers and owners. The TNFD, however, also identifies development institutions as group of financial institutions particularly affected by nature-related risks. Development institutions were included in the TNFD due to their important role in nature-related financing, particularly in emerging markets, including key areas that are of great relevance for biodiversity and their ecosystem services, and/or associated risks. Financial institutions provide lending, grants and hybrid financing, etc to various entities in emerging economies.

There is, however, greater divergence across the two frameworks with respect to the non-financial sectors and industries prioritized. Both TNFD and TCFD identify energy, transportation, materials and building, and agriculture, food, and forestry as key affected areas, with only minor distinctions, related to a great extent to the different classification systems used. While the TCFD relies on the Global Industry Classification system, the TNFD uses the Sustainable Industry Classification System (SICS). The SICS was developed by the Sustainability Accounting Standards Board (SASB) and will provide the classification of the International Sustainability Standards Board (ISSB) – the emerging global baseline for sustainability disclosure – that the TNFD also seeks alignment with. There are however some additional differences related to intrinsic differences across the types of risks that they seek to address. In the case of the TNFD, for example, there are some additional industries – as for example alternative energy, water utilities, health care and biotechnology and pharmaceuticals, in the list of affected sectors.

Overall, the sectors and industries highlighted by key studies overlap relatively well with the ones identified by the TNFD framework as industries exposed to nature-related physical, transition risks (and systemic dimensions). Relative to the list based on the literature review, the only industries that are missing in the TNFD are some manufacturing related industries such as household products, electronics, machinery and equipment, medical equipment, and supplies. There is also some divergence with respect to an explicit emphasis on fishing and aquaculture, water transportation that are perhaps indirectly captured by the prioritization of biomes – rivers and streams, but also marine shelf – as part of the TNFD.

Table 3-3 Exposed sectors Identified by the TCFD and TNFD

Supplemental Guidance for Financial and Non-Financial Sectors		
	TCFD (Global Industry Classification)	TNFD (Sustainable Industry Classification)
Financial	• Banks • Insurance Companies • Asset Owners • Asset Managers	• Banks* • Insurance Companies* • Asset Owners* • Asset Managers* • Development Institutions*

Supplemental Guidance for Financial and Non-Financial Sectors		
Non-Financial	• Energy • Oil and Gas • Coal • Electric Utilities • Transportation • Air Freight • Passenger Air Transportation • Maritime Transportation • Rail Transportation • Trucking Services • Automobiles and Components • Materials and Buildings • Metals and Mining • Chemicals • Construction Materials • Capital Goods • Real Estate Management and Development • Agriculture, Food and Forest Products • Beverages • Agriculture • Packaged Foods and Meats • Paper and Forest Products	• Food and Beverage • Agriculture and Farming* • Food and Beverage Retail* • Renewable Resources and Alternative Energy • Forestry and Paper • Alternative Energy • Infrastructure • Utilities • Water Utilities • Electric Utilities* • Extractive and Minerals Processing • Construction Materials • Metals and Mining* • Oil and Gas* • Health Care • Biotechnology and Pharmaceuticals • Resource Transformation • Chemicals • Consumer Goods • Apparel and Textiles • Transportation • Marine Transportation

Source: Trinomics, based on review of the sectoral approach of the TCFD and TNFD.

Note: * - refers to those sectors/industries for which version 4.0 of the TNFD already developed some additional guidance, sometimes with light changes in the overall classification.

3.2.3. Relevance for biodiversity and nature risk assessment and management

The (sub)sectors exposed to biodiversity and nature related risks are considered by or integrated into relevant references in different ways. Some references, mostly reports, use them as cases to illustrate and/or examine exposure to biodiversity and nature related risks and/or their transformation into financial risk. Other studies integrate sectoral considerations primarily to approximate the significance of exposure to biodiversity and nature related risks of their financial portfolios, in the absence of comparable data at the micro level. Financial risk assessment disclosure frameworks and sustainability reporting frameworks in general, often use them to develop additional (or in some cases separate) standards or implementation guidelines to otherwise sector agnostic requirements and/or recommendations.

3.2.3.1. Illustrative cases and case studies

NGO publications and authoritative reports often adopt a sectoral focus describing how specific sectors are affected by nature-related risks. These reports are broadly aimed at raising awareness or deepening understanding of how physical and transition risks are relevant to different sectors. More specifically, UNDP SIF (2021) ([192]) analysed the dependence of the global insurance sector on nature, how nature-related risk can affect the sector and whether these risks are financially material to the sector's underwriting and investment business. In addition, UNEP (2022) ([193]) analysed the main dependencies and impacts for 10 high-risk sectors as priorities for initial action, aiming to assist financial institutions with developing a sectoral focus when assessing nature-related risks and developing potential tools and data collection methodologies. Lastly, ShareAction (2020) published a report that explores how major asset managers address challenges of biodiversity loss and ecosystem degradation; however, this report only presents current practices and asset managers' perceptions and does not provide a methodology or an assessment approach for integrating such considerations in the processes of asset management companies.

A significant part of the reports of industry associations includes references to sectors to also analyse exposure to biodiversity and nature risk through dependence and/or impact within a specific sector. For instance, CISL, Deutsche Bank, & UBP (2022) ([194]), Robeco & CISL (2022) ([195]) and CISL & AON (2022) ([196]) are all case studies that present an assessment of a specific type of financial risk focusing on a specific sector (or value chain) with the aim to enable and promote further such risk assessments across the financial system. CISL, Deutsche Bank, UBP (2022) assess the transition risk of fertiliser companies due to the adoption of the Farm to Fork Strategy in the EU; Robeco & CISL (2022) analyse the physical risks of companies in the agriculture value chain due to soil degradation; and CISL & AON (2022) map the dependencies of different industry sectors on a variety of ecosystem services.

3.2.3.2. Assessment proxy to substitute micro-level evaluations

Financial institutions generally lack quantitative and qualitative information from non-financial corporates that their businesses depend on, so they are constrained in their abilities to conduct a detailed analysis. They often rely on external databases indicating

([192]) UNDP Sustainable Insurance Forum (SIF) (2021). SIF scoping study: Nature-related risks in the global insurance sector. United Nations Development Programme, New York.

([193]) UN Environment Programme (2022). Prioritising nature-related disclosures. Considerations for high-risk sectors. UNEP-WCMC, Cambridge, UK.

([194]) University of Cambridge Institute for Sustainability Leadership (CISL), Deutsche Bank and Union Bancaire Privée (UBP) (2022). Nature-related financial risk: use case. The EU Farm to Fork Strategy and Fertiliser Companies.

([195]) Robeco and University of Cambridge Institute for Sustainability Leadership (CISL) (2022). How soil degradation amplifies the financial vulnerability of listed companies in the agricultural value chain.

([196]) University of Cambridge Institute for Sustainability Leadership (CISL) and AON (2022). Nature-related financial risk: use case. Mapping exposure to nature-related risks across financial indices

impact, dependence and risk associated with them to evaluate their own exposures, that are often at the (sub)sectoral level.

Most of the **risk assessment frameworks of major central banks** incorporate sectoral considerations into their methodologies. As described above, the risk of financial institutions to biodiversity loss and ecosystem degradation is ultimately determined by the nature-related impact and dependencies of the companies they finance. Therefore, the first step in the implementation of the risk assessment framework is to assess the impacts and dependencies of these companies and link them to the financial products/assets financial institutions have in their portfolios. Since focusing on each company separately would require a wealth of data currently not available to most financial institutions, to determine companies' exposure, frameworks examine the impact and dependencies of the whole sector (or sub-sector) these companies belong to, using assessment tools or more generic qualitative information. As a result, all risk assessment frameworks have to rely at least to some extent upon sectoral exposure information to determine the risk of financial institutions. More specifically, in the framework developed by the Dutch Central Bank (De Nederlandsche Bank, DNB), the sectors of the Dutch economy are assessed for their exposure to physical and transition risks, and subsequently the risk of the Dutch financial institutions is calculated based on the shares and corporate bonds of the exposed sectors these institutions hold in their portfolio. Similarly, the framework developed by the French Central Bank (Banque de France) focuses on company securities ([197]) that financial institutions hold in their portfolios, and their risk is estimated based on the exposure of the sectors of these companies and their location. In other (more qualitative) frameworks, such as the one described in the Bank of Mexico & UNEP (2020) ([198]) or in BfN (2022) ([199]) and in NCFA (2018) ([200]), assessment of risk focuses on the extent "priority sectors" contribute to financial institutions' portfolios. Under this approach, financial institutions identify priority sectors – by either using impact and dependency assessment tools or through qualitative analysis – to address the bulk of their exposure to ecosystem degradation and biodiversity loss before moving on to sectors with lower impacts or dependencies on nature.

The sectoral approach is not specific only to the risk assessment of the financial institutions but is also connected to the recommendations formulated by **risk assessment and disclosure frameworks, such as the TNFD**, as part of its LEAP risk and opportunity assessment approach (Locate, Evaluate, Assess and Prepare). Within the LEAP-FI approach, adjusted to meet the needs of financial institutions, sectors are a key entry point for the integrated risk and opportunity assessment, as entities from the financial sector are encouraged to explore their capital allocation to sectors, which asset classes/financial products do they have and how they interact with nature in those

([197]) Refers to listed shares, short-term debt securities and long-term debt securities

([198]) Bank of Mexico & UNEP (2020). Climate and environmental risks and opportunities in Mexico's financial system from diagnosis to action

([199]) BfN (2022). Biodiversity and finance: Managing the double materiality. Bundesamt für Naturschutz

([200]) Natural Capital Finance Alliance and PricewaterhouseCoopers (2018). Integrating Natural Capital in Risk Assessments: A step-by-step guide for banks. Geneva, Oxford and London

sectors, which locations (biomes/ecosystems) are they connected to. Additionally, at the next steps of the assessment and analysis, the LEAP-FI also recommends the use sectoral level data and analysis that is most feasible. These steps often rely on the use of specific tools and data sources that were generally developed by third parties. Some examples in this regard are the sector materiality matrix of the Science-Based Targets Network (SBTN), the ENCORE database, as well as the TNFD sector and biome guidance that is discussed below.

3.2.3.3. Sector specific implementation guidelines

The TNFD and TCFD exemplify the approach whereby additional guidelines are provided for the implementation of otherwise sector-agnostic assessment and/or disclosure metrics for entities from exposed (sub)sectors. The supplemental guides for the affected sectors highlight important considerations that should be factored in and provide suggestions for implementing the general disclosures to obtain a fuller picture of potential financial impacts in those sectors. As can be seen from Table 3-3, supplemental guidance is provided for the financial and non-financial sectors that are greatly affected by biodiversity and nature risk. These materials will also help to improve comparability within sectors. Draft disclosure metrics for financial institutions, agriculture and food sectors have been issued already as part of version 4 of the TNFD. There is also additional guidance on the use of the LEAP approach that also covers financial institutions, agriculture and food, mining and metals, and energy. Additional guidance and disclosure metrics will be released for further priority sectors, as they are developed by the Taskforce.

In the case of the TNFD, the additional guidance for financial institutions, for example, is to be applied at the level of the financial entity rather than at the level of financial products, as is the case with the TCFD. The TNFD financial sector guidance has also taken a sub-sector neutral approach, unlike the TCFD approach that produces tailored guidance for banks, insurance companies, asset owners and managers. The supplemental guidance for financial institutions includes recommendations with respect to governance, strategy, risk and impact management, as well as metrics and targets.

With respect to risk and impact management, for example, the additional guidance provides further information regarding the identification of a need for assessment of risk (including a further deep dive analysis for clients that have been identified as most impactful or dependent on nature, its integration into the traditional risk management approach, etc); and management of the identified risk (as for example adjustments to their pricing, or portfolio composition; due diligence and engagement activity with clients and counterparts to encourage clients to improve their posture with regard to nature related impacts and dependencies, etc). Similarly, the TNFD also includes specific recommendations regarding particular metrics that could be used to assess potential impact and risks, summarized in Table 3-4.

Table 3-4 Examples of TNFD supplemental guidance provided to the financial sector

TNFD Supplemental Guidelines for Financial Institutions regarding some Risk and Mitigation Indicators		
Category	Example metrics	Potential breakdown
Exposure to physical risk	Assets under management, lending, financing, or insurance activities exposed to material physical risks (absolute volume or %)	By sector By geography, such as country of biome
Exposure to transition risk	Assets under management, lending, financing, or insurance activities exposed to material transition risks (absolute volume or %) by sector and/or geography.	By sector By geography, such as country of biome
	Assets under management, lending, financing, or insurance activities in companies with environmental controversies (absolute volume or %) and heightened reputational risks	By sector By geography, such as country of biome
Mitigation of nature-related risk	Volume of financial flow (investment, lending, insurance) with evidence of material mitigation of nature-related risk through for example, engagement, due diligence, or sustainability linked KPIs	Absolute amounts Proportion of financing flows

Source: The TNFD Nature-Related Risk and Opportunity Management and Disclosure Framework – Beta v0.4 Annex 4.5 Financial Institutions metrics supplement – March 2023

In the case of agriculture and food sector, the additional metrics guidance refers primarily to impact drivers, including various metrics for climate change, land/freshwater/ocean-use change, pollution, resource use; and changes to the state of nature, with a focus on ecosystem condition and extent. ([201])

([201]) TNFD (2023): The TNFD Nature-Related Risk and Opportunity Management and Disclosure Framework: Beta 4.0 Annex 4.3. Disclosure Metrics Annexes, March 2023.

Not all biodiversity-relevant management and disclosure frameworks use sectoral aspects to provide additional guidelines with respect to core management and disclosure recommendations. Some frameworks take an additional step further, and develop separate sector-specific standards and metrics, that generally complement the general cross-sectoral standards.

3.2.3.4. Sector specific assessment approaches

Developing of sector-specific assessment and/or disclosure metrics for exposed sectors, associated with other risk disclosure and management approaches, such as SASB, GRI and even the ESRS.

Industry based sustainability disclosure standards is a key feature of the **SASB, integrated into ISSB since August 2022,** designed to meet investor information needs and enable companies to share relevant information for global capital markets, that is now becoming integrated into the ISSB Standards. The ISSB standards will retain this industry focus, spanning across 77 industries, believed to ensure a focus on the drivers of risk that are most relevant to business models within a given industry, but including also some cross-industry standards to ensure comparability. The SASB standards for financial sector included specific standards for: asset managers, commercial banks, consumer finance, insurance, investment banking and brokerage, mortgage finance, and security and commodity exchanges. Most of these standards included some generic requirements with respect to description of approach to incorporate environmental, social and governance (ESG) factors in their credit analysis. Biodiversity and ecosystem related aspects played a somewhat greater role for example in the industry specific standards for agriculture, but still related primarily to climate change and the use of genetically modified organisms (GMOs) rather than in a direct and independent manner. This might change as the SASB standards are improved and adjusted through the ISSB revision process.

The emphasis on biodiversity is much greater in the framework of the **Global Reporting Initiative (GRI) standards**, with a specific disclosure section dedicated to this dimension. The recommended disclosure requirements – if biodiversity is a material issue to disclose on for an entity refers to the operational sites owned, leased, managed in, or adjacent to protected areas and areas of high biodiversity value; significant impacts on activities, products, and services on biodiversity; habitats protected or restored; and IUCN species and national conservation list species with habitats in areas affected by operations. Additionally, however, the GRI also releases sector-specific supplemental standards to sectors associated with high sustainability impact, including oil and gas; coal; agriculture, aquiculture, and fishing; mining; textiles and apparel. Sector standards project for financial services will commence in 2023. In the case of agriculture, aquaculture and fishing sector, the supplemental sectors also cover biodiversity, with additional disclosure requirements for aquaculture (e.g. key information regarding the aquatic organisms produced, juvenile seeds stocks used as inputs, and the use of fishing products in feed) and fishing (e.g. key characteristics and information for each species of aquatic organisms caught or harvested).

Similarly, the recently adopted **European Sustainability Reporting Standards (ESRS)** associated with the EU's Corporate Sustainability Reporting Directive (CSRD) combine a set of detailed disclosures on biodiversity for entities across sectors, with additional, sector-specific disclosure requirements, to be developed over the next few years. Somewhat similar to the TNFD approach, the biodiversity and ecosystem section of the cross-sectoral ESRS includes disclosure requirements regarding the consideration of biodiversity and ecosystems in strategy and business model; policies, actions and resources related to biodiversity and ecosystems; the processes to identify and assess material biodiversity and ecosystem-related impacts, risks and opportunities; and key metrics and targets. The latter include disclosure requirements regarding targets, impact metrics, and anticipated financial effects associated with biodiversity and ecosystem change. The implementation of the CSRD and the ESRS follows a gradual phase-in approach, both in terms of the companies with specific characteristics (companies with less than 750 employees do not have to report on biodiversity during the first two years) and some of the metrics (initial reporting on the anticipated financial effects of biodiversity and ecosystem-related impacts, risks and opportunities).

With the increasing use of these management and disclosure frameworks, financial institutions should have at their disposal direct and relevant micro-level data to assess their exposure to biodiversity and nature risks. In the meantime, however, financial institutions will continue to rely on external datasets and various proxies at the sectoral level to evaluate their exposure. But the disclosure frameworks also exemplify that sectoral considerations could be used to collect additional data from or impose additional mitigation requirements upon entities in highly exposed sectors, or at least implement their sectoral agnostic due-diligence approaches with further attention to detail.

3.2.4. Sectoral sensitivity assessment approaches

The references reviewed for the identification of (sub)sectors exposed to biodiversity and nature related risk reveal considerable heterogeneity in their overall approaches, especially with respect to the methods used. To the extent that the references rely on a more systematic approach to identify (sub)sectors exposed to biodiversity and nature related risks, these tend to convergence around one of two key approaches. The first one refers to the review of relevant resources, often validated through consultations with market participants. The second main approach relies primarily on the use of assessment tools like ENCORE to assess materiality of exposure of specific (sub)sectors and on environmentally extended multi-regional input-output databases to consider inter-sectoral (value chain) and locational aspects.

3.2.4.1. Risk drivers and types considered

As already explained, nature-related financial risks encompass both physical and transition risks. Drivers of physical risks relate to the dependence of companies on ecosystem services to produce goods and services, while drivers of transition risks relate to the impacts companies have on ecosystems and biodiversity. **A significant part of**

the nature-related risk assessment frameworks reviewed under this study, **included both physical and transition risk drivers** in their methodologies to assess the exposure of (sub)sectors and industries to biodiversity and nature related risks. More specifically, in most of these sources, physical risk drivers for financial institutions are represented by the dependencies of sectors or production process on a range of ecosystem services. In term of the transition risk drivers, the reviewed sources focused on the IPBES drivers of ecosystem degradation and biodiversity loss. The idea is that financial institutions that invest in sectors that, through their operations, contribute to the five major drivers of biodiversity loss, increase their transition risks because of the policy and societal changes that aim to halt and reverse these damages. There has been **less consideration given to systemic risk/dimensions**, even though sectors and sectoral linkages are expected to play a considerable role in case of the emergence of ecosystem collapse, contribute to aggregated risk and and conduct contagion risk. ([202])

3.2.4.2. Assessment and identification approach

In **the case of the TNFD**, the identification of exposed sectors and industries, was based on a review and consolidation of existing sector-specific research and assessment focused on nature-related dependencies, impacts, risks, and opportunities. These were then used to assess and prioritize the exposure of sub-sectors to the five key risk drivers either through dependence or impact. Their research and assessment included studies by UNEP, World Economic Forum and PwC, Finance for Biodiversity Initiative, and EU Technical Expert Group on Sustainable Finance. The evaluation based on this review was then aligned with the SICS classification scheme to identify the thematic sectors, sub-sectors, and industries for prioritization, that are summarized by Table 3-2. This was then validated through consultation and engagement with the public, as the TNFD adopted an open innovation approach that encourages market participants to co-create the TNFD framework. In alignment with this approach, the first set of draft sector and biome guidance has also been developed through consultation with market participants in each sector, including several organisational members of the TNFD forum and TNFD knowledge partners.

The TCFD also relied on a similar approach to identify exposed sub-sectors, based on an initial ranking of various sectors and industries in function of their likelihood to be affected by three factors associated with both physical and transition risk – GHG emissions, energy usage, and water usage. As in the case of the TNFD, the initial assessment was done based on the revision of various sources that provided relevant information and was used to identify affected industries, organized into four main groups. The selection was then validated through 1) public consultations, 2) additional review of numerous sector-specific disclosure guidance documents, 3) consultation of the analysis provided by the Intergovernmental Panel on Climate Change (IPCC), and 4) examination

([202]) TNFD (2023): Definition of ecosystem collapse, aggregated and contagion risks refer to entire sectors being affected (ecosystem collapse risk) or constituting the main transmission channel (aggregated and contagion risk).

of relevant research and documentation from non-governmental organizations (NGOs) and industry organizations.

Sector level proxies and considerations used by quantitative risk assessment frameworks are often integrated into **specific assessment tools** that these rely on and whose use is recommended by the TNFD LEAP-FI guidelines as well. These assessment tools were already introduced by Table 2.1. that provides a comprehensive overview of nature related risk-assessment approaches, including exposure assessment tools and relevant databases. Both DNB (2020) and the Banque de France (2021), for example, also rely on sectoral level analysis for the assessment of their exposure to physical and transition risks. To gauge the physical risks, the study analysed the dependencies of the Dutch financial institutions on 21 ecosystem services using **the ENCORE tool**, while, for the transition risks, the report used the **GLOBIO model** to calculate the biodiversity footprint of these institutions because of changing land use and GHG emissions. A similar approach is used in the study of the French central bank. To calculate the dependency score of the companies that French financial institutions have invested in, the study obtains levels of dependency of production processes on ecosystem services **using the ENCORE** tool and then calculates dependence on these ecosystem services. To estimate the biodiversity footprint of the companies in the portfolios of the French financial institutions, the study used the **BIA-GBS methodology**, covering most of the IPBES drivers. A more recent study prepared by the Central Bank of Malaysia, analyses the biodiversity impacts and dependencies of banking and economic sectors using **the ENCORE tool** for both nature-related physical and transition risk. ([203]) As an additional element for the transition risk assessment, the study also considered the exposure of banks loans for the purchase of commercial real estate, infrastructure and construction in areas considered as key biodiversity areas was also quantified.

While an exhaustive analysis of all these assessment tools that rely on sectoral approaches is beyond the scope of the study, Boxes 1 and 2 discuss some of the most relevant ones that could be further improved upon and integrated in recommendations given to financial institutions as well.

([203]) World Bank and Bank Negara Malaysia (BNM). An Exploration of Nature-Related Financial Risks in Malaysia. Kuala Lumpur. World Bank. (2022); ENCORE.

3.2.4.1. Box 1: The main assessment tool used to assess materiality of nature related risk for industries

The **ENCORE tool** constitutes the predominant approach to assess the materiality of sectoral exposure to nature related physical and transition risk. Its use allows for the assessment of materiality of exposure on an ordinal scale, ranging from "very low" to "very high". This evaluation is possible across 11 sectors and 157 sub-industries, through 86 production processes that can be linked to various sub-industries and sectors.

The ENCORE rating is based on a comprehensive review of the current body of relevant information on ecosystem services dependencies and impacts on key drivers for all economic sectors. For the assessment of exposure to dependence risk, literature reviews were carried out for each ecosystem service class and production process combination using a systematic search approach. The evaluations are also informed by expert interviews carried out with sector specialists to validate information for some dependencies given the existence of some gaps. This resulted in a comprehensive assessment of dependencies of each of the 167 economic sub-industries upon 21 ecosystem services. As with the approach for dependencies, literature reviews and expert interviews were also carried out for each impact driver and production process combination.

For each of this link between production process and impact drivers and production process and ecosystem service, ENCORE provides a rating from "Very low" to "Very high" according to the level of impact or dependency each process has on impact drivers or ecosystem services, respectively. The synthesis of the rating of each production process employed by a sub-industry produces the overall rating of the sub-industry.

To assess the potential importance of the contribution an ecosystem service makes to a production process, the materiality evaluation considered two key aspects. Firstly, it assessed the significance of the loss of functionality if the ecosystem service is disrupted, leading to a potential evaluation of limited, moderate, and severe loss of functionality. Secondly, it also considers the significance of the financial loss due to the loss of functionality, focused primarily on the companies' profits, and allowing for limited, moderate, and severe financial loss as possible outcomes. The dependency materiality rating reflects both considerations, whereby a "very high" rating means that both the loss of functionality and the financial impact is severe.

The evaluation of the significance of a potential impact of a production process follows a similar approach, considering three aspects. These include an evaluation of the frequency with which the impact is expected to occur (ranging from high to low), of the speed at which it might affect the natural capital (with less than a year, between one and three years, and more than three years as possible responses), and the severity of the expected impact (high to low). These evaluations are then consolidated to derive the final evaluation of materiality, on a scale from very low to very high.

The ENCORE tool, however, does not consider inter-sectoral linkages, locational aspects, or the role of mitigation measures in its overall assessment approach.

Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

3.2.4.2. Inter-sectoral considerations

Although almost all publications reviewed in this study and stakeholder interviewed highlight the importance of considering physical and transition risks at value chain level, **not all assessment approaches look beyond first-order impacts and dependencies and considers inter-sectoral (value chain) linkages in an explicit manner**.

TNFD's LEAP approach specifically mentions the importance of analysing organisations' value chains, involving both upstream (including third-party suppliers) and downstream (including final product use and disposal) considerations. This refers to mostly "locating" the corporations' interface with nature, which of course relates to the evaluation of the size and scale of dependencies and impacts. SBTN Initial Guidance as well suggests that organisations assess physical and transition risks at value chain level along sector- and company-level to produce an extended list of dependencies and impacts. Using information on geolocation of business activities together with sophisticated assessment tools, corporations, and financial institutions by extension, can produce more accurate and robust impact and dependency assessment results. A comprehensive value chain analysis is one of the future avenues of research of nature-related physical and transition risks, as it is a quite complex exercise that requires a wealth of data and information to be collected and shared by companies. BfN (2022) proposes using a similar four-step approach that is used for climate risk analysis, moving from the analysis of direct impacts, to impacts of acquired or consumed production inputs, to impacts from sources not owned by the company up- and downstream, to finally spatial footprint of existing facilities. These approaches are still in their infancy; however, DNB (2020) did consider the impact made through companies' supply chains and Banque de France (2021) considered upstream dependencies, both using input-output models.

3.2.4.3. Box 2: Input-output databases used to consider inter-sectoral and locational aspects at industry level

Environmentally extended multi-regional input-output tables allow to trace consumption and production patterns linked to a specific (sub)sector throughout its supply chain and across nations, that is then used to assess environmental pressures associated with them. This can then be used to integrate inter-sectoral (value chain) and locational considerations in biodiversity and nature related risk assessments at the (sub)sectoral level. The **EXIOBASE input-output database** constitutes one commonly used input-output table for this purpose, that provides harmonized and detailed supply-use tables for several countries, estimating emissions and resource extractions by sector and industry. ([204]) This dataset can then be used to assess environmental impacts, including impacts on ecosystem services and biodiversity, associated with the final consumption of goods. Another example in this regard is the **EORA Global MRIO database** that matches multi-regional IO tables that allows for the assessment of inter-sectoral linkages across 15,909 sectors across 190 countries. The IO tables, moreover, extend to environmental indicators covering GHG emissions, air pollution, energy use, water requirements, land occupation, N and P emissions, and primary inputs to agriculture (covering 172 types of crops).

Source: EXIOBASE ([205]), EORA Global Supply Chain Analysis ([206])

([204]) https://www.exiobase.eu/index.php/about-exiobase
([205]) Accessible through: https://www.exiobase.eu/index.php/about-exiobase
([206]) Accessible through: https://worldmrio.com/

3.2.4.4. Considerations of locational aspects

Unlike greenhouse gases, which do not have different effects on climate change depending on where they are emitted, locational aspects are particularly important when assessing nature-related financial risks, as economic activities directly affect the ecosystems in which they take place. For example, textile manufacturing, that is a water-intensive production process, that takes place in a drought-prone area would entail a substantially higher magnitude of dependency and impact on the freshwater ecosystem of that area than if it took place in a water-abundant area. Therefore, while similar economic activities would give rise to similar types of impacts and dependencies in different locations, the size and scope will be location-specific. ([207]) As such, for a comprehensive identification, assessment, and management of nature-related physical and transition risks, a thorough consideration of (sub)sector' interface with nature both directly and through its upstream and downstream value chains is necessary. For that reason, the first stage of the LEAP approach of the TNFD refers to "Locating" the interface of corporations with nature. To do that, TNFD suggests four core steps for financial institutions to address locational aspects, starting with understanding their footprint and the footprint of their assets in companies across several geographies; discerning the biomes (e.g., tundra, coral reefs, savannas) and ecosystems in which they operate as well as the condition and importance of these ecosystems at each location; prioritising areas and ecosystems with high integrity or biodiversity significance or experiencing rapid decline or important pressures; and finally identifying which sectors, business units, value chains or asset classes are interfacing with nature in these priority locations. Apart from TNFD, **several assessment frameworks reviewed in this study** have integrated in their approaches **at least some location-specific considerations** when analysing physical and transition risks of **corporations, sectors, and financial institutions**.

3.2.4.5. Time horizons and scenario analysis

Time horizons can also be important for the identification and assessment of nature-related financial risks. Time horizons come into play when considering physical risks, as these can be acute or chronic (see Section 2.3.1), which have implications in terms of the time of their materialisation. Acute physical risks become apparent in the short term, while chronic risks emerge in the longer term. In addition, the condition of the ecosystems that (sub)sectors interact with can change in different points in time, that should be considered when assessing the current and future integrity and significance of these ecosystems. Although the time horizon of the materialisation of the physical and transition risks at the (sub)sectoral level should be considered, **most of the assessment frameworks reviewed here did not integrate this into their methodologies**. Similarly, none of the reviewed resources has relied on any scenario analysis for the identification and prioritization of exposed sectors.

([207]) TNFD (2023). Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.4. Annex 4.6 Guidance on LEAP: Methods for assessing nature-related risk

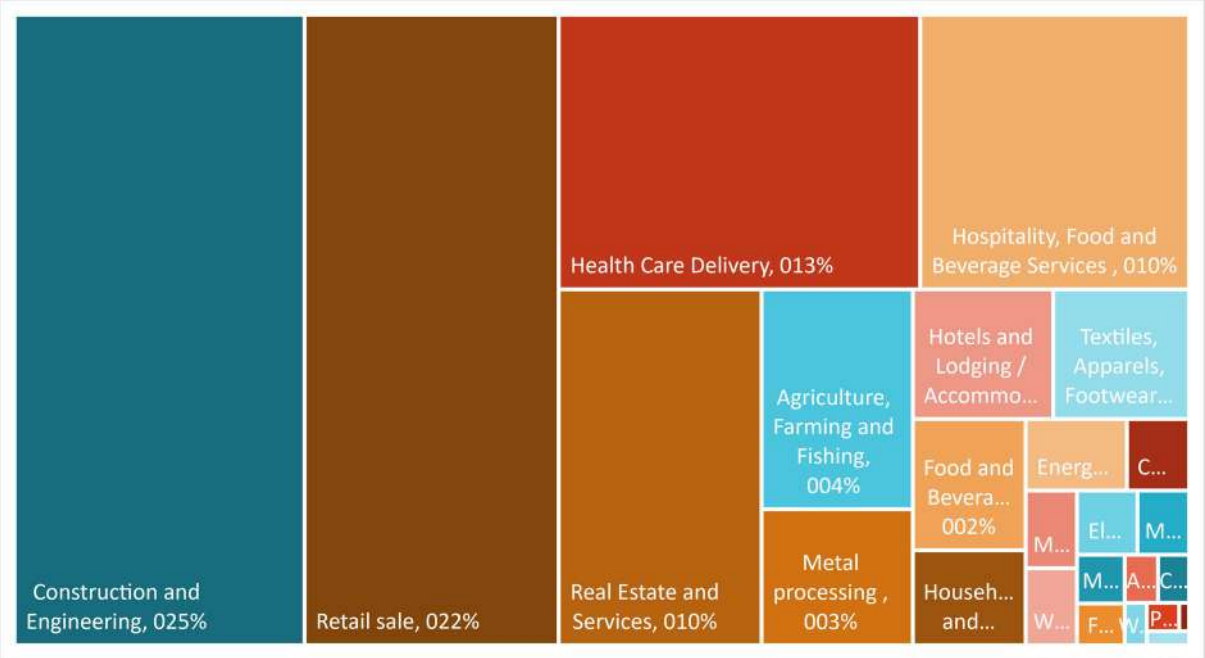
3.3. Prioritization of exposed (sub)sectors from the EU perspective

In this section a methodology is developed and applied to contextualize the exposed sectors within the EU and to prioritize them according to their nature-related and economic/financial materiality. The results indicate that within the EU, real estate and construction, agriculture, and health care and pharmaceuticals are the most exposed to the potential economic/financial impact of nature-related risks. Our assessment also reveals, however, that data limitations remain significant even at the sectoral level and highlights the importance of more systematic consideration of inter-sectoral (value chain) linkages and of locational aspects to understand transmission channels and inform mitigation measures.

The list of (sub)sectors and industries exposed to biodiversity and nature risk, identified through the literature review, and summarized by Table 3-2, constitute a significant part of the European Union economy. In 2021, for example, approximately half of the companies from the 27 EU Member States (corresponding to 15 million companies) operated in these (sub)sectors and industries through their main activities. (208) A significant part of these companies was active in the construction and engineering sector (25%), retail sale (22%), health care delivery (13%), followed by hospitality, food, and beverages services (9.97%), real estate and services (9.75%), agriculture, farming, and fishing (4.5%), metal processing (2.78%). The sectoral distribution of these companies is presented in Figure 3-2.

([208]) Estimation based on company statistics from the Eurostat Structural Business Database.

Figure 3-2 Sectoral distribution of companies with main activities in (sub)sectors exposed to biodiversity and nature risk



Source: Eurostat Structural Business Statistics, 2021

Dependence and impact on biodiversity and ecosystem services of the companies from these sectors could translate into significant financial risk for them and for the financial institutions that invest in or loan to them, underwrite their insurance policies and/or manage their assets. According to statistics collected by the European Commission and the European Central Banks's as part of their survey on access to finance of enterprises (SAFE) ([209]), approximately 2.3 million companies from the affected sectors – about 7% of all EU companies - have used loans over the past 6 months. This corresponds relatively well with the estimated 3 million companies financed by Euro area banks that were estimated by the European Central Bank to be highly dependent on at least one ecosystem service. ([210])

The companies from these sectors would necessitate additional measures to manage the exposure of financial institutions to biodiversity and nature degradation risk in the future in an effective manner, as for example through adjustments in their due diligence procedures. Such measures would affect not only those companies that currently rely on bank loans or equity as external financing, but those that apply for external forms of financing. According to the SAFE survey statistics, the average share of companies that applied for bank loans in the past six months from these sectors, and thus had to go through the initial evaluation process was 21% (3.1 million companies). The share of companies that consider using loans in the future from these sectors is even more

([209]) European Commission (2022) Survey on the Access to Finance of Enterprises (SAFE): Analytical Report for 2022. Available at: https://single-market-economy.ec.europa.eu/access-finance/data-and-surveys-safe_en

([210]) Elderson, Frank (2023) The economy and banks need nature to survive, ECB Blog published on 8 of June 2023. Available at: https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230608~5cffb7c349.en.html

substantial, at 46% or close to 7 million companies, or 22 % of all companies from the EU.

Adopting adequate biodiversity and nature related governance, strategy, and risk management measures, however, might require significant resources by financial institutions, and as such, would benefit from a **prioritization of affected (sub)sectors** in function of the significance of the risk that they are exposed to.

The current sub-section provides an illustration of an approach to measure and prioritize the significance of exposure to biodiversity and nature risk from the perspective of the EU economy, that could serve as a starting point for similar exercises by financial institutions as well. It is important to note, however, that this methodology would have to be adjusted to the specific business models and portfolios of the specific financial institution in question.

In what follows, this sub-section proceeds with an outline of the methodological approach used to prioritize the affected sectors and identify those industries that are most materially exposed from the perspective of the EU economy. It then presents step-by-step the implementation of this approach, indicating also partial results. The sub-section then concludes with a discussion of the results and of key limitations of the approach, that will be addressed in the next sub-section.

3.3.1. Methodology

The methodology to assess and prioritize (sub)sectors from the perspective of the EU economy relied as a starting point on the list of 30 industries identified through the literature review but entailed several additional stages. Overall, the approach follows **TNFD risk materiality assessment guidelines**, ([211]) discussed also in section 2.4.2, that recommends using:

Biodiversity and nature/ecosystem related risk (BES) exposure metrics, based on nature related dependencies and impacts, that is often assessed through heat maps, evaluating in relative terms the severity of exposure in terms of very low to very high levels of exposure; and

Metrics assessing the magnitude of potential economic/financial implications. While these are often difficult to quantify, this is generally based on an assessment of potential for damages to the economic/financial performance, sometimes integrating also forward-looking analysis.

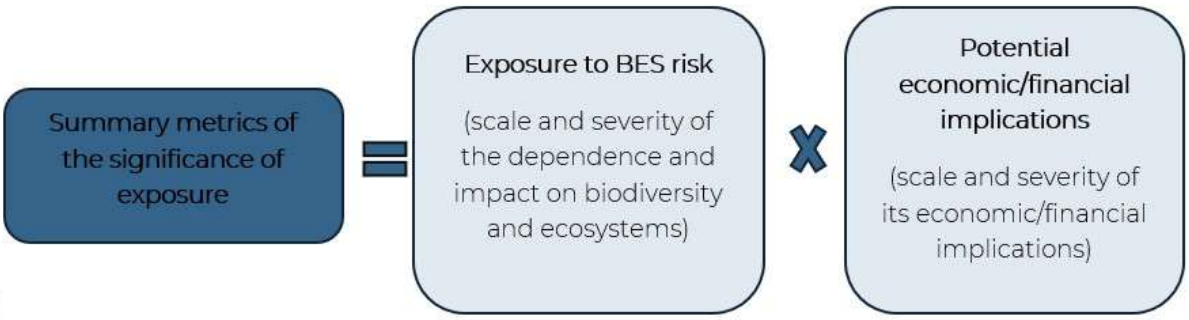
These two components can also be understood proxies of 1) the scale and severity of the dependence and impact on biodiversity and ecosystem, and 2) of the scale and severity of its implications for society from these dependencies and impacts. Factoring in these two components allows for the computation of summary metrics of the significance of the exposure associated with each (sub)sector and a prioritization among

([211])TNFD (2023). Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.4. Available at: https://framework.tnfd.global/leap-the-risk-and-opportunity-assessment-approach/assess/a4-risk-and-opportunity-materiality-assessment/

them. This can, therefore, be understood as a proxy for the financial/economic importance of the exposure to material/elevated physical and transition risks.

The key components of this overall approach are summarized by Figure 3-3, that also structures the analysis undertaken in this study into three key stages.

Figure 3-3 Assessment and prioritization of exposure to BES risk



In a first stage, the **severity of the potential negative implications of biodiversity and nature related dependence and impact** were evaluated for each sub-sectors and industries identified through the literature review was assessed, as a proxy of the severity of the exposure to biodiversity and nature risk.

This was done primarily with the use of the ENCORE tool – that is commonly used by financial institutions (and systems) to better understand, assess, and integrate the risks that environmental degradation and biodiversity loss causes for their activities, as explained in Section 3.2. In essence, ENCORE provides scores, ranging from “very low” to “very high”, for the materiality of dependence and impact of economic activities, considering the specific industrial processes that they entail. Materiality in this context refers primarily to the potential of having a significant impact on financial performance. For a more detailed explanation of the methodological approach of the ENCORE tool, please see Box 1. In this essence, ENCORE relies on various types of resources to assess the materiality of dependence upon 21 ecosystem services and impact on 11 drivers, across approximately 157 sub-industries. The latter is classified into 11 sectors, 25 industry groups, and 74 industries.

However, the sub-industry classification used by ENCORE, based on the Global Industry Classification Standards (GICS), does not follow the classification of sectors found in the long list of sub-sectors of this study, informed by several references using divergence sectoral classification systems. Therefore, the first step of our approach was to link each sub-sector in the long list to the ENCORE production processes it involves. For example, the sub-sector “Textiles, Apparels, Footwears and Accessories” of the long list was linked with the ENCORE production processes of “Natural fibre production”, “Synthetic fibre production”, and “Footwear production”. Upon an alignment of the affected sub-sectors and industries identified through the literature review with these 86 activities, the affected industries identified through the literature review were ranked on an ordinal scale of significance of dependence and impact. This provided the basis for an evaluation of the

severity of the exposure to physical and transition risk at a general level, that is explained in greater detail under section 3.3.2. For an overall biodiversity and nature related risk assessment score, the scoring for exposure to biodiversity and nature related physical and transition risk were added.

The second stage entailed the evaluation of the **economic significance** of these sub-sectors and industries, that **approximated the significance of the potential economic/financial implications** that the materialization of biodiversity and nature - related risks assessed in Stage 1 could bring about**.** In other words, this evaluation captures the vulnerability of the EU economy to the potential disruptions and financial implications of biodiversity loss and ecosystem degradation.

This part of the analysis first relied on matching the list of 30 affected sectors with corresponding NACE codes. This was necessary because the list was compiled from the revision of several resources, that often used very different classification system. NACE (Nomenclature of Economic Activities) is the European statistical classification of economic activities, that is commonly used by Eurostat and by relevant EU regulations. Considering the emphasis on the EU economy in the study, it made sense to converge all the alternative classification systems towards NACE. Another significant advantage of NACE is that it uses four hierarchical levels of classification, from 21 sections (level 1) to 615 classes (level 4), thus allowing an adequate fit across all the affected (sub)sectors and industries.

Secondary statistics were then collected for all the NACE codes associated to the 30 (sub)sectors and industries, to assess their overall significance for the EU economy. This included data on gross capital formation (often used as a proxy for investments), employment, and value added as they constitute key dimensions of the EU economy. These were then used to compute an economic relevance indicator, that conferred equal importance to the three economic dimensions. This was used as a proxy of the likelihood that the severity of the exposure to BES risk assessed in Stage 1 will materialize and affect the EU, given the specifics of the EU economy. In the case of financial institutions, however, it will suffice to focus on their portfolio data to acquire an assessment of the extent or likelihood of their exposure to BES risk.

Finally, **in the last/third stage**, an **overall assessment score was computed**, using the integrated dependence and impact materiality score, on one hand, and an indicator of economic relevance, on the other. This significance of exposure score can therefore be considered the ultimate materiality score that allows for a prioritization of sub-sectors both in terms of the extent of risk of its financial performance being affected by biodiversity loss and ecosystem degradation, and the extent of economic damage that this could result in. This materiality or significance of exposure score was then used to rank and prioritize the 30 sub-sectors and industries in function of the significance of their BES risk exposure.

3.3.2. Biodiversity and nature related risk assessment

The first stage of the prioritization consisted of the evaluation and ranking of the severity of the exposure of sub-sectors to nature related impact and dependence, relying on the use of the ENCORE tool.

The analysis started with aligning of all affected sub-sectors with their corresponding industrial processes. This then allowed for a rating of the materiality of nature related impact and dependency of the individual processes for each (sub)sector, using the average of the rating across all industrial processes associated with them. To do that, the qualitative description of impacts and dependencies was substituted by a quantitative score between 1 and 5, with “Very low” corresponding to 1 and “Very high” to 5. For example, the process of “Natural fibre production” has a “Very high” impact on “Water use” and “Synthetic fibre production” and “Footwear production” have a “High” impact on “Water use”, which translates into “High” impact on water use on average for the “Textile, Apparels, Footwears and Accessories” sub-sector ((5+4+4)/3= 4). This process was followed for each sub-sector, assigning an average score for each ecosystem service and impact driver, as can be in Figure 3-4 that constitutes an excerpt from the workbook used for our estimations.

Figure 3-4 Excerpt from the workbook used for the estimation of the impact and dependency scores of the affected (sub)sectors

Industry	Dependency on nature and ecosystem services										
	Direct physical input					Enables production processes					
	Animal-based energy	Fibres and other materials	Genetic materials	Groundwater	Surface water	Maintain nursery habitats	Pollination	Soil quality	Ventilation	Water flow maintenance	Water quality
Agriculture and Farming	2	4	3	5	5		4	4	2	4	4
Forestry	2	5		5	5		4	4		4	
Fishing and Aquaculture		4	2	1	5	5		1	1	3	5
Metals and Mining				4	4					4	
Oil and Gas				2	2				1	1	2
Automobiles and Components				3	3					2	1
Biotechnology and Pharmaceutics			3	3	4					3	2
Chemicals (and Biofuels)				1	1				1	1	1
Household and Personal Products		2		3	4					2	
Construction Materials				5	5						2
Electronics				3	3						
Food and Beverages			2	5	5			2		3	3
Machinery and Equipment				3	3				1	3	2
Medical equipment and supplies											
Metal processing				3	3				1	3	2
Oil and Gas - Mid and Downstream				4	4					1	4
Pulp and Paper products		3		5	5						
Textiles, Apparels, Footwears and Accessories; (		3		5	5					3	2
Energy Production		3		3	4				1	4	2
Transmission and Distribution											
Water and Waste Services / Water Utilities				5	5			3		5	4
Construction and Engineering				3	3			2	1	3	
Retail sale											
Air Transportation				2	2						
Water Transportation				3	4					2	3
Hospitality, Food and Beverage Services				3					1		
Hotels and Lodging / Accommodation		2		4	4						2

To estimate the overall dependency and impact scores of each sub-sector in the long list, we considered both the scores of the affected impact drivers and ecosystem

services, as well as the number of the affected drivers and services. This allowed for the score to capture both the "depth" and "breadth" of impacts and dependencies.

The formulas used for the estimation of the overall scores for each sub-sector were :

$$Subsector\ Impact\ score = \alpha * \frac{\sum Impact\ driver\ scores}{Number\ of\ affected\ drivers} + \beta * \left(\frac{Number\ of\ affected\ drivers}{11} * 5\right)$$

$$Subsector\ Dependency\ score = \alpha * \frac{\sum Dependency\ scores}{Number\ of\ affected\ services} + \beta * \left(\frac{Number\ of\ affected\ services}{21} * 5\right)$$

The weights (α and β) used in the derivation of the impact and dependency scores serve primarily illustration purposes. A specific set of weights, as we foresee, might require an inclusive consultation process with a broad group of stakeholders, which is beyond the scope of the project. However, according to the results of the preliminary sensitivity/robustness test, that we have carried out, there was no strong impact on ranking of the sectors when changing from 70-30 to 50-50 weights: only one of the seven top-ranked sectors was exchanged for another sector.

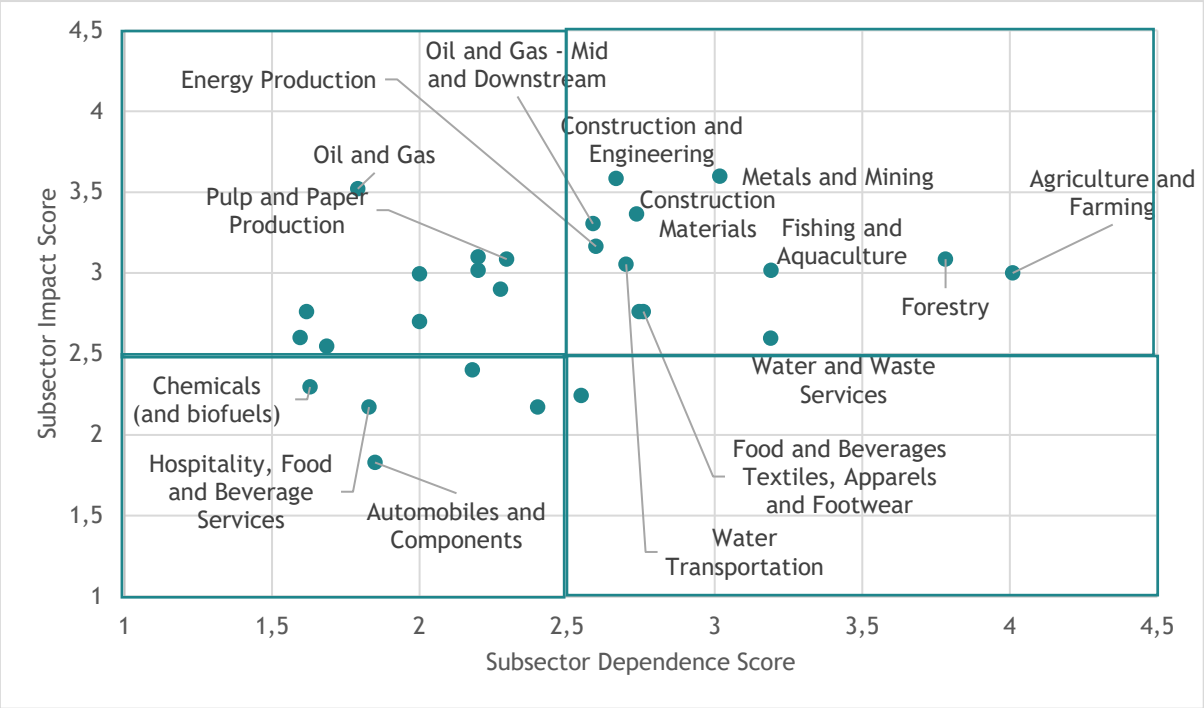
Figure 3-5 below presents the results corresponding to a weight of 0.7 for the depth (α = 0.7) and a weight of .3 (β =0.3) for the breadth of the impact and dependence scores. This scatterplot allows for the classification of the affected industries into four main groups.

Those with an overall score of dependency and impact score below 2.5 each, situated in the bottom left quadrant, could be considered *the least exposed industries to BES risk*. This group includes: Hotels and Lodging; Media and Communication; Hospitality, Food and Beverage Services; Chemicals (and Biofuels); Automobile and Component manufacturing, that are not very materially exposed to BES related risks through their direct industrial processes.

The second group is *the dependent industries group*, including those subsectors with higher than 2.5 dependence score, but below 2.5 impact score. This is composed of only the Energy Transmission and Distribution. More numerous is the *impact industries group*, consisting of Health Care Delivery, Air Transportation, Electronics, Household and Personal Products, Metal Processing, Real Estate and Services, Machinery and Equipment, Biotechnology and Pharmaceuticals, Oil and Gas, and Energy Production.

All the other industries belong to the *high impact and high dependence group*, with their respective scores above the 2.5 midpoint. This group includes Energy Production, Oil and Gas – Mid and Downstream, Construction and Engineering, Water Transportation, Metals and Mining, Fishing and Aquaculture, Forestry, Agriculture and Farming, Food and Beverages, Textiles and Apparels, and Water and Waste Services.

Figure 3-5 Subsector dependence and impact score



Source: Trinomics calculations based on data from Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

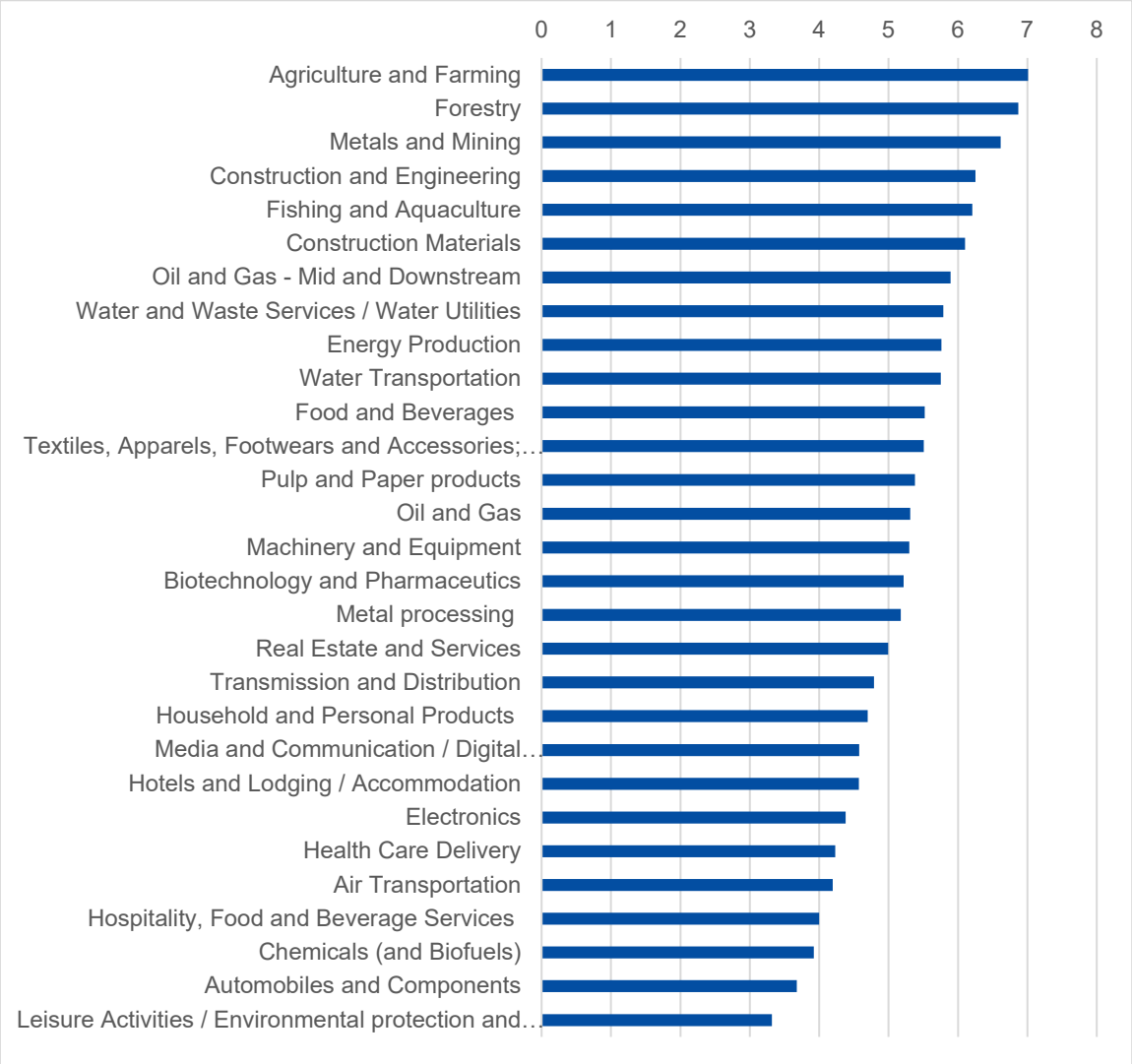
The overall sector's score is constructed as a sum of the two scores above: the impact score and the dependency score. This therefore attributes equal importance to the two components.

$$Subsector\ BES\ Risk\ Exposure\ Score = Subsector\ Impact\ Score + Subsector\ Dependency\ Score$$

A similar weighting approach might be potentially used also for the overall score calculation to fine tune the methodology to better reflect the risks prioritized. For example, a greater preoccupation with transition risk stemming from a potential tightening of the environmental regulation may require putting more weight on the "impact" part of the overall score. Financial ties to specific locations where ecosystems services are degraded and therefore their further provision is endangered, on other hand, might require putting more weight on the "dependency" part of the overall score to better capture relevant risks.

Figure 3-6 presents the ranking of the affected industries in function of their overall BES risk exposure scores. Consistent with Figure 3-2, this highlights the importance of the subsectors belonging to the fourth – high impact and high dependence group. The top quartile, consisting of the seven industries with the highest BES related risk scores includes: Agriculture and Farming, Forestry, Metals and Mining, Construction and Engineering, Fishing and Aquaculture, Construction Materials, and Oil and Gas – Mid and Downstream, in diminishing order of magnitude.

Figure 3-6 Ranking of industries based on their BES risk exposure scores



Source: Trinomics calculations based on data from Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

The figure also reveals that the Leisure Activities and Environmental Protection that align relatively well with the activities eligible for significant contribution to the protection and restoration of biodiversity and ecosystem under the EU Taxonomy Regulation – Accommodation and Conservation activities, are associated with relatively low BES risk exposure score. This, to a large extent is because the ENCORE tool and this study places greater emphasis on potential adverse effects of nature-related physical as well as transition risk. The EU Taxonomy, on other hand, focuses on economic activities that could be making a significant positive contribution to environmental objectives.

The sub-sectors identified as the most exposed to BES-related risk by the analysis within the study, are however, consistent with the Commission commissioned study caried out by Ramboll that evaluated and ranked activities according to their potential to exert

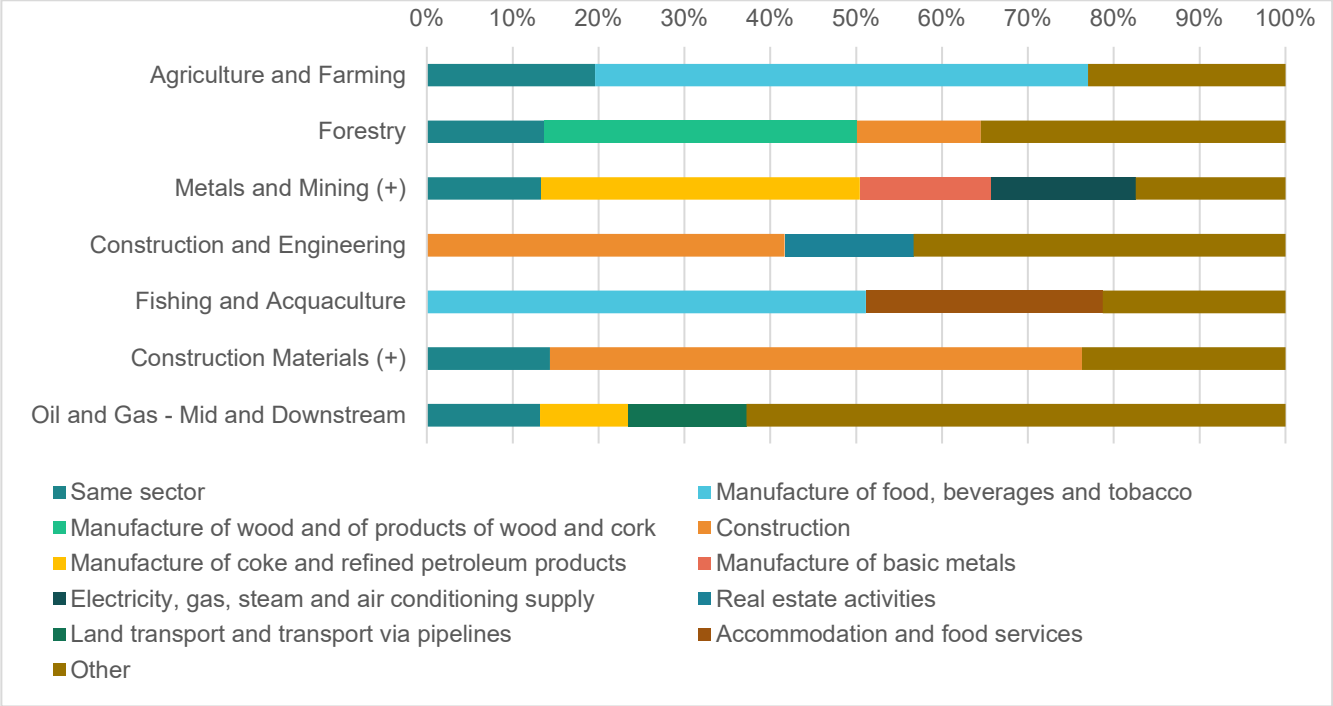
positive impact upon biodiversity and ecosystem. ([212]) This assessment was based on a different methodology, that prioritized impact, from the perspective of the potential to reduce negative impact and contribute to positive improvements. It also relied on a different source of data – the data collected on the European Environment Information and Observation Network (EIONET) on pressures and threats across ecosystems and conservation measures across Member States. The results also identified marine fishing, agriculture, forestry, real estate development to have high potential for positive improvements, while mining and quarrying – including metals and mining, and extraction of oil and gas – was associated with medium improvement potential.

The severity of the nature-related risks that these sub-sectors are exposed to can also **have implications for other sectors that they are interconnected with** through the supply chains. This is especially true for sectors that they are interconnected with downstream, through the supply of essential inputs for those industries. The indirectly exposed (sub)sectors would also have to be systematically incorporated in the nature related risk assessment and management methodologies of financial institutions, to ensure a comprehensive approach to the identification and mitigation of physical and transition risk. This can be done using input-output tables, as explained under section 3.2.4 and exemplified by Box 2.

The seven sub-sectors that are most exposed to nature-related risks, for example, provide important supplies to at least eight other sectors, thus indirectly exposing them as well to nature-related risks. These sectors are reflected by Figure 3-7, that indicates the sectoral distribution of the intermediate output (output that is used as supply in the same or other sectors) from each of the most exposed sub-sectors, highlighting those sectors that absorb more than 10% of intermediate output.

([212]) Ramboll/ European Commission DG Environment (2020) Final Report on Sustainable Finance Taxonomy Data Collection and Environmental Objectives. Service Request in the context of Framework Contract on Economic analysis of environmental policies and analytical support in the context of Better Regulation ENV.F.1/FRA/2019/000.

Figure 3-7. Downstream linkages of the seven sub-sectors most exposed to BES-related risk



Source: Trinomics calculations, using the WIOD database from 2014. ([213])

The figure shows that in the case of **agriculture and farming** for example, approximately 20 % of intermediate outputs are used within the same sub-sector. The predominant part of agriculture and farming output, however, is used for the manufacture of food, beverages, and tobacco. Similarly, in the case of **fishing and agriculture**, 51 % of intermediate output is destined for food manufacturing, with another 26% destined to accommodation and food services. This means, that the food and beverages sector is indirectly exposed to the nature-related risks of agriculture and farming, and fishing and agriculture as well, that are not captured by the ENCORE data and the analysis.

In the case of **forestry**, more than a third (36 %) of the intermediate output supplies the manufacturing of wood, wood products and cork (except furniture), with an additional 14 % used by the construction sector. The construction sector stands out as an important indirectly exposed sector not only through forestry, but also **construction materials**, with more than 60 percent of construction materials used by the construction sector. **Construction and engineering**, then at its own end, is interconnected with the real estate sector, with 15 percent of intermediate output of the construction sector used by the real estate service sector. Once again, construction ad engineering is therefore also

([213]) Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R. and de Vries, G. J. (2015), "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production" , Review of International Economics., 23: 575–605.

indirectly exposed to nature related risks associated with forestry and construction materials, that are once again, not adequately captured within the scoring approach.

The sectoral inter-linkages of **metals and mining** are captured at a broader level, through the mining and quarrying sector that in addition to metals and mining also includes oil and gas extraction (oil and gas – upstream), another sub-sector exposed to nature related risk. A significant part of the output from this sector is used for the manufacture of coke and refined petroleum products (37%), manufacture of basic metals (15%) and the supply of electricity, gas, steam and air conditioning (17%). Finally, the mid and downstream processing of oil and gas also supplies the manufacture of coke and refined petroleum products, albeit with a lower share - 10% - of the intermediate output, than in the case of oil and gas extraction. An additional third % of its output is used by manufacture of chemicals and chemical products, and by land transport and transport via pipelines, with 13% of the total output destined to each of these sectors.

3.3.1. EU relevance assessment

To make the analysis more EU-specific and acquire a better sense of the potential economic implications for the EU, a sector-specific “EU economic relevance indicator” was derived to assess the potential economic/financial implications for the EU of the biodiversity and nature related dependence and impact assessed through the previous stage of the study.

This part of the analysis built on the **alignment of the 30 exposed (sub)sectors and industries with corresponding NACE codes**. As can be seen in Table 3-1A (in the annex), this alignment resulted in the inclusion of (sub)sectors and industries at various levels of NACE aggregation, spanning across 13 out of the total 21 NACE sections (level 1). They covered: agriculture, forestry, and fishing (A), mining and quarrying (B), manufacturing (C), electricity, gas, steam, and air conditioning supply (D), water supply, sewerage, waste management and remediation activities (E), construction (F), trade (G), transportation (F), accommodation (I), information and communication (J), real estate (L) and human health activities (Q).

The exposed industries identified through the literature correspond to **NACE codes at different levels of aggregation**. A significant part of the exposed industries was matched with NACE codes at the division (NACE 2) level. Examples in this regard are A1: crop and animal production, A2: forestry and logging, and A3: Fishing and aquaculture, thus covering the entire Agriculture, forestry, and fishing (A) section. There are also several manufacturing related industries at the division level. An exception in this regard is manufacturing of medical equipment and suppliers, associated with division group or level 3 NACE codes, such as C32.5: Manufacture of medical and dental instruments and suppliers; and C26.2: Manufacture of irradiation, electromedical and electrotherapeutical equipment. The NACE codes corresponding to production, and transmission and distribution of electricity, are at the highest level of granularity with level 4 class codes associated with these two industries.

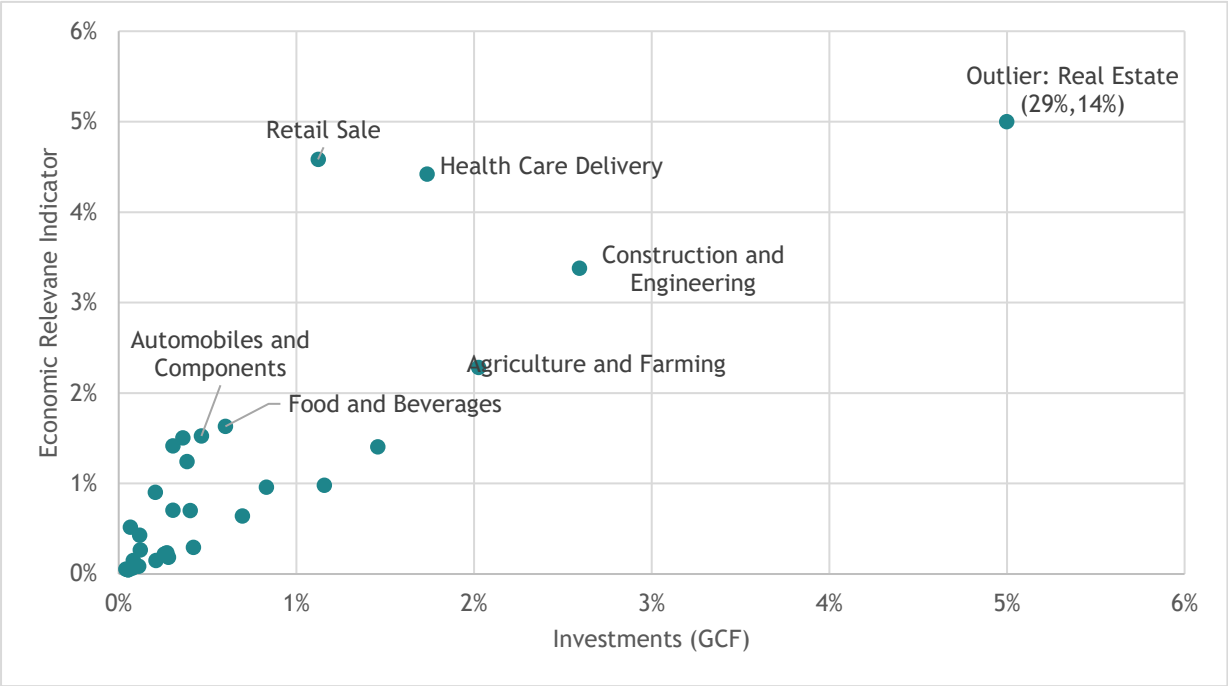
To determine the **economic relevance of these sub-sectors** and as such approximate the potential economic implications of the materialization of the BES risk, an indicator was computed that considered the significance of these sub-sectors in terms of investments, employment and gross value added. These are also reflected by Table 3-1A in the Annex. This indicator was computed, using the formula below, as the equally weighted sum (or average) of their relative share in total investments, employment and gross value added associated with affected subsectors, respectively. Investments were assessed through gross capital formation, that refers to resident producers' investments, deducting disposals, in fixed assets thar are used in the production of other goods and services for a period of more than a year. ([214]) The secondary data used for this part of the analysis was based on the Eurostat national account databases (for gross capital formation, and gross value added) and structural statistics (for employment).

$$Subsector\ EU\ relevance\ indicator = \frac{Subsector\ investment}{Investments\ of\ all\ exposed\ subsectors} * 0.33 + \frac{Subsector\ gross\ value\ added}{Gross\ value\ added\ of\ all\ exposed\ subsectors} * 0.33 + \frac{Subsector\ employment}{Employment\ of\ all\ exposed\ subsectors} * 0.33$$

Considering all three dimensions of economic relevance allows for a more comprehensive assessment of the potential economic implications of possible disruptions within each sub-sectors connected to biodiversity and nature dependence or impact. The three dimensions are not always closely correlated, as illustrated also by Figure 3-7 that represents the association across the significance of investments and the overall economic relevance of sub-sectors. The figure suggests that considering gross value added and employment generally raises the economic relevance of most sectors, as exemplified by retail sale, automobiles and components, and health care delivery. In the case of health care delivery, for example, while the relative significance of investments is 1.74%, its overall economic significance is approximately 4.5%. A significant exception in this regard is real estate, where the relevance of investments (29%) is somewhat counterbalanced by low shares of employment (less than 1%), resulting in a relatively lower share of overall economic significance (of 14%). Due to these high values, real estate and services is marked as an outlier on Figure 3-7, with its real values specified in the labelling, rather than on the axis, due merely to reasons related to the ease of visualization.

([214]) European Commission (2023) Glossary: Gross fixed capital formation. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Gross_fixed_capital_formation_(GFCF)

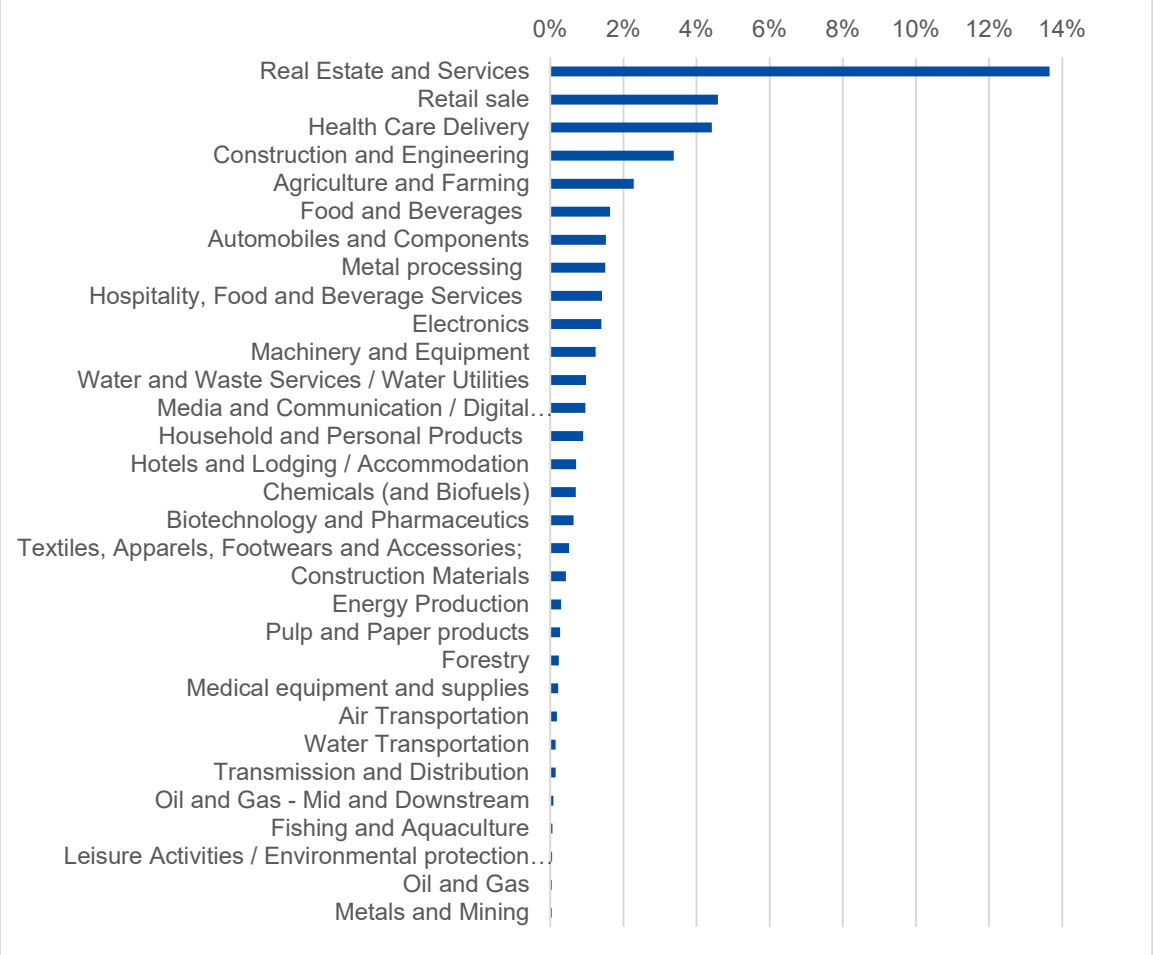
Figure 3-7 Relative importance of investments and the overall economic relevance of sub-sectors exposed to biodiversity and nature risk



Source: Trinomics calculations based on data from Eurostat, 2020 and 2021

Based on the analysis, the affected subsector with the greatest relevance for the EU economy is by far real estate and services, illustrated also by Figure 3-8, that shows the **ranking of all subsectors according to their EU relevance**. As can be seen from this figure, the EU economic relevance score ranges from 14% to 0.05% corresponding to real estate and services, and metals and mining respectively. Real estate and services are then followed by retail sale (4.58%), healthcare delivery (4.42%), construction and engineering (3.38%), agriculture and farming (2.3%), food and beverages (1.63%), automobiles and components (1.53%) and metal processing (1.5%). Given the significance of these sub-sectors to the EU economy, in terms of investments, gross value added and employment, the economic/financial implications of the materialization of exposure to physical and/or transition risk could be understood as similar in their relative importance.

Figure 3-8 Ranking of sub-sectors exposed to biodiversity and nature risk based on their EU economic relevance



Source: Trinomics calculations based on data from Eurostat, 2020 and 2021

It is important to keep in mind that the financial materiality of exposure to nature-related risks across (sub)sectors will most likely be different for financial institutions than it is for the EU economy, and will differ considerably across financial institutions, depending on the sectoral composition of their portfolios. Additionally, the financing activities of financial institutions from the EU cover industry activities globally and are therefore exposed to different locational and global inter-sectoral aspects of exposure to nature-related risks. The lack of adequate data at the global level would therefore pose additional challenges to financial institutions, that could be assessed through less granular approaches, and thus generate additional uncertainties.

3.3.1. Significance of exposure score

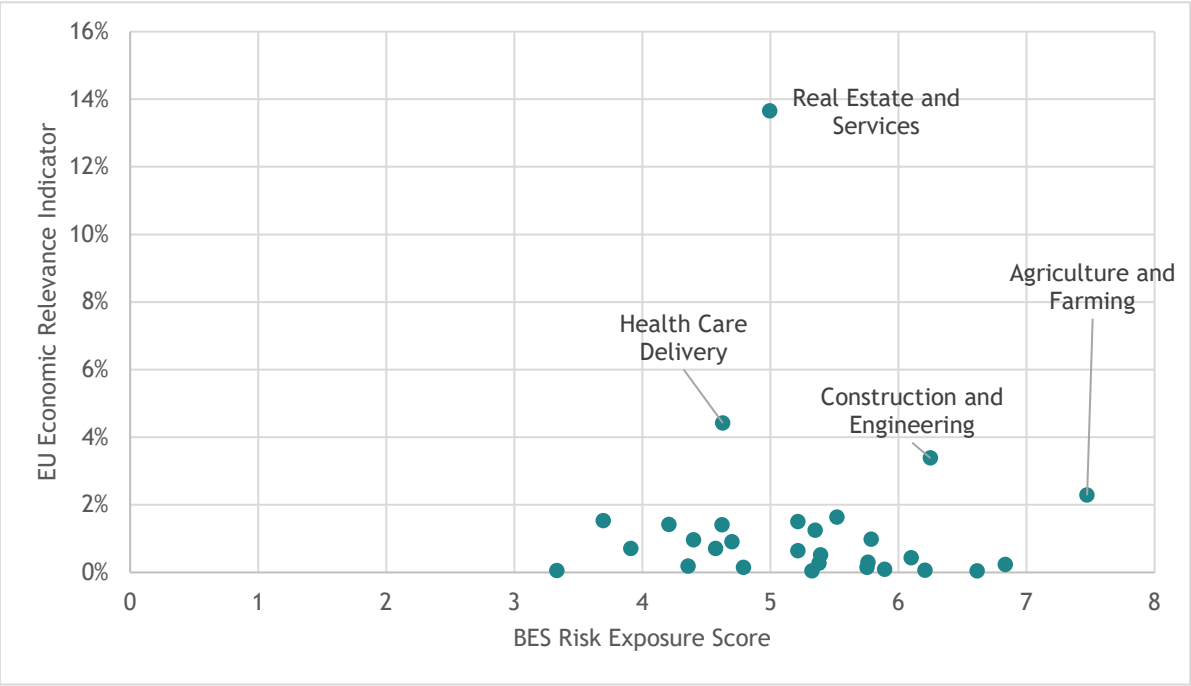
The final score assessing and ranking the significance of exposure to biodiversity and nature risk is calculated as a weighed multiplicative score with two components – the overall biodiversity and nature related risk score and EU economic relevance indicator - calculated through the previous stages of the analysis. This is in contrast with the additive

calculation approach employed for assessing the overall biodiversity and nature risk exposure score. The concept and logic of this approach is that a score constructed as multiplication would correctly 'ignore' sectors which are either not exposed to biodiversity and nature related risk (BES), i.e. BES_risk = 0 (regardless of their EU economic relevance), and will also correctly disregard sectors which are of no EU economic relevance, i.e. EU economic relevance indicator = 0 regardless of their biodiversity and nature risk. At the same time, sectors which are both 'risky' and 'economically relevant' would get the highest score. This is what is naturally required from the EU relevance-adjusted score.

$$Significance\ of\ exposure\ score = \ BES\ risk\ exposure\ score\ \hat{}a * EUeconomic\ relevance\ indicator\ \hat{}b$$

As noted earlier, the BES risk exposure score varies between 2 and 8, while the EU economic relevance indicator varies between 0.05% and 14%. This is also indicated by Figure 3-9 that maps the biodiversity and nature risk exposure scores and EU economic relevance indicator for the affected sub-sectors. Knowing the ranges is important for exponentiation to make sure that a higher initial value corresponds to a higher exponentiated value. A similar remark made on the weighting used for the biodiversity and nature related risk score is valid here: selection of a specific set of weights might require an inclusive consultation process with the broad group of stakeholders, which is beyond the scope of the project. For the purposes of the illustration of the methodology, we have tested the weights of “a” between one and six, while keeping the “b” weight fixed at the value of one. The variation in the relative significance of a and b, allows for granting greater or lesser importance to the BES risk exposure score relative to the EU economic relevance indicator.

Figure 3-9 Mapping BES Risk Exposure Scores and EU Economic Relevance Indicators for the affected sub-sectors



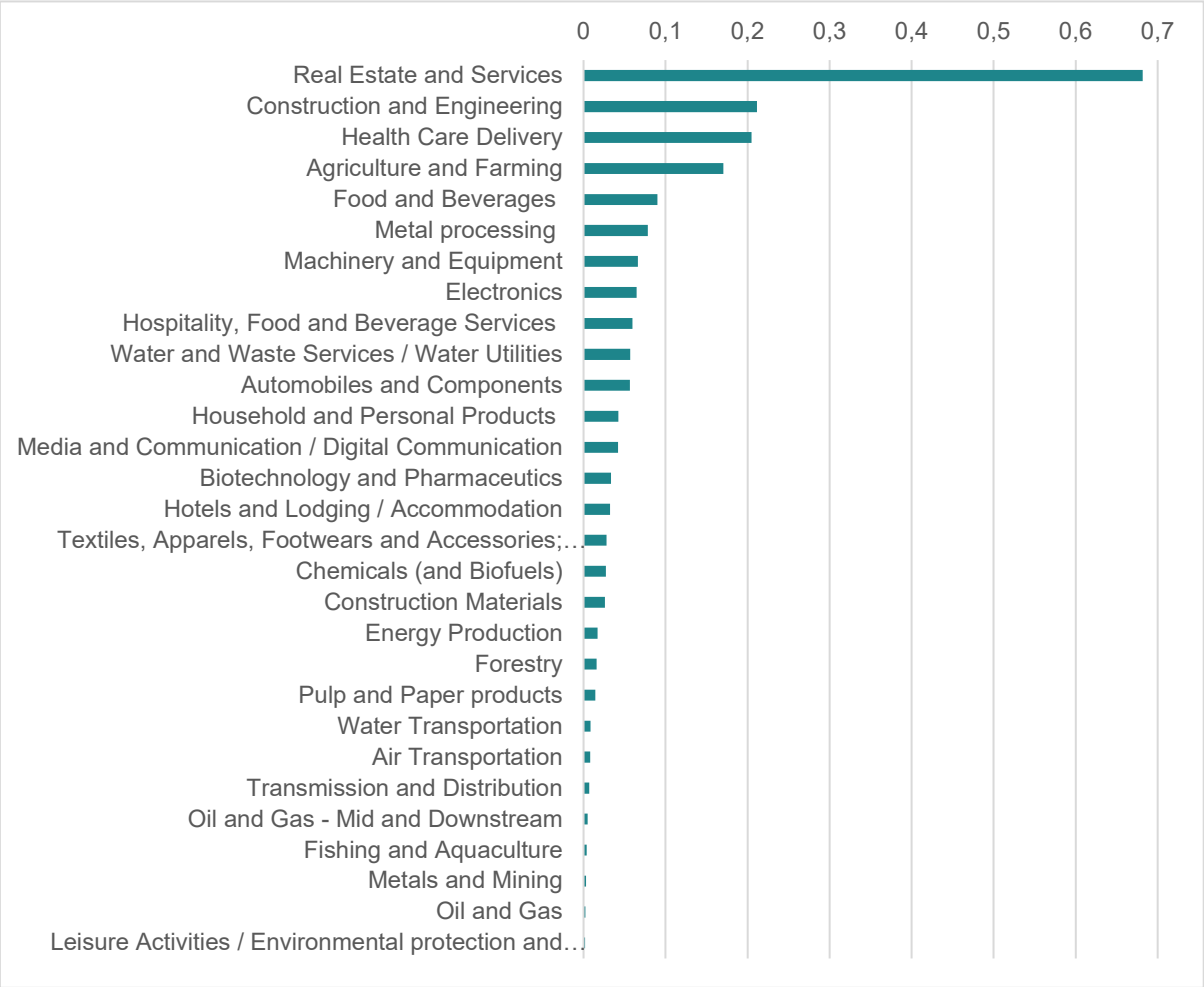
Source: Trinomics calculations based on data from Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE), and Eurostat, 2020 and 2021.

The results of the baseline estimation, based on a proportional importance attached to BES risk exposure score and EU economic relevance indicator (a=1 and b=1) are presented in Figure 3-10. This also corresponds a BES risk estimation score that grants greater importance to the average score (α =0.7) and relatively lower importance to the broadness of the evaluation (β=0.3). As can be seen in the figure, the sub-sector attached to the most significant exposure is Real Estate and Services. **The top quartile – including the most significantly exposed industries** - also includes Construction and Engineering, Health Care Delivery, Agriculture and Farming, Food and Beverages, Metal Processing, and Machinery and Equipment. The significant exposure of these sectors within the EU context are largely determined by their economic significance in terms of investment, employment, or production value. The real estate sector, for example, absorbed 29% of the total gross capital formation of the EU in 2021. ([215]) Real estate and health care also stand out with respect to their contribution to the total EU gross value added, with 11% and 5% respectively. ([216]) While their BES risk exposure is lower than of other sectors, materialisation of BES risks could have a significant impact on the EU economy and financial system. The case studies of these sectors – as part of Section 3.4. - further elaborate on the significance of their ties with financial institutions and on the pathways through which the exposures of these sectors to nature related-risks can affect banks, investment funds, insurance companies.

([215]) Eurostat (2021): Gross capital formation by industry.

([216]) Eurostat (2021): National accounts aggregates by industry.

Figure 3-10 Ranking of sub-sectors based on the significance of the exposure score



Source: Trinomics calculations based on data from Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE), and Eurostat, 2020 and 2021.

The significance of exposure score demonstrated robustness in the sensitivity check that entailed experimenting with different weights. Firstly, the set of top seven sectors, corresponding to the top quartile, did not change significantly when the relative weights associated with the depth and breadth of the biodiversity and nature related risk assessment score (the values of α and β) changed (for both "a" weight of one and six). This resulted only in the substitution of machinery and equipment with health care and delivery, as the latter is evaluated across more ecosystem services and drivers, than the former. Secondly, the change in the "a" weight from one to six has also led to a change by only one sector in a set of top seven sectors (regardless of the 70-30 or 50-50 weights used in the underlying sector score calculation). This reveals that when EU economic relevance is given less importance, water and waste services acquire greater relevance due to their relatively greater exposure to biodiversity and nature related risk as the general level. Overall, however, the results are quite robust, and this replacement occurs at a later stage (at a=4) of the rebalancing of importance across the two main components of the Significance of Exposure Score. The results of these different weighs used in the computation of the overall significance of exposure score are captured by Table 3-5.

Table 3-5 Robustness check of the ranking of sub-sectors based on their overall significance of exposure score

Significance of exposure score (α =0.7 and β =0.3, a = 1 and b =1)		Significance of exposure score (α = 0.5 and β =0.5, a = 1 and b =1)		Significance of exposure score (α = 0.7 and β =0.3, a = 6 and b =1)		Significance of exposure score (α = 0.5 and β =0.5, a = 6 and b =1)	
Industry	Score	Industry	Score	Industry	Score	Industry	Score
Real estate and services	0.682	Real estate and services	0.608	Agriculture and Farming	3,978	Agriculture and Farming	2,359
Construction and Engineering	0.211	Construction and Engineering	0.202	Real Estate and Services	2,121	Construction and Engineering	1,517
Health Care Delivery	0.205	Health Care Delivery	0.164	Construction and Engineering	2,015	Real Estate and Services	1,063
Agriculture and Farming	0.171	Agriculture and Farming	0.156	Food and Beverages	462	Food and Beverages	287
Food and Beverages	0.090	Food and Beverages	0.083	Health Care Delivery	435	Metal Processing	240
Metal Processing	0.078	Metal Processing	0.075	Water and Waste Services	369	Water and Waste Services	232
Machinery and Equipment	0.066	Machinery and Equipment	0.063	Metal Processing	303	Machinery and Equipment	205

Source: Trinomics calculations based on data from Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE), and Eurostat, 2020 and 2021.

The presented analysis, however, also has **some important limitations.** The methodological approach, for example, fails to consider inter-sectoral (value chain) linkages and locational aspects of the exposure to biodiversity and nature related risk in a systematic manner. Industries, however, can be exposed to biodiversity and nature related risks not only through their direct industrial processes, captured through the ENCORE tool, but also through the operations up and downstream in their supply chains. The exposure of the real estate sector, for example, is also affected by the nature related physical and transition risks associated with construction and engineering, manufacturing of construction materials and of construction equipment, but even forestry, that provide essential supplies to the development and maintenance of real estate assets. Agriculture and farming influences industries upstream, through the provision of key ingredients to food and beverage manufacturing, for example, but even food and beverage related hospitality services. Finally, health care delivery, is greatly exposed to nature related risks in pharmaceuticals and biotechnology, manufacturing of medical equipment and supplies, etc.

Additionally, the significance of exposure of industries to physical and transition risk is expected to vary considerably across the geographical specificities and regulatory contexts associated with the locations where most of the production of goods and services takes place. The real estate sector, for example, is more exposed to destruction of or damage to real estate assets in geographical areas that have a higher likelihood to

be affected by drought, flooding, wildfires, or natural catastrophes, and/or where building regulations are more stringent. Its exposure to biodiversity and nature impact risk will also be much more significant in surroundings close to biodiversity sensitive areas, where they could cause more significant damage and face significant reputational risks, especially in countries with more active environmental organizations that can monitor and signal negative impact on such biodiversity hotspots.

These inter-sectoral and geographical aspects will have to be factored in by financial institutions in a more systematic manner. The next section – Section 3.4. will provide an illustration of the relevance of the inter-sectoral and of locational factors for three key sectors from the list of most materially exposed sub-sectors: real estate (and construction), agriculture and farming, and health care delivery. Considering the strong interlinkages between real estate and construction (the second most materially exposed sub-sector on Figure 3-10), it will be integrated in the real estate sector analysis, through the inter-sectoral considerations. Similarly, the deeper analysis of the two other selected sub-sectors– agriculture and health care – the other materially exposed sectors will be given further attention though the analysis of nature-related risks that they are interlinked with through the inter-sectoral linkages. The analysis catered around these three sub-sectors can then serve as the basis for the formulation of some recommendations on how to approach this in a more systematic manner as part of Task 3.

3.4. Transmission and mitigation mechanisms in most exposed (sub)sectors

This section consists of a series of three case studies focusing on three most materially exposed sub-sectors: real estate, agriculture and farming, and health care delivery to address key gaps of the overall analysis and provide further guidelines for the development of a systematic approach by financial institutions. The analysis for each sub-sectors is focused upon and organized around the following four key dimensions:

Key features of each sub-sector, including its ties to financial institutions;

Deeper analysis of biodiversity and nature related risks that it is exposed to, including an analysis of hidden risks associated with sub-sectors and locations that they are interlinked with;

Key transmission channels through which the biodiversity and nature related risks associated with the sub-sector can impact financial institutions;, and

Mitigation measures that could be adopted to prevent and minimize exposure to these risks.

In this section, we analyze the nature and biodiversity related risks in more detail within our identified most materially exposed (sub) sectors/industries. The assessment

conducted focuses on getting a comprehensive overview with a purpose to discern the intricate interplay of locational and inter-sectoral (value chain) dimensions that shape the exposure of these sectors. By delving into this, we aim to unravel the underlying dynamics that influence how transition and physical risks (and systemic dimensions) manifest as financial risks across sectors. The analysis therefore also entails an examination of the key transmission channels and mitigation mechanisms that steer sectoral exposure towards these diverse risk categories, forming an essential bridge between economic sectors and financial institutions.

For the three most relevant sectors identified for the European context – Real estate and Construction, Agriculture and Farming, and, Healthcare and Pharmaceuticals – we assess the key features that define the sector, and its connection to nature and biodiversity resources. We assess how biodiversity and nature risks are linked to the main processes and operations and delve deeper into possible locational aspects of these risks. We also attempt to identify and further elaborate on the key sectoral transmission channels noting that both Task 1 findings and the literature review for Task 2, that focused on sector level analysis, have indicated that substantial data gaps exist in this realm. Finally, we provide an overview of recommended mitigation measures that are most feasible considering the current understanding, disclosure, and integration of nature-related risks in the sector.

3.4.1. Sub-Sector 1: Real Estate

3.4.1.1. Key features of the real estate and construction sector

The real estate sector refers to a whole range of **economic activities** related to the design, development, even demolition, as well as acquisition, renting and operating, and other services associated with residential or non-residential buildings, civil engineering projects and related installations. Real estate development, services, and operations is reliant on construction and engineering, but also the manufacturing of construction materials and machinery, that are therefore an important part of the real estate supply chain. These are economic areas that were identified as exposed sub-sectors, as reflected by Table 3-2, with real estate and construction among the most materially exposed sectors from the perspective of the EU economy, as can be seen in Figure 3-10.

These activities play an **important role in the EU's economy**. Real estate and services contribute to approximately 11 percent of gross value added (GVA) generated in the EU, as can be seen also in Table 3-6, representing one of the key sectors in the EU economy. The significance of construction and engineering, manufacturing of construction materials and of machinery and equipment, that would also cover construction materials, is more modest, at a total of approximately 1.5-2%. The relevance of the real estate sector is even more substantial in terms of its role in the accumulation of fixed assets (GFA) within EU, that are often financed through external sources, indicating the

importance of ties to the financial sector. This is also true for construction and engineering, that is integrated into real estate development. Construction and engineering also employ a significant part of the EU workforce, at almost 7 percent. The relevance of real estate and services, and of manufacturing of construction materials, is more modest in this regard, at 0.60 and 0.83%, respectively.

Table 3-6: Significance of real estate and construction for the EU economy – as share in EU total

	Investments (GCF)	Employment	Production (GVA)
Construction Materials (C32)	0.12%	0.60%	0.58%
Machinery and Equipment (C28)	0.38%	1.62%	1.75%
Real Estate and Services (L68)	29.29%	0.83%	11.25%
Construction and Engineering (F41)	2.59%	6.68%	0.98%

Source: Eurostat, 2020 and 2021.

The relative importance of real estate and services sectors – in terms of share in total value added – is particularly significant in the southern European countries of Greece (16%), Italy (14%), Portugal (13%), France (13%), Spain (13%). It has a lower significance in Poland, Ireland, Malta, and Lithuania, at around 6%, where other economic sectors play a more prominent role. ([217])

The real estate and construction sector has **strong ties to financial institutions**, as demonstrated also by the 2008 global financial crises. The financial sector, *especially banks*, have a primary role in financing real estate investments. Bank mortgage loan portfolios exceed 200% of banks' Common Equity Tier 1 (CET1) capital in most euro area countries, and loans to companies engaged in real estate activities are also of great significance across several EU member states. ([218]) Additionally, real estate properties are a very important form of storage of wealth for households, *asset owners and managers*. The investment opportunity presented by the real estate debt market, for example, is significant in Europe, with nearly 1000 billion Euros available in the mid-2010s. ([219])

Investing in real estate presents challenges that do not exist in capital markets, as the maximization of the property's value can be affected by damage, tends to deteriorate over time, and is also more difficult to sell. Investors therefore channel funds towards several types of properties, with different risks associated with them. When it comes to real estate in riskier areas – as for example those more exposed to flooding, to fire or extreme weather, investments are often conditional on proper insurance coverage.

([217]) Source: Eurostat. National accounts aggregates by industry (up to NACE A*64) [NAMA_10_A64__custom_6799575]

([218]) Lang, Hannes Jan ; Markus Behn, Barbara Jamulska and Marco Lo Duca (2022) : Real estate markets, financial stability and macroprudential policy; ECB Macroprudential Bulletin. Source: https://www.ecb.europa.eu/pub/financial-stability/macroprudential-bulletin/html/ecb.mpbu202210_1~53d521bde7.en.html

([219]) Berckel, Gerard-Jan : The Evolution of Real Estate and real assets investment by insurers. Available at : https://www.aon.com/unitedkingdom/insights/evolution-of-real-estate.jsp

Insurance companies worldwide have been underwriting property risks for centuries, tracing their origins to property risks posed by fires. In 2019, approximately 8% of all premiums and around 6% of claims paid, amounting to 1254 and 997 billion Euros respectively, were related to insurance that protect property against risks such as fire, theft and weather damage. ([220]) Today, however, insurers also invest in real estate – whether in the form of equity or debt – to maximize their portfolio yields ([221]), albeit this percentage is still relatively low – of approximately 1 % in their total investment portfolio. ([222])

3.4.1.2. Biodiversity and nature related risks

Physical Risk

The direct dependence of real estate and services is relatively low (at an aggregate score of 2), but real estate development is also exposed indirectly through the higher levels of ecosystem service dependence in construction and engineering (2.7) and manufacturing of construction materials (2.7). Real estate development, for example, is highly dependent on surface and ground water, as can be seen from Figure 3-11. This is particularly problematic in locations exposed to drought and climate change. According to recent analysis, for example, drought hazard has been increasing across several EU member states, including countries where the economic relevance of real estate is very significant, such as Italy, Spain, and Portugal. ([223]) These countries exposed to extreme temperatures are also often the most exposed to forest fires.

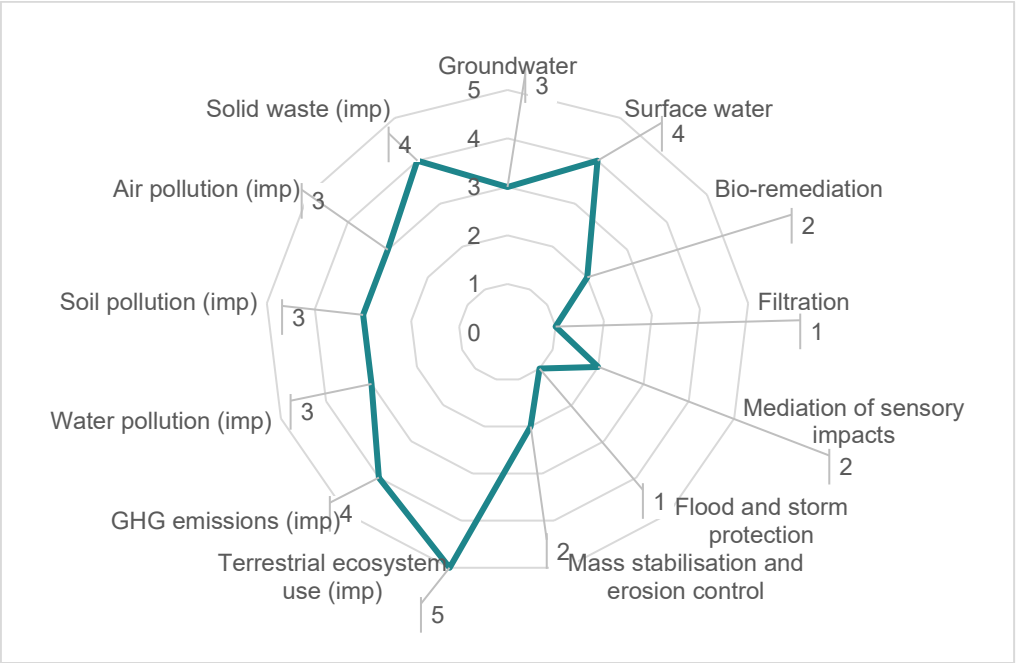
Figure 3-11 - Biodiversity and nature related dependencies and impacts (imp) in Real estate and Services

([220]) Insurance Europe (2019) : European Insurance in Figure : 2019 data. Available at : https://insuranceeurope.eu/publications/689/european-insurance-in-figures-2019-data/

([221]) Appicelli, Frank (2020) : Insurance Company High-Yield Real Estate Investments : Available at : https://www.carltonfields.com/insights/expect-focus/2019/insurance-company-high-yield-real-estate-invesmen

([222]) Insurance Europe (2021) European insurance : Preliminary figures 2021. Available at : https://www.insuranceeurope.eu/publications/2674/european-insurance-preliminary-figures-2021/download/Preliminary+figures%202021.pdf

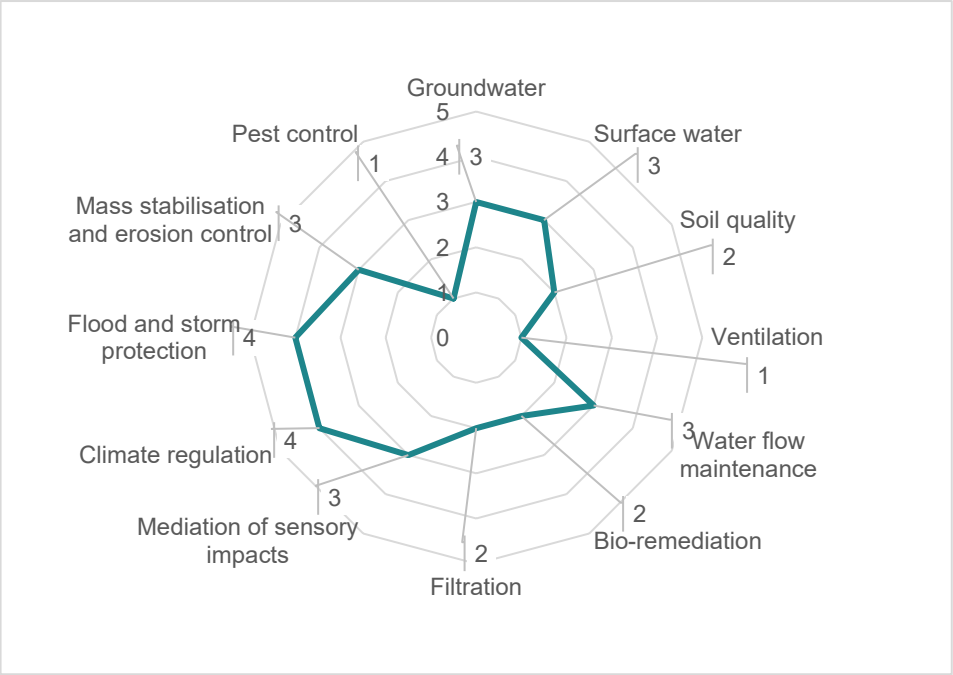
([223]) European Commission (2022) Drought in Europe : August 2022. GDO Analytical report. Available at : https://edo.jrc.ec.europa.eu/documents/news/GDO-EDODroughtNews202208_Europe.pdf



Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

Water related ecosystem, such as water flow maintenance, is also relevant for construction by enabling the production process and preventing disruptions. Habitats provide essential protection from flood and storms by the sheltering and attenuating effects of natural and planted vegetation. They also contribute, along with other ecosystem services, to mass stabilization and erosion control, that is especially important in coastal areas and on slopes. Additionally, they can contribute to climate regulation, as for example, vegetation can modify temperature, humidity and even wind speeds. These affect construction and engineering, albeit at different levels of materiality, as shown on Figure 3-12.

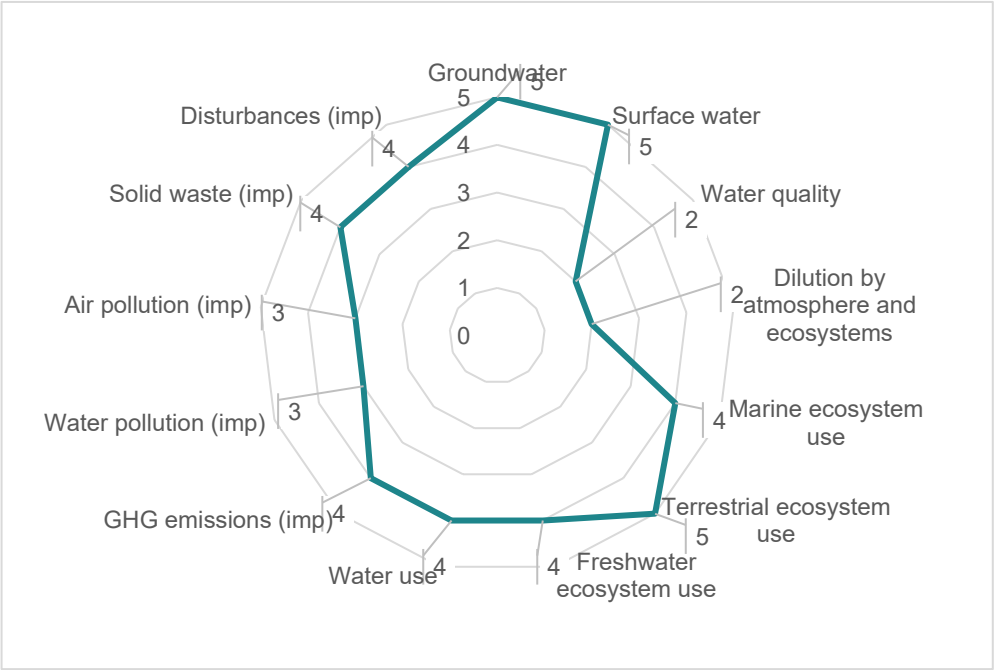
Figure 3-12 – Biodiversity and nature related dependencies in Construction and Engineering



Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

Dependence is, once again, very high for the manufacturing of construction materials, as shown by Figure 3-13. Water constitutes an essential direct physical input for mortar, mixing of cement concrete and for curing works during construction. The quality of water can thus significantly enable (or undermine) the production process of construction materials.

Figure 3-13 – Biodiversity and nature related impacts and dependencies in Construction Materials



Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

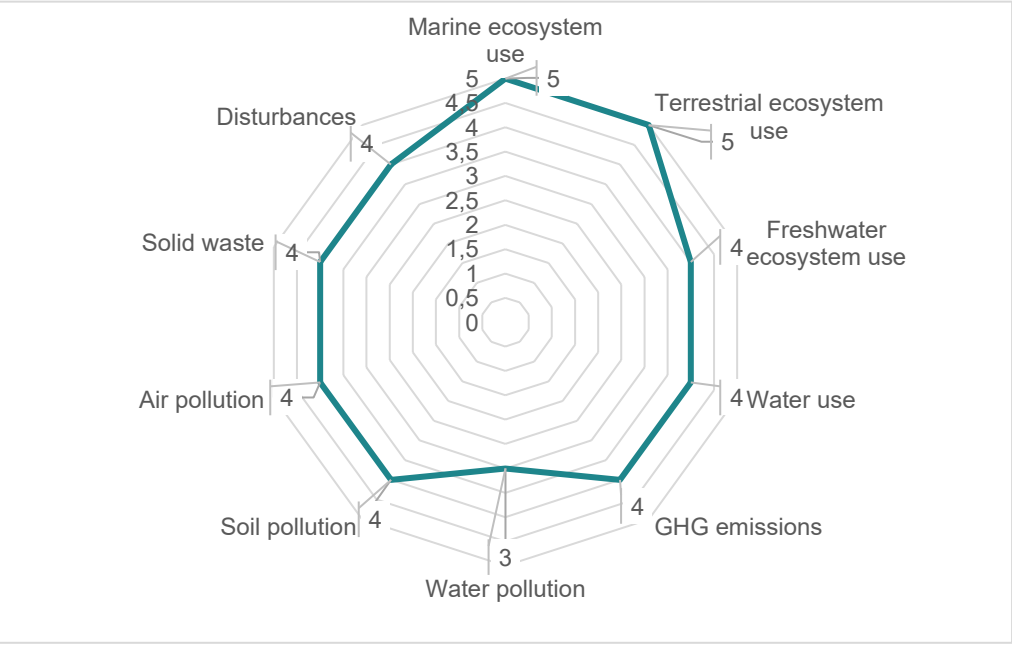
Transition Risk

The exposure of real estate and constructions to biodiversity and nature related risk is more significant through its impacts than through its dependence on nature. The overall impact score of real estate is of moderate materiality (score of 3, relative to dependence score of 2), but exposure is once again more significant through construction and engineering (impact score of 6.2) and construction materials (score of 6).

Developing and operating **real estate** can result in clearing and degradation of habitats, that can bring about the loss of biodiversity and of construction sites in surrounding areas. The use of vehicles and heavy machinery can also cause soil compaction, that can harm the growth of vegetation. Additionally, construction can lead to flooding as hard surfaces reduce the ability of the land to absorb rainwater. Transportation connected to real estate sector, particularly during development, often lead to significant GHG emissions and air pollution. The latter can result from using fossil fuels, spills of diesel, paints, solvents, or other toxic materials, that can also pollute water and soil. The locational aspects become relevant in terms of regulation, as requirements regarding the disposal of toxic construction waste products is less stringent in some parts of the world or are less enforced, even within the EU. This to some extent applies to the production and recycling of solid waste as well. Real estate and services can be associated with high volumes of solid waste, including glass, metal, paper, wood, but even in the forms of products, such as office equipment or apartment furniture. The intensity of the impact of real estate and services on these dimensions is shown by Figure 3-11.

Construction can also result in the clearing and degradation of habitats, risk of flooding, and soil compaction, leading to significant impact on terrestrial, marine, and freshwater ecosystems. It also has significant impact on GHG emissions, water use, generation of solid waste, air and soil pollution, and disturbances, at high levels of materiality, as captured by Figure 3-14. Producing **construction materials** can result in significant destruction of terrestrial ecosystems, through the removal of vegetation and soil excavation, that modifies habitats, and/or lead to loss of species, soil erosion and land degradation. Pits and quarries disrupt the existing movement of surface and groundwater, with implications on the quantity and quality of water available across specific locations. It also relies on the use of significant amounts of water – estimated at around 100-600 litres per tonne per clinker produced in the manufacture of cement ([224]), with the specific amount depending largely on the type of cement line technology used. ([225])Similarly, brick production uses significant amounts of water to create consistent and mouldable clay for firing. Manufacturing of construction materials is also associated with substantial GHG emissions, contributing to the overall footprint of buildings. Cement manufacture, for example, contributes to N2, O2, SO2 emissions, as well as the formation of water vapours and formation of micro-components (CO and NOx). The predominant part of CO2 emissions result from the high temperatures used in the production of lime. Finally, the manufacturing of construction materials leads to the generation of a significant amount of waste and noise pollution.

Figure 3-14 – Biodiversity and nature related impacts in Construction and Engineering



Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

([224]) Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE), available at: https://encore.naturalcapital.finance/en/explore?tab=dependencies;

([225]) César Valderrama, Ricard Granados, José Luis Cortina, Carles M. Gasol, Manel Guillem, Alejandro Josa, Implementation of best available techniques in cement manufacturing: a life-cycle assessment study, Journal of Cleaner Production, Volume 25, 2012, Pages 60-67, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2011.11.055.

Transmission channels

Financial institutions have no material direct dependence or impact on BES but are significantly exposed to biodiversity and nature related risks indirectly, through for example, their close ties to the real estate sector. The physical and transition risks associated with the sector can lead to significant decline in the value of properties and their ability to generate income, as for example through reduced rental income and limited resale opportunities. Rising insurance premiums and additional maintenance costs, can increase operational costs, reducing profit margins. Finally, significant investments, as for example, in flood or wildfire defences can limit returns on investments. These can be particularly prominent in vulnerable areas characterized by fragile habitats and/or areas characterized by extreme temperatures. The exposure of financial institutions to nature-related risks associated with real estate development and services, can therefore be very significant through either of the main transmission channels identified in section 2.2.3.

The transmission of these nature-related risks to financial institutions can also take place a larger scale, as physical and/or transition risks affect entire locations. Recent history has shown that the real estate sector is closely linked to financial stability. This is perhaps best illustrated by the onset of the 2009 financial crisis, when a cascading of foreclosures and defaults crashed the housing market, with major implications on credit lending institutions and the financial securities that backed up subprime mortgages. Such widespread effects can also result from exposure to nature-related risks that affect real estate rentability, insurance and ability to pay back loans. Natural hazards exacerbated by climate change pose risks to the stability of real estate prices and financial institutions, especially in areas exposed to extreme weather conditions ([226]), as climate change can affect ecosystem services through the onset of floods, drought, and wildfires, leading to a cascading impact on sectors dependent upon BES.

In the southern part of Europe, for example, especially in the Mediterranean basin including Italy, Spain, Greece and Portugal, wildfires have grown more prominent, destroying property, and generating significant losses in real estate. These are sometimes further accentuated by the planting of highly flammable mono-cultures, such as eucalyptus, that is relevant for the paper industry. Onsets of floods and of wildfires in specific areas, can bring about significant declines in the value of properties and a shift in demand, with a significant impact on the entire sector and financial institutions funding mortgages and investing in real estate developments in these areas. The costs of maintaining and operating property in these areas more exposed to climate-related natural risks are also increasing, through increased usage of water to keep things cool, more significant repair bills, and a significant increase in insurance premiums.

Climate change related natural hazards can also bring about a cascading effect of transition risks, as for example public policies change to address these challenges. New rules regarding building structures, urban drainage, green spaces, and wetland creation,

([226]) Gourevitch, J.D., Kousky, C., Liao, Y.(. et al. Unpriced climate risk and the potential consequences of overvaluation in US housing markets. Nat. Clim. Chang. 13, 250–257 (2023). Available at: https://www.nature.com/articles/s41558-023-01594-8

for example, can also have major impact on real sector in areas where the internalization of these costs can influence property values, with implications on financial institutions as well. ([227])

While these transmissions at larger scales are also possible within the real estate sector, these build on the same transmission channels as at a more micro scale linked to credit, underwriting, market and liquidity risks.

Credit risk

Credit institutions are particularly exposed to this sector via credit risk on loans. ([228]) The realization of the physical risk drivers, especially their manifestation at a larger geographical scale, as for example with respect to climate-related natural hazards, can lead to significant damage to the value of assets, and consequently the debtor's wealth and ability to repay its credits. The physical risk drivers can also reduce the cash flows of the affected properties, as for example through their sale and renting, with major implications on the abilities of real estate companies to repay credits. There is for example significant empirical evidence of property values decline because of drought, flooding, and wildfires, with implications on the predicted probability of default as well as on increasing non-performing asset ratios and lowering bank equity ratios. ([229]) But credit risks are also closely linked to biodiversity and nature related transition risk, especially as the EU and several member states are becoming more and more aware and ambitious regarding the importance of limiting negative impact on biodiversity and ecosystem degradation, with the new regulations and policies often imposing significant costs on real estate developers and operators, with implications on their ability to repay debts.

The potentially negative influence of biodiversity and nature related risks on debt repayment is further accentuated by the fact that according to recent data bank lending to the sector is occurring at high loan-to-value ratios in several EU member states, making financial institutions providing credit to the real estate sector especially exposed to credit risk. ([230]) If the value of the loan collateral decreases, for example, the loan-to-value ratio goes up, increasing banks' loss-given default ratios and potentially leading to higher capital requirements. This could significantly influence the ability of banks to provide further credit supply, and as such also relates to operational risks, that will be discussed further on in this section. These developments refer primarily to banks, but insurance companies increasingly participate in real estate debt investments.

([227]) ESRB (2023) : ESRB issues a recommendation on vulnerabilities in the commercial real estate sector in the European Economic Area. ESRB Press release from 25 January 2023. Available at : https://www.esrb.europa.eu/news/pr/date/2023/html/esrb.pr230125~f97abe5330.en.html

([228]) ibid

([229]) Basel Committee on Banking Supervision (2021) : Climate-related risk drivers and their transmission channels. Bank for International Settlements from April 2021. https://c2e2.unepccc.org/wp-content/uploads/sites/3/2021/04/bis-climate-related-risk-drivers-and-their-transimission-channels-14-april-2021.pdf

([230]) ibid

Underwriting risk

Underwriting risk results from the potential loss borne due to inaccurate assessment or the risks associated with insurance policies, including those for property that constitutes a significant part of insurance premiums and claims. Where insured properties suffer nature-related damage, insurers may face increasing number and amounts of claims. Even in the absence of major catastrophes, more gradual and slow deterioration of ecosystems and degradation of biodiversity can also lead to significant rise in the claims of insurance policies. This can result, for example, from the decay in nature-based prevention against wind, water, or temperature related damage, such as coral reefs or wetlands, that leads to significant damage to properties. ([231]) Nature-related physical and transition risks, can therefore lead to a significant increase in insurance claims, exceeding the premiums earned when these have not been properly factored into the pricing of insurance policies.

Market risks

The realization of biodiversity and nature related risks can bring about significant changes in real estate assets and rentals, as they cause damage or influence maintenance costs. The exposure of financial institutions to biodiversity and nature related physical risks is not linked merely to climate related natural hazards, but also through other risk drivers, such as use of terrestrial and water ecosystems, that can influence asset values through their interference with availability of water, protection from flooding and landslides, and climate regulation. Loss in biodiversity can affect the value of real estate assets developed and of properties in general, affecting investments and the collateral value of assets backing mortgages. ([232])Similarly, tightening regulations regarding buildings and/or surrounding areas, can also lead to a decline in the value of assets and services that are particularly exposed to it, with implications on the investment stocks. Considering the significant role of real estate in investments, such adverse movements in prices would therefore greatly impact asset owners and managers focused on the sector, but also insurance companies through their asset portfolios set up to counterbalance liabilities. ([233])

Liquidity risk

Buildings are generally relatively immobile and illiquid assets that can't be moved or sold very easily. These features, however, also make them especially vulnerable to nature-related risks. The strong linkages of financial institutions with the real estate sector through investments also influences their exposure to liquidity risk. This is primarily through the influence on their ability to sell properties quickly and at an adequate price,

([231]) European Insurance and Occupational Pensions Authority (EIOPA) (2023) EIOPA Staff Paper on nature-related risks and impacts for insurance. Available at : https://www.eiopa.europa.eu/publications/eiopa-staff-paper-nature-related-risks-and-impacts-insurance_en

([232]) ibid

([233]) ibid

due for example, once again through a biodiversity and nature related decline in the asset's value or an increase in the maintenance cost, that influences profitability of rentals or investment returns. The investors facing nature-related liquidity risk, could transition into market risk, if financial institutions decide to or are able to hold onto the properties, in expectation of a future shift in the value of the assets. Liquidity risk is, however, more closely linked to the need for refinancing or liquidity, potentially also associated with nature related reasons that cause net cash outflows or depletion of liquidity buffers. This could be the case, for example, if incomes decline or maintenance costs increase due to nature-related factors, with implications on the amount of savings deposited, thus undermining the stability of sources of funding for banks.

Operational risks

Operational risks refer primarily to disruption in business continuity and exposure to reputational and liability risks. This could for example refer to increased legal and regulatory compliance costs associated with real estate sector-relevant public policies that seek to prevent or minimize nature-related risks (eg, more stringent building requirements), and as such operational risks is particularly closely linked to biodiversity and nature related transition risk. Sometimes, being associated with investees who have a negative impact on nature can cause reputation risks, even in the absence of mandatory regulation. Inaction to decarbonise in real estate development, for example, could result in the real estate and related financial institutions facing public pressure to reduce share of emissions and/or quantity of waste generated. ([234]) Reputational cost can transform into litigation risks, depending on the applicable regulatory framework regarding real estate across various member states. Legislation regarding disclosure on biodiversity-related risks, stricter building standards, increase the risk for operational risks either directly or indirectly, through the counterparts from the real estate sector. These become operational risks through their potentially negative impact on stakeholder and shareholder value.

3.4.1.1. Identifying key mitigation measures

Mitigation measures to minimize exposure to biodiversity and nature related risk and its transformation into financial risk can consist of both actions taken by both financial institutions and their counterparts from the real estate sector.

In the real estate sector, nature-related risk management currently has a strong emphasis on climate change considerations. ([235]) This is to a large extent due to the recognition of dependence on natural assets and ecosystems being associated with the realization that climate change can bring about natural catastrophes. There is also

([234]) United Nations Environmental Programme Finance Initiative (UNEPFI) (2023) Climate Risks in the Real Estate Sector. March 2023 Climate Change Publications TCFD. Available at : https://www.unepfi.org/wordpress/wp-content/uploads/2023/03/Real-Estate-Sector-Risks-Briefing.pdf

([235]) United Nations Environmental Programme Finance Initiative (UNEPFI) (2023) Climate Risks in the Real Estate Sector. March 2023 Climate Change Publications TCFD. Available at : https://www.unepfi.org/wordpress/wp-content/uploads/2023/03/Real-Estate-Sector-Risks-Briefing.pdf

growing awareness that real estate development can have a negative impact on climate change due to deforestation, soil degradation, land use changes and exploitation of resources. Additionally, nature and biodiversity are often seen an opportunity to achieve net zero goals. The steps taken to address the climate-related natural risks and opportunities could therefore serve as an important reference point within efforts to prevent, minimize and potentially offset nature-related risks in the sector. ([236])

Mitigation measures in the real estate development and services sector can refer to 1) assessment of nature related risks affecting real estate development and operations, 2) integrating these risks and potential costs into business strategies and practices, 3) adjustments in the design and material selection for new buildings to prevent and reduce exposure, 4) retrofitting of existing buildings and infrastructures to minimize exposure, and 5) improving comprehensive data collection and reporting regulations, to ensure that the progress over time and/or lack thereof is identified and understood. ([237])

Conducting risk assessments for nature (1) can enable businesses to understand how they are dependent and impacting biodiversity, what they can to do to prevent and minimize negative impacts. This might influence decisions regarding the location of future real estate development projects (2), avoiding for example, exposure to high risks, such as coastal areas and/or very close to biodiversity sensitive areas. Specific solutions to improve the design of new and use of existing assets can rely on the use of nature-based solutions (NBS), such as sustainable urban drainage, green roofs and walls, urban parks and green spaces, street trees, wetland creation, etc. ([238]) During the design phase (3), greater attention can also be paid to sustainability aspects, thus ensuring reduced waste generation and improved waste management, reduce use and impact on water, etc. Retrofitting existing building to improve sustainability (4), could consist of using nature-based solutions to ensure protection from flooding, soil erosion, ensure natural ventilation and solar shading, etc. Finally, the improvement of comprehensive data collection (5) refers to the regular assessment and reporting of biodiversity and ecosystem-related risks and opportunities by real estate entities so that they would adjust their own strategies and risk management approaches accordingly.

While **financial institutions** at this point do not seem to apply real estate sector specific mitigation measures to address nature related risks at large scale, some adjustments could be made to the use of their overall environment-related and/or real-estate focused risk assessment strategies. ([239])

([236]) United Nations Environmental Programme Finance Initiative (UNEPFI) (2023) Climate Risks in the Real Estate Sector. March 2023 Climate Change Publications TCFD. Available at : https://www.unepfi.org/wordpress/wp-content/uploads/2023/03/Real-Estate-Sector-Risks-Briefing.pdf

([237]) ibid

([238]) Savvides, Becca (2023) Why Nature-Related risk management is key to real estate's climate resilience. UK&I Thinking Sustainability. Available at : https://www.cushmanwakefield.com/en/united-kingdom/insights/why-nature-related-risk-management-is-key-to-real-estates-climate-resilience

([239]) European Central Bank (2020) : Guide on climate-related and environmental risks. ECB Publication, November 2020. Available at : https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.202011finalguideonclimate-relatedandenvironmentalrisks~58213f6564.en.pdf

These could also be grouped in key areas. In a first stage, the mitigation measures could consist in *improved identification and analysis of nature-related risks*, particularly with respect to real estate sector, relying on collection of additional data and use of modern technologies. Property insurers, for example, are expected for example, to adopt more selective underwriting and increased adoption technologies, such as risk hazard mapping and arial imagery, to meet the challenges posed by Europe's increasing vulnerability to large-scale losses resulting from flooding, storms, drought, heat waves and forest fires. ([240]) In the case of investments into property assets and real estate sector in general, initial analysis of potential rates of returns over the long term, should also be extended to factor in nature-related risks and opportunities. With respect to banks, due diligence should also be extended to collect relevant data on nature-related risks, including information regarding the adoption of mitigation measures. These should be complemented by additional measures to monitor and report the effectiveness of the financial entities to address these risks. This could take place at project, economic activity and/or entity levels. Nature-related risk assessment disclosure and reporting frameworks, such as the TNFD, could be a starting point for continuous assessment and reporting, at least at the entity level.

3.4.2. Sub-Sector 2: Agriculture and Farming

3.4.2.1. Key features of the agriculture sector

The European agri-food sector is pivotal in the European economy and disruptions of the underpinning ecosystem services could expose the sector, and most importantly far-ranging society, to a number of risks. This sector spans activities from crop and livestock farming to food product manufacturing, thereby including agriculture, farming, and food processing, packaging, and transport, but distinctly stands apart from fisheries and forestry. In 2022, the agri-food sector's gross added value was estimated at EUR 222.3 billion, contributing 1.4% of the EU's GDP ([241]). The agri-food industry provides an estimated 8.7 million people with jobs, accounting for 4.2% of total employment in the EU in 2020 ([242]). The sector is deeply complex, since agricultural products are traded in large quantities on the global market. Trade in agricultural products has been expanding significantly over the past years, with an average annual growth of 5.6% ([243]), consistent with the increasingly global and complex supply chains that interconnect the EU with the rest of the world.

Investing in agricultural supply chains and rural areas is crucial to address the growing demands and challenges surrounding food security. The CAP remains one of the largest

([240]) Global Data (2022): Property Insurance Industry in Europe will surpass $156 billion in 2025, forecasts Global Data. Available at: https://www.globaldata.com/data-insights/financial-services/property-insurance-industry-in-europe-will-surpass-forecasts-globaldata/

([241]) Eurostat (2022). Performance of the agricultural sector.

([242]) Eurostat (2022). Framers and the agricultural labor force – statistics.

([243]) Eurostat (2023). Extra-EU trade in agricultural goods.

public investment tools in the EU budget. For the period of 2021-2027 EUR 378 billion was made available to the CAP, representing 31% of the total EU budget ([244]). The sector is generally characterized by low and fluctuating profits margins and cash flows, combined with intrinsic risks related to animal disease, climate change, soil health, and water use/access (ground and surface waters). This has led financial institutions, particularly banks, to be more hesitant to provide credit, financing, or insurance to the sector: farmers are sometimes considered a risk due to their lack in creditworthiness and low repayment capacity ([245]). The financing gap in the sector remains substantial: an estimated EUR 12.5 billion in the EU 24 (excluding the Republic of Cyprus, Luxembourg, and Malta for which comparable data was not available), and is likely to increase in the future ([246]). The Farm to Fork and Biodiversity strategy, for example, will require farmers to undertake additional investments, that will be contingent on both public and private funding available to help produce in a more environmentally friendly and sustainable manner.

However, the agricultural sector also presents significant opportunities. Growing prospects in the global economy and the EUs' role in exporting products will most likely attract investments from financial institutions ([247]). Additionally, sustainable farming practices also provide new opportunities for innovation and improved efficiency, while also reducing environmental footprints, resource use, and restoring biodiversity. Regenerative agriculture therefore offers a way of farming that generates financial, ecological, and social returns. Investing in regenerative agriculture therefore also presents opportunities for new and innovative financing opportunities ([248]). Financial institutions can, and must, play a critical role in the sectors transformation from intensive farmland to nature-inclusive farmlands.

Inter-sectoral connections

Agricultural sector is receiving inputs from several industries: fertilizer (N,P,K - P,K-mining, natural gas extraction), chemical (crop protection), petrochemical (oil extraction, diesel production), machinery (tractors etc. which links to technology and innovation) and energy (oil and gas). Oil & gas (mid and downstream) are both in the top 7 highest ranked sectors according to analytical assessment using ENCORE data. It is also linked to the transport sector, as the movement of agricultural products between farms and to markets require transportation and a distribution network. It is also important to consider that

([244]) Negre (2023). Financing of the CAP. Fact Sheets on the European Union. European Parliament.

([245]) EIB (2020). Financial needs in the agriculture and agri-food sectors in the European Union. Summary report. Available here: https://www.fi-compass.eu/sites/default/files/publications/financial_needs_agriculture_agrifood_sectors_eu_summary.pdf

([246]) Ibid

([247]) Sustainable Finance Platform (2022). Financing regenerative agriculture. Regenerative finance solutions to restore and conserve biodiversity. Available here: https://www.dnb.nl/media/adjnzhdz/web-financing-regenerative-agriculture-final.pdf

([248]) Sustainable Finance Platform (2022). Financing regenerative agriculture. Regenerative finance solutions to restore and conserve biodiversity. Available here: https://www.dnb.nl/media/adjnzhdz/web-financing-regenerative-agriculture-final.pdf

today's food production, and future improvements in efficient and sustainable food production, is largely reliant on agricultural technological advancements driven by R&D. Furthermore, achieving resilient crops and adapting plant species links directly to innovation in genetics, and genetic research. On the other hand, the agriculture sector also supplies outputs to various industries: retail and wholesale (through food, textiles and apparel, and leather), energy (through bioenergy), chemicals industries, pharmaceuticals and healthcare, and tourism (i.e. artisanal products, cultural creative industries). The pharmaceuticals and healthcare sector are among the more materially exposed sub-sectors within the EU economy. In addition, the energy production sector, depending on weighting applied, is either part of the top 7 ranked sectors, or closely following them. In summary, agriculture and farming industry is not only ranked high in terms of combined impact-dependency on the nature but is also firmly connected to other materially exposed sub-sectors, implying that its ranking is likely to remain high when considering indirect impacts and dependencies established through inter-sectoral connections.

A risk assessment of biodiversity and ecosystem services impacts on the European economy, particularly in the sectors of agriculture, food, and beverages, necessitates an in-depth exploration to understand both its direct and latent impacts of a very large array of drivers. Here we identify some of the most significant risk drivers affecting the European agricultural sector. Many of the sector's dependencies are also directly impacted by their unsustainable practices, resulting in direct impacts on the sector's outputs and economic valuations, and subsequently heightening their own risks and vulnerabilities. The agricultural sector stands as a good illustration of the complexity of double materiality. Disruptions to these services can reverberate across the agricultural sector, impacting both the quantity and quality of food produced. The intricate dance of ecosystem services is not just a matter of environmental or agricultural significance; it has profound economic ramifications, especially when viewed through the lens of the European economy. Europe, with its diverse landscapes, climate zones, and agricultural traditions, is a continent deeply reliant on the robustness of its ecosystems to ensure its food security, and to reduce its dependency on foreign imports and thus its vulnerability to economic embargos. We present each risk driver by a description of the causal linkages between an endangered ecosystem service and agri-food production followed by assessments of the economic implications.

3.4.2.2. Biodiversity and nature related risks

The strong connection between the agricultural sector and the natural environment, along with its wide range of services, means that the sector has several direct dependencies. It is therefore no surprise that the sector is therefore globally ranked as one of the most vulnerable to financial risk. However, the sector is at the same time responsible for the global decline in biodiversity, through its direct detrimental impacts. Agriculture is the number one driver of biodiversity loss globally and contributes to one

third of global emissions ([249]) ([250]) Livestock production and feed account for over 70% of all agricultural land use ([251]), whilst cattle and soy for animal feed are both among the top three drivers of deforestation globally ([252]).

In terms of dependencies, our assessment revealed that groundwater, surface water, flood and storm protection and erosion control as some of the most significant ones. Thereafter follow a series of other high dependencies (with a minimum value of 4) including pollination, soil quality, water flow and quality, climate regulation and disease control (Figure 3-14). Within these categories, we consider different levels of materiality. The highest materiality rating goes to flood and storm protection, which is provided by the sheltering, buffering and attenuating effects of natural and planted vegetation. The production processes is extremely vulnerable from disruptions from floods, especially considering that the severity of the impact would be long-lasting on the production process and thus pose significant risk. Similarly, the production process is extremely vulnerable to pest-control and disease. The degree of protection offered by the ecosystem service is critical and irreplaceable for the production process. The 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. Water flow and quality are indispensable for the production process. On the other hand, pollination, soil quality and erosion control have a high materiality, but here the system can cope with some disruptions before posing significant risks. However, considering the extent to which the sector is dependent on these services means that these pose a high risk to the production process.

As stated previously, the agricultural sector is an example of double materiality – most of the ecosystem services that the sector depends on are also directly impacted by the unsustainable and intensified practices currently in place. Water and soil health are significantly impacted by the sector. The impact of agriculture on water use/scarcity, water pollution (particularly through eutrophication and chemical pollution) and soil degradation (from chemical contamination) not only directly poses a risk on the agricultural sectors dependencies but also directly affects other sectors dependencies on these resources (Figure 3-14). Thus, the impact of the agricultural sector is one that is not only of detriment to itself but is far reaching into a number of other sectors associated to its supply chain as well as of other economic significance (e.g. drinking water, human health, food and beverages, pharmaceuticals, antimicrobial resistance, disease outbreaks and healthcare, fisheries, other recreational activities ([253]).) In

([249]) Benton et al. (2021). Food system impacts on biodiversity loss. Research Paper. Energy, Environment and Resource Programme.

([250]) Fairr (2022). Biodiversity and Nature risks – implications for investors and policy.

([251]) FAO (2021). Land use statistics and indicators. Available here: https://www.fao.org/documents/card/en/c/cb6033en/

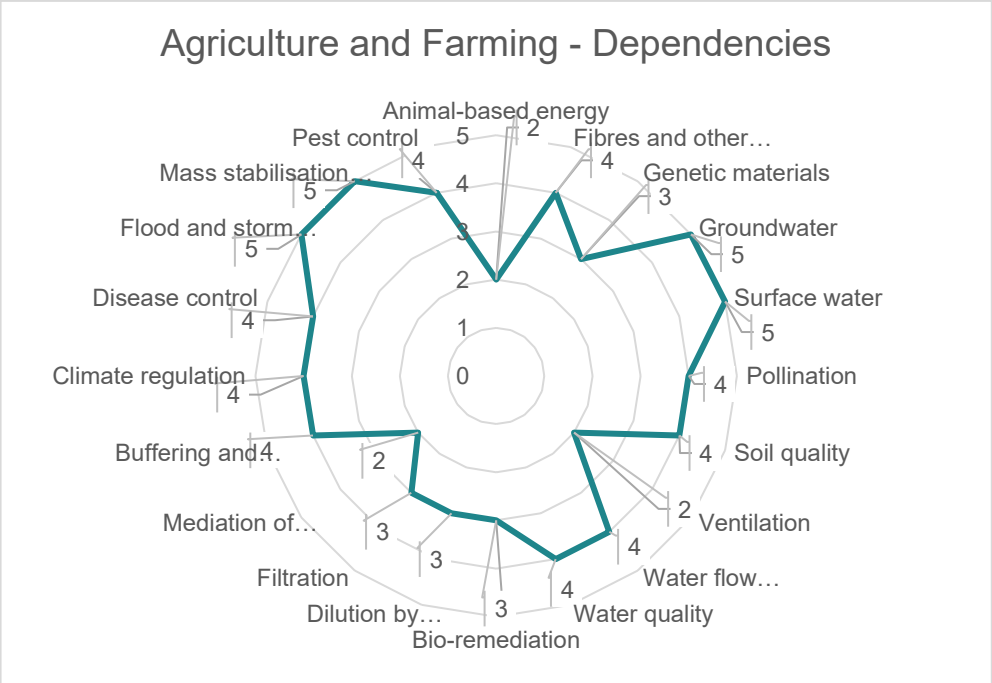
([252]) Weisse and Goldman (2021). Just 7 commodities replaced an area of forest twice the size of Germany between 2001 and 2015. Available here: https://www.wri.org/insights/just-7-commodities-replaced-area-forest-twice-size-germany-between-2001-and-2015

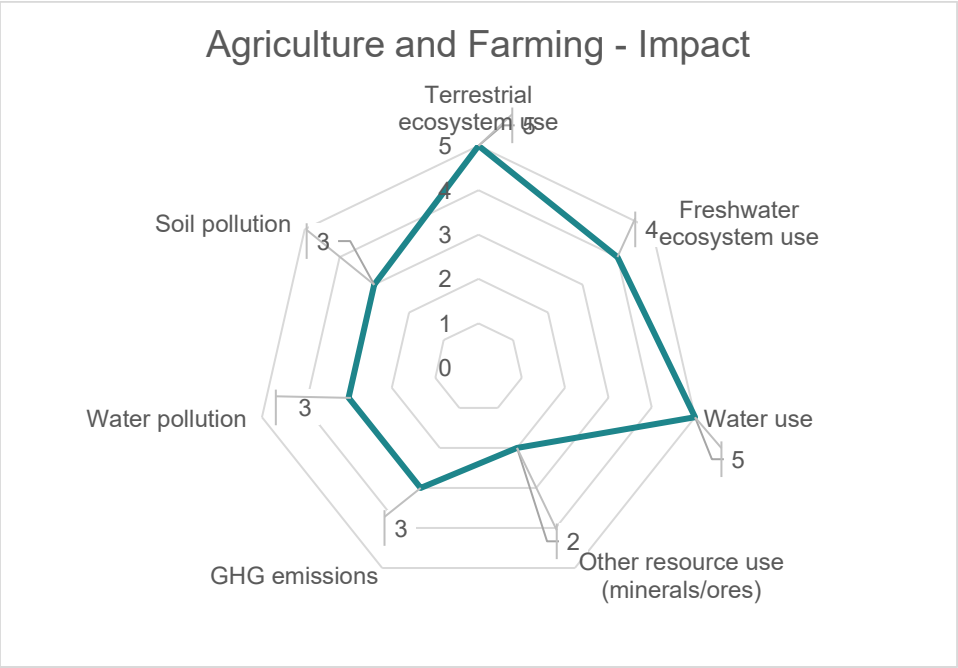
([253]) OECD (2012). Agriculture and water quality: monetary costs and benefits across OECD countries. OECD Publishing.

addition, the agricultural sector substantially contributes to GHG emissions and thus fuels climate change impacts that consequently further amplify degradation of all other ecosystem services. The far-reaching impacts of the agricultural sector's unsustainable actions are further evidence as to why urgent action is needed to transform practices, and highlight just how vast investment opportunities can be – and the significance of the benefits that could be reaped.

We provide a brief overview of the ecosystem services of highest relevant to the agricultural sectors dependence and impacts, elaborating on the importance of the service, the possible economic implications, and the inter-linkages with other sectors.

Figure 3-15 – Biodiversity and nature related impacts and dependencies in the agricultural sector





Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

Water Resources (Surface & Groundwater)

Beyond mere irrigation, water acts as the primary solvent and medium for various biochemical processes in plants. Healthy water systems enable the transportation of nutrients, ensuring optimal plant health, which directly translates to yield and quality. This requires water sources to not only be abundant, but also for water quality to be good enough to be able to expose to agricultural products meant for consumption. The economic ramifications of water quality and scarcity are profound. Crop failures or reductions due to inadequate water quality or quantity could cause substantial economic setbacks. This not only puts stress on public utilities but also amplifies costs throughout the agricultural supply chain. European Court of Auditors report has found that although both the Common Agricultural Policy (CAP) and the Water Framework Directive (WFD) set requirements on MS to control agricultural use of water, and thus make the use more sustainable, they have so far failed in achieving this leaving the agricultural sector with the largest consumption for European freshwater resources, in many cases far beyond sustainable levels. ([254])

Flood and storm protection

Ecosystems, such as wetland and natural vegetation, act as buffer against flood and storm impact, by absorbing excess water, slow down water and reduce the intensity of these events. This physical protection shields agricultural areas from direct damage from inundation, erosion, and debris that can be carried by floodwater. Protection from floods and storms does not only provide a physical protection to crops, livestock and fields but links to a number of other dependencies including: soil health (preventing soil erosion

([254]) European Court of Auditors (2021). Sustainable water use in agriculture: CAP funds more likely to promote greater rather than more efficient water use. Available here: https://www.eca.europa.eu/Lists/ECADocuments/SR21_20/SR_CAP-and-water_EN.pdf

and nutrient loss) and stability of water supply (preventing disruption in water sources and ensuring regulated water flow during periods of heavy rainfall). In addition, ecosystem services that allow for flood protection provide direct protection to key infrastructure (buildings, equipment, irrigation systems). The extreme precipitation in western Europe from 12th to 15th of July in 2021 was estimated to affect a total area of 2470 km^2 with severe inundation. A total of 200 people died, and the economic loss within this short period was estimated at EUR 3 billion ([255]).

Soil Quality & Erosion Control

Erosion, caused primarily by water and wind, leads to the loss of fertile topsoil, significantly diminishing its productive capacity. Erosion control, often facilitated by vegetative cover and specific farming practices, is essential to ensure the long-term productivity of lands. The economic toll of unchecked erosion is steep. It is estimated that soil erosion costs European countries EUR 1.25 billion in annual agricultural productivity loss and EUR 155 million in GDP loss. that soil degradation could result in losses of up to €38 billion annually within Europe ([256]). The direct costs hit mainly farmers through loss in production, damage to plantation and cost of additional nutrients needed to balance the loss. However, indirect costs remain unaccounted for but are estimated to be felt across various sectors of the economy including loss of wildlife habitat, land abandonment, damages to road and railways and public infrastructure. ([257])

Pollination

Pollination is a symbiotic relationship where pollinators, including bees, butterflies, and beetles, enable the reproduction of entomophilous plants. Through their actions, they assure fruit set, thereby having a direct impact on the yield and quality of crops. It has been estimated that pollinators improve or stabilize yields of approximately 75% of crop-plant species globally ([258]). Any disruption or diminishment of this service can significantly alter the quantity and quality of produce, with repercussions on the entire supply chain. Globally, the estimated economic value of wild and managed pollination services was estimated at USD 215 billion in 2005, which represent 9.5% of global food production ([259]). Tangible benefits to the economy of pollinators to the EU's agricultural outputs are estimated at EUR 5 billion a year at leas – for some crops the contribution of pollinators can amount to half of the market value of produce ([260]). A decrease in the pollination service would, in the medium to long term, lead to increased costs in the agri-

([255]) He et al. (2021). Brief communication: Western Europe flood in 2021: mapping agriculture flood exposure from SAR. Natural hazards and Earth systems sciences. EGU.

([256]) EU Science hub (2018). Soil erosion costs European farmers EUR 1.25 billion a year. News announcement. Available here: https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/soil-erosion-costs-european-farmers-eu125-billion-year-2018-02-27_en

([257]) Ibid.

([258]) Klein et al (2007).

([259]) Vanbergen, A. J., et al. (2013). Threats to ecosystem service: pressures on pollinators. Frontiers in Ecology and the Environment, 11(5), 251-259

([260]) EC (2023). Questions and answers on A New Deal for Pollinators. Available here: https://ec.europa.eu/commission/presscorner/detail/%20en/qanda_23_282

food supply chain, raising prices for consumers and potentially resulting in economic downturns in regions heavily reliant on specific crops.

Pest Control & Invasive Species Management

The natural equilibrium of ecosystems involves native predators and competitors keeping potential pests in check. Disruptions to this balance, whether due to decreased predator populations or the introduction of invasive species, can lead to significant agricultural losses. Additionally, monoculture plantations increase the risk of disease and pets out brakes due to the lack of genetic diversity and thus reduced capacity for adaptation and immune-resilience. Beyond immediate crop losses, the costs associated with managing and controlling these threats are substantial. A recent study estimated that the total cost of invasive alien species damage between 1960 and 2020 was USD 140 billion across the EU: the agricultural sector was most impacted with overall USD 36 billion of damage ([261]). Cost of managing disease, pests and invasive alien species vary significantly between types of agriculture. For example, the annual average cost of chemical crop protection in European for outside horticulture was estimated at EUR 808/ha while for olives it was EUR 83/ha ([262]). However, the cost can also vary based on techniques and technology used. As such, costs of damage as well as management of these dependencies pose a significant risk to the agricultural sector and as such a number of associated, inter-linked sectors. Climate change is likely to exacerbate the problem, reducing plant resilience, increase the stress exposure to crops and thus ultimately leading to an increase in disease outbreaks and proliferation.

Locational specificities

The main nature related risks in agriculture vary widely across regions, as there is signification variation in their exposures to deforestation for cropland/plantations/pasture expansion; unsustainable water use (ground water depletion, soil subsidence), soil degradation, nutrient pollution, overgrazing. Deforestation is happening mostly for the reason of expanding economically productive land and, according to FAO ([263]) in the past years it has been seen mostly in Brazil, Tanzania, and Indonesia, whereas through trade, that impact is relevant also in the EU context, especially with respect to biofuels ([264]). Unsustainable water use i.e. high level of a water stress index (ratio of total withdrawals to total renewable supply) varies substantially by region, and according to the WRI estimate ([265]) many world regions are prone to this issue including a few EU countries, where excessive water extraction in some cases has even resulted in ground subsidence causing damages in buildings (see “A Case Study Aquifer Management in Spain” by

([261]) Haubrock et al (2021). Economic costs of invasive alien species across Europe. NeoBiota 67, 153-190.

([262]) EPRS (2021). Cost of crop protection measures. European Parliament. Available at: https://www.europarl.europa.eu/RegData/etudes/STUD/2021/690043/EPRS_STU(2021)690043_EN.pdf

([263]) https://ourworldindata.org/deforestation

([264]) Hutt (2022). What are the EU’s options in plam oil standoff? Business Malaysia. Available here: https://www.dw.com/en/what-are-eus-options-in-palm-oil-row-with-malaysia-and-indonesia/a-62564129

([265]) WRI (2013). Water stress by country. Available at: https://www.wri.org/data/water-stress-country

EARSC266), which is a demonstration of the systemic risk type of effects, according to the adopted TNFD typology. While soil degradation is a global scale issue (267) with some prominent hotspots including in the EU, there are activities ramping up to restore degraded soils (e.g. in Brazil: (268) 269) Nutrient pollution is a prominent issue at the EU scale. According to EPA, while nutrient concentrations in the environment have generally decreased over the past three decades, excess nutrient pollution remains one of the most serious issues affecting human and ecosystem health in the EU with impacts manifesting as eutrophication, air pollution and climate change. Relatively high nitrogen surpluses are found in intensive livestock regions including north-western Germany, the Netherlands, Belgium, Luxembourg, Brittany in France and the Po Valley in Italy (EPA, map on spatial variation in N and P surplus (270): Finally, grazing areas vary considerably by the world regions with EU being a minor contributor among those (271). However, grazing is found to be a major contributor to variation in European Union land and water footprints when tracking food through the global trade (272)

3.4.2.3. Transmission channels

The agricultural sector, while seemingly distinct from the financial realm, is intricately woven into the fabric of the financial sector and the broader economy through a network of direct and indirect transmission channels. As such, financial institutions are by no means immune to the cascading and transcending risks originating from the agricultural sector. Transmission channels thus range from micro to macro level, translating into credit, market, liquidity and operational risks.

Financial institutions, particularly banks and credit providers, have established direct connections to agriculture via lending portfolios. This leads to **direct exposure to risks through agricultural lending**. The repercussions of ecosystem service disruptions, leading to diminished agricultural yields, can elevate the likelihood of loan defaults, directly affecting financial institutions' stability. The ECB reported that in 2022 it held around EUR 20 billion in vulnerable loans ([273]). The effect of the COVID pandemic

([266]) Mamais et al (2020). Sentinels benefits Sutdy (SeBS) – A case study on Aquifer Management in Spain. Available here: https://earsc.org/sebs/wp-content/uploads/2020/10/Aquifer-Management-in-Spain_vf.pdf

([267]) Borrelli et al (2017). An assessment of the global impact of 21st century land use change on soil erosion. Nature Communications, 8.

([268]) The Nature Conservancy (2020) Guia de Conduta Ambiental para investiments e empresitmos para producao de soja no Cerrado. Available here: https://www.tnc.org.br/content/dam/tnc/nature/en/documents/brasil/tnc-guiacondutaambiental-pt.pdf

([269]) Seone et al. (2023). Restauracao ecologica em sistemas agroflorestais sueccesionais do Vale do Ribeira, Sao Paolo. Embrapa.

([270]) EEA (2022). Cross-cutting story 4: Nutrients. Available here: https://www.eea.europa.eu/publications/zero-pollution/cross-cutting-stories/nutrients

([271]) Statista (2009). Areas of grazing land in selected world regions in 1961, 1991, and 2007. Available here: https://www.statista.com/statistics/269236/grazing-land-worldwide-by-region/

([272]) Vanham et al (2023). Multi-model assessment identifies livestock grazing as a major contributor to variation in European Union land and water footprints. Nature Food, 4.

([273]) ECB (2023). Financial Stability Review – Corporate vulnerability and the risks of lower growth and higher rates. Available here: https://www.ecb.europa.eu/pub/financial-stability/fsr/focus/2023/html/ecb.fsrbox202305_01~3d6c7da2aa.en.html

resulted in that the agricultural sectors vulnerability posed one of the largest threats to banks, as they were significantly affected by the outbreak. With a 10% drop in farm revenues, which could result from reduced pollination or water shortages, the risk to loan portfolios can surge by significant amounts in a short timeframe. In addition, banks can experience **collateral value decline**. Banks frequently accept agricultural land or assets as collateral against loans. Degradation of soil quality, or increased vulnerability of lands to events like wildfires and floods can depreciate the value of these assets. As such, nature related loss translate directly into **capital depreciation and increased investment needs** in the agricultural sector. Financial institutions also invest in a broad spectrum of assets, including agri-business stocks and bonds. **Disturbances in ecosystem services** can trigger market apprehensions about the future profitability of these businesses, leading to stock price volatility and as such translate into investment portfolio risks.

Linked to that financial institutions are also indirectly exposed through the consequences on the supply chain: they have credit exposures to the entire agri-food supply chain, from farm equipment manufacturers to food retailers. **Disruptions at the agricultural production level** therefore can ripple through this chain, **affecting the profitability and creditworthiness** of a multitude of enterprises. Furthermore, the fact that the agricultural sector has inter-linkages with significant number of other sectors across multiple supply chains also means that any larger disruption to the sector, affecting productivity, would create large macroeconomic feedback loops. These can potentially lead to changes in **consumer behavior and spending, increased unemployment, and diminished economic grow**th – all of which can act as transmission channels to financial institutions. Such macroeconomic shifts can affect the overall credit environment and increase default rates across various sectors, not just agriculture. Note that in particular a shift in **consumer behavior** can translate into legal and reputational risks not only for the businesses in the sector but directly to financial institutions themselves. Inaction to improve agricultural practices and shift towards more sustainable, and less environmentally harmful practices could drive down spending on key agricultural products. Case studies show that farms focused on pigs and poultry could lose up to 34% with increasing awareness of consumers to reduce their meat consumption ([274]).

Finally, as noted previously impacts of floods and stormwater on agriculture not only cause production disruptions but can also **affect key agricultural infrastructure**. Property damages and business disruption from severe weather is a key transmission channel at the micro level, which can directly translate into operational risks for financial institutions.

3.4.2.4. Identifying key mitigation measures

The criticality of ecosystem services to the European agricultural sector has been underscored by various studies, with disruptions in these services posing considerable

([274]) Rieger et al (2023). From fork to farm: impacts of more sustainable diets in the EU-27 on the agricultural sector. Journal of Agricultural Economics.

risks to both food security and the economy. Since the economic health and success of the sector is intrinsically and directly linked to a number of key ecosystem services, there are a number of mitigation approaches that can be taken at individual farm level. At the company level a responsible and cautious strategy can be implemented with regard to: avoiding activities leading to deforestation; implementation of the prudent soil management ensuring its healthy state and, where necessary, also carrying out soil restoration; careful fertilizer application following best practices to prevent or reduce nutrient pollution; rational spatial allocation of livestock and other strategies to avoid overgrazing. A number of direct mitigation actions in relation to specific dependencies are known, and are all linked to improving agricultural practices:

- **POLLINATORS:** Enhancing habitat diversity by planting wildflower strips and hedgerows, and reducing pesticide use can bolster pollinator populations ([275]). Implementing such measures can increase crop yields by up to 25% through improved pollination ([276])
- **WATER MANAGEMENT:** Implementing efficient irrigation systems, such as drip irrigation, and optimizing water storage can conserve water and reduce waste ([277]). Furthermore, the restoration of wetlands can enhance water purification processes. Efficient irrigation can reduce water usage by 30-60%, preserving vital water resources ([278])
- **CLIMATE ATTENUATION:** Reforestation and afforestation, combined with sustainable land management practices, can act as carbon sinks and buffer regional climates ([279]). Properly managed reforestation can sequester around 205 Gt of carbon, countering anthropogenic emissions and mitigating climate-related risks ([280])
- **SOIL QUALITY AND EROSION:** Adopting conservation tillage, crop rotation, and planting cover crops can substantially reduce soil erosion and maintain soil fertility ([281]). Conservation tillage alone can reduce soil erosion rates by up to 90% in certain contexts ([282]).
- **PEST CONTROL AND INVASIVE ALIEN SPECIES:** Promoting biological control agents, integrated pest management, and stringent border controls can mitigate the risks posed by pests and invasive species ([283]). Integrated pest management can reduce pesticide use by up to 90% while maintaining or

([275]) Potts, S.G. et al. (2016). Safeguarding pollinators and their values to human well-being. Nature.

([276]) Gallai, N. et al. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. Ecological Economics.

([277]) Hanjra, M.A. & Qureshi, M.E. (2010). Global water crisis and future food security in an era of climate change. Food Policy.

([278]) Jägermeyr, J. et al. (2016). Integrated crop water management might sustainably halve the global food gap. Environmental Research Letters.

([279]) Bastin, J.F. et al. (2019). The global tree restoration potential. Science.

([280]) Ibid

([281]) Montgomery, D.R. (2007). Soil erosion and agricultural sustainability. PNAS.

([282]) Pimentel, D. & Kounang, N. (1998). Ecology of Soil Erosion in Ecosystems. Ecosystems.

([283]) Ehler, L.E. (2006). Integrated pest management (IPM): definition, historical development and implementation, and the other IPM. Pest Management Science.

increasing crop yields ([284])

In addition, the sector in its entirety, and the financial sector can take mitigative actions too. At a broader sectoral level, and with the assumption of essential regulations and policies at sub-national, national, and supra-national tiers, there exists the potential to advance, encourage, support, and even enforce mitigation measures at the company level. This larger-scale approach allows for the promotion and incentivization of practices that contribute to sustainability, while also making certain measures obligatory through legal frameworks. An apt example of such large-scale intervention is the Water Framework Directive (WFD) which includes components to regulate the water usage to prevent the unsustainable depletion of this vital resource. This regulation extends beyond the scope of individual companies, primarily due to the intricate interdependencies among various users drawing water from shared streams or utilizing communal groundwater sources. In essence, these regulatory efforts transcend individual company boundaries to ensure the responsible and equitable management of resources that are shared among multiple entities. However, as noted previously, investigations into the enforcement and proper implementation of water prices and taxation have remained weak in the EU. While sectoral policies can indeed pose a viable mitigative approach, they are often too weakly enforced.

Finally financial institutions play a critical role in supporting the transition of the agricultural sector, and thus directly reducing its own risk exposure. Considering the substantial financing gap that remains for the agricultural sector, and with increasing scale of impacts, the financial sector will play a critical role in financing more sustainable practices. Banks possess the capacity to effectively mitigate their risks by strategically shaping the composition of their stocks and loans portfolios, adapting them as needed to align with changing risk profiles. For insurers, a crucial aspect lies in establishing a robust financial estimation mechanism that can accurately assess the potential liabilities stemming from insuring nature-related risks. This involves a thorough understanding of the intricate nature of these risks and their potential financial implications. Similarly, asset managers and company owners should be proactive in implementing the interventions discussed per dependency, tailoring them to suit the specific circumstances of the companies they oversee. By adopting these measures, financial institutions, insurers, asset managers, and company owners can collectively contribute to a more resilient and sustainable financial landscape, safeguarding their interests while promoting responsible practices in the face of nature-related challenges.

([284]) Pretty, J. et al. (2008). The environmental and social benefits of specific IPM practices. Critical Issues in Environmental Taxation

3.4.1. Sub-Sector 3: Health Care Delivery

3.4.1.1. Key features of the health care delivery sector

The health care delivery industry consists of different economic activities. According to the NACE classification system, it includes hospital activities, medical and dental practice activities, while excluding residential care activities. In 2020, the human health activities' gross added value was EUR 646,588 million? accounting for 5% of the total gross value added in the EU27. The gross capital formation was EUR 55,661 million, slightly less than the investments in assets in the agriculture and farming industry (both industries represent 2% of the total GCF in 2021). In terms of employment, the healthcare industry provides around 6% of the jobs in EU27 in 2021. While the sector is dominated by public care delivery, the private sector plays a (growing) substantial role either indirectly by the provision of ancillary goods and services, or by direct healthcare delivery through, for instance, Public-Private Partnerships.

Public healthcare is one of the most important public spending in the EU27 (accounting for 11% in 2020) ([285]). Private investors are relatively less significant, for various reasons. A study by the EIB's advisory hub on the healthcare sector in the EU highlighted several investments barriers including constraints of healthcare investment promoters, insufficient access to funding, regulatory barriers, as well as lack of consolidation of business models and of sufficient scale or volume of activities for financing (e.g. loan period or volume). The report also concludes that the healthcare sector in the EU is characterised by strong differences across member states, due to national healthcare system set-up, the value and types of investments, various investment barriers and national policy contexts. Moreover, looking at the different financed projects in 2015, it seems that investments are mainly directed to hospital facilities, followed by e-health, hospital facilities and medical equipment and other healthcare investments. Healthcare investments in primary care facilities and long-term care facilities are rather low. ([286])

Relevance and role of financial institutions in the sector

Financial actors nonetheless invest in the health sector in various roles, from lenders, intermediaries to investors, whilst deploying a wide variety of financial instruments (e.g. loans, equity investments, and venture capital). ([287]) In addition, there is a growing importance of private equity in the healthcare sector. In Germany, it is estimated that about 750 of overall 3800 ambulatory healthcare centres were in the hands of private equity funds in 2020, despite regulations aimed at preventing this type of ownership. ([288])

([285]) Eurostat (2023). Healthcare expenditure statistics

([286]) EIB (2019.)Health sector study – EIB Advisory Hub.

([287]) Krech R, Kickbusch I, Franz C, et al. Banking for health: the role of financial sector actors in investing in global health. BMJ Glob Health 2018;3:e000597. doi:10.1136/ bmjgh-2017-000597

([288]) Bernd Rechel and others, Private equity investment in Europe's primary care sector—a call for research and policy action, European Journal of Public Health, Volume 33, Issue 3, June 2023, Pages 354–355, https://doi.org/10.1093/eurpub/ckad061

Pension funds often have the healthcare sector in their portfolio. For instance, the Defined Benefit (DB) pension funds in the Netherlands and the United Kingdom have 8.5% investments in equity in health care (total investments in equity account for 32.1% of all investments). ([289])

Another important actor in the healthcare sector are the insurance companies that provide individuals or groups with a range of services to supplement, complement or sometimes replace publicly financed healthcare, depending on the national healthcare system. The insurance policies cover the medical costs of illness or accidents. ([290]) The role of private health insurers is becoming ever more significant because of Europe's ageing populations and increasing strains on national healthcare systems. In 2019, 12% of all claims and benefits were directed to health in the EU. ([291]) Of which four-fifths of all claims were paid in the four largest markets, namely the Netherlands, Germany, France, and Switzerland.

Finally, asset managers are also active in the health sector driven by technology development and increasing demand because of the ageing population. ([292]) Moreover, asset managers increasingly see ESG impact, providing an incentive for investments in affordable healthcare and stewardship. ([293])

Location and supply chain information

The services directly contributing to healthcare delivery (e.g. nursing) occur predominantly in respective Member States, however, the production of equipment and medicines often takes place outside the EU. Countries like India and China play an important role in manufacture of medicines and equipment. In 2018–19, India exported nearly $19 billion worth of pharmaceuticals to more than 200 countries, including the EU. ([294]) Relying on countries outside the EU to produce essential materials and drugs, is risky, and has in the past resulted in shortages in supply which hampers the functioning healthcare sector in the EU. ([295]) While drug and equipment delivery problems are not a new issue, the Covid-19 pandemic further revealed the EU's dependence on certain supply chains for equipment such as gloves, gowns, and N95 masks, as well as life-support machines, and oxygen generators. ([296]) ([297])

([289]) European Commission (2019). Study on the drivers of investments in equity by insurers and pension funds

([290]) Insurance Europe (2023). Health Insurance.

([291]) Insurance Europe (2019). European Insurance in Figures

([292]) Fund Europe (2022). Why asset managers are becoming vital to the future of healthcare.

([293]) EFAMA (2022). Asset Management in Europe. An overview of the asset management in Europe.

([294]) Guerin PJ, Singh-Phulgenda S, Strub-Wourgaft N. The consequence of COVID-19 on the global supply of medical products: Why Indian generics matter for the world? F1000Res. 2020 Apr 1;9:225. doi: 10.12688/f1000research.23057.1.

([295]) European Commission (2022). Vulnerabilities of the global supply chains of medicines. Structured. Dialogue on the security of medicines supply Commission Staff Working Document.

([296]) McKinsey (2022). Optimizing health system supply chain performance

([297]) World Bank Blogs (2022). Tackling health care supply chain challenges through innovations in measurement

The EU expressed its concerns regarding dependency upon these supply chains, and announced several measures to address this, including the Pharmaceutical Strategy for Europe ("Pharmaceutical Strategy") of November 2020, which includes several actions aimed at improving the availability of medicines, with lower dependence on imports. ([298]) However, securing medicine and equipment supply is often challenging due to the complexity of these supply chains. For instance, shifting the production of the manufacturing of equipment, requires upstream enterprises such as aluminium, integrated circuits, lithium batteries, pneumatic fittings, and raw material manufacturers to increase their supplies.

3.4.1.2. Biodiversity and nature -related risks

Maintaining healthy, functional ecosystems is intrinsically linked to human health. Similarly, a functioning healthcare system is largely dependent on healthy ecosystems, due to, inter alia, the provision of genetic resources required for drug production, the control of disease vectors (thus reducing the burden on healthcare systems to treat infected patients), in addition to an array of psychological and nutritional benefits. ([299]). While the estimated percentage of pharmaceutical drugs sourced directly or indirectly from nature varies, several studies highlight the significant importance of the active ingredients from nature for the pharmaceutical market and some estimations reach as as high as 50 % of all approved drugs. ([300])

The figures below present the dependencies and impacts of the Healthcare Delivery and the Biotechnology and Pharmaceutical sector, based on ENCORE data. It shows that the Health care delivery sectors depends on ground water, surface water, mass stabilisation and erosion control. The dependence on water is closely tied to essential requirements such as supplying hospitals with water for cooling, cleaning, and drinking purposes. The environmental impacts stemming from the healthcare delivery sector are most pronounced in terms of greenhouse gas (GHG) emissions, followed by water and soil pollution.

According to a study conducted by RIVM (2022), the healthcare sector in the Netherlands accounts for 7.3% of the national GHG emissions ([301]), making it a significant contributor. It also contributes to 13% of abiotic mineral usage, 7.5% of freshwater consumption, and 4.2% of waste production. ([302]) Notably, medicines and various chemical products drive a major portion of these impacts, for instance, around 40% of the estimated 7.3% GHG

([298]) European Commission (2022). Vulnerabilities of the global supply chains of medicines. Structured. Dialogue on the security of medicines supply Commission Staff Working Document

([299]) Mazer-Amirshahi and Fox (2018) Saline Shortages — Many Causes, No Simple Solution

([300]) KPMG and Nature Value Initiative (2011). Biodiversity and ecosystem services. Risk and opportunity analysis within the pharmaceutical sector. On Behalf of Robeco Asset Management; J. Nat. Prod. 2016, 79, 3, 629–661 Publication Date:February 7, 2016 https://doi.org/10.1021/acs.jnatprod.5b01055

([301]) This includes emissions both within the Netherlands and abroad

([302]) RIVM (2022). Het effect van de Nederlandse zorg op het milieu Methode voor milieuvoetafdruk en voorbeelden voor een goede zorgomgeving. M.A. Steenmeijer et al. DOI 10.21945/RIVM-2022-0127

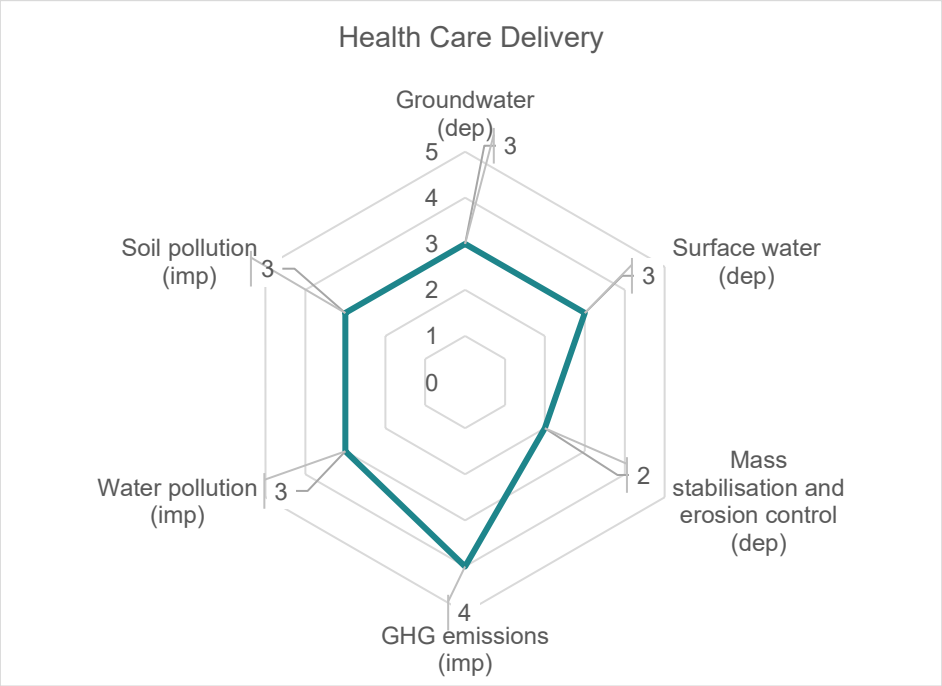
emissions are associated with the production of medicines and other chemical products. The consumption of food also has a substantial impact the environment, notably in relation to freshwater consumption, land use and waste production.

The report also includes a hotpots analysis, revealing that over 70% of raw materials (metals and minerals) is concentrated in Asia, whereas GHG emissions, accounting for nearly 40%, are centered in the Netherlands.

As partly highlighted in the text above, the Pharmaceutical and Biotechnology sector shows more dependencies and impacts on nature. The highest dependency is on surface water, followed by water flow maintenance, water quality, ground water, bioremediation, dilution by atmosphere and ecosystems, filtration and mass stabilisation and erosion control. The sector's impact on nature is the highest for solid waste & pollution, water use & pollution, and to a lesser extent air pollution. Literature review further mentions overexploitation of active ingredients from nature. ([303])

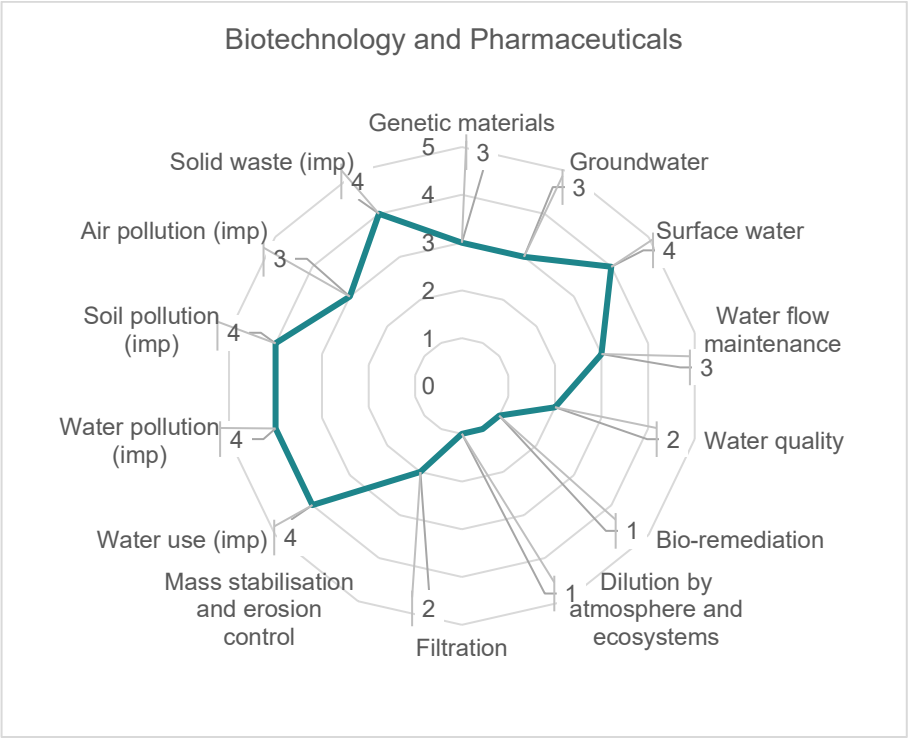
There are different risks associated with the process of 1) discovering new drugs, 2) drug testing and developments, 3) drug manufacturing, to eventually 4) selling and distribute the drugs. For instance, drug testing often is exposed to reputational risks as animal testing is controversial topic and regulations are increasing. ([304])

Figures 3-16 Impacts and denepencies on nature



([303]) KPMG and Nature Value Initiative (2011). Biodiversity and ecosystem services. Risk and opportunity analysis within the pharmaceutical sector. On Behalf of Robeco Asset Management

([304]) KPMG and Nature Value Initiative (2011). Biodiversity and ecosystem services. Risk and opportunity analysis within the pharmaceutical sector. On Behalf of Robeco Asset Management



Source: Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)

The figures 3-16 above capture the key risks relevant to the healthcare sector, however, as noted in section **Error! Reference source not found.**, a number of 'hidden' risks are not captured here. For example, a key risk to be considered is microbial resistance. The World Health Organization lists this as among the greatest threats to global health, ([305]) with the loss of nature one of the key contributing factors promoting the increased circulation of antibiotic resistance genes throughout the environment. The destruction and/or degradation of ecosystems not only reduces the genetic pool of molecules which could be utilised for future pharmaceutical products, but also inhibits the ability of ecosystems to provide a biological barrier to resist the spread of antimicrobial resistance. ([306]) In addition, the healthcare sector can also be an exacerbating factor in propelling antimicrobial resistance throughout the environment through pollutant discharge. Such waste from pharmaceutical manufacturing and community/healthcare settings spreads resistant microbes throughout the environment, providing an increased risk of transmission of antimicrobial resistance between humans and animals. ([307])

3.4.1.3. Identifying the key transmission channels

Given the dependence of the healthcare system on intact, functioning nature, a range of impact on the sector can be foreseen through the loss of nature. Using the framework

([305]) UNEP (2023) Bracing for Superbugs. Available at: https://www.unep.org/resources/superbugs/environmental-action

([306]) UNEP (2023) Bracing for Superbugs. Available at: https://www.unep.org/resources/superbugs/environmental-action

([307]) UNEP (2023) Bracing for Superbugs. Available at: https://www.unep.org/resources/superbugs/environmental-action

established in task 1, each of the transmission channels to the healthcare sector are discussed below.

Changing demand. Nature loss, and the continued degradation of ecosystems (and their health) is projected to increase the risk of human exposure to new and already established zoonotic diseases. ([308]) With such proliferation of diseases encountered by the population, it can be expected that further strain is placed on the healthcare system to treat and develop preventative measures to cope with patient uptake. Second-order impacts such as the negative feedback loops and interlinkages associated with nature-loss, climate change and (the increased severity and frequency of) extreme weather can also impact healthcare systems- through limiting access to healthcare infrastructure. As an example, in 2012 Hurricane Sandy led to the temporary closure and forced movement of patients from a hospital which serves 500,000 patients annually. ([309]) Such closures can place further strain on hospitals and healthcare providers through the forced movement of patients and increased demand for healthcare due to the risk of injury from such climate events. In turn, such increased demand and potential overcrowding can reduce the quality of care.

Raw price volatility. Building upon the example presented above, extreme weather, exacerbated by nature loss has the potential to cause physical damage to healthcare infrastructure, which in turn can lead to supply chain issues and price volatility. The 2017 Hurricane Maria resulted in critical damage to a saline production facility (used for, inter alia, the sterilisation of medical equipment) ([310]) - interrupting supply lines and costs of imports. Furthermore, the growth in human population has resulted in an increased demand and trade of wild species for medicinal purposes, ([311]) yet with the continued global destruction of ecosystems and thus natural resources, it could be foreseen that prices associated with wild harvested medicines could increase. This is captured in figure 3-17 below from Chen et al., which highlights the correlation between (wild) medicinal plant availability and associated pricing.

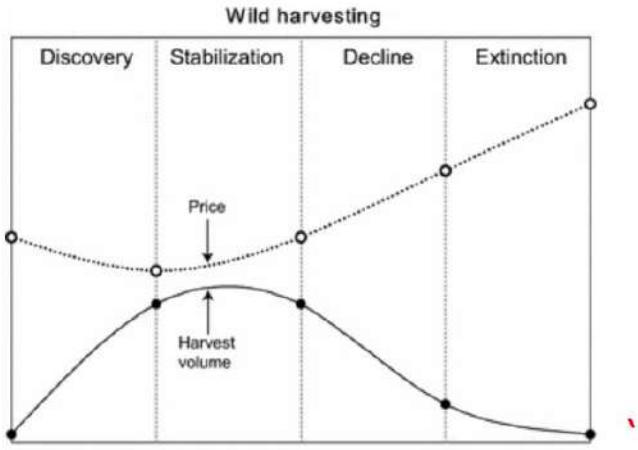
([308]) Keesing and Ostfeld (2021) Impacts of biodiversity and biodiversity loss on zoonotic diseases

([309]) See: https://www.commonwealthfund.org/blog/2018/be-high-performing-us-health-system-will-need-adapt-climate-change

([310]) Marie-Lawrence et al., (2020) Leveraging a Bayesian network approach to model and analyze supplier vulnerability to severe weather risk: A case study of the U.S. pharmaceutical supply chain following Hurricane Maria

([311]) Schippmann et al., (2006) A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects

Figure 3-17 Wild harvesting price and volume interactions of medicinal plants



Source: Chen et al., (2016) ([312])

Asset value. Aside from the potential impacts of physical damage to healthcare assets from nature loss (erosion and/or weather extremes causing structural damage to healthcare infrastructure, costs and/or quality of water treatment increasing due to waterborne diseases- impacting health of patients or costs of running healthcare facilities, etc.), healthcare asset values can be indirectly impacted by nature-loss. The reputation and patient confidence associated with healthcare facilities can, at least in-part, be determined by the natural surroundings of the facilities- with patients associating deteriorated environmental conditions with diminished quality of healthcare services. This in turn, can not only impact the financial performance of the healthcare provider, but also the values of their respective assets.

Change in profitability/increased litigation. In the scenario presented above relating to 'raw price volatility', it could be foreseen that the (over) exploitation of genetic material used within the healthcare sector (such as pharmaceuticals) can lead to litigation due to non-compliance with legislation. ([313]) A good example of this is compliance with the Convention on Biological Diversity and the requirement for benefit sharing of genetic resources. Industries/organisations which have a monopoly on genetic resources may be forced to share access and use of such resources- to ultimately benefit the communities in which such resources originate. Such regulations, which prevent (inter alia) the overexploitation of such resources, can therefore negatively impact the profitability of companies which patent and profiteer from naturally-derived products (pharmaceuticals) – due to limiting their exclusivity to genetic resources.

Disruption of activities/value chains. Finally, it can be foreseen that nature loss can impact multiple segments of the healthcare value chain. As outlined in the above sections, the projected loss of natural medicines (humankind are estimated at losing at

([312]) Chen et al., (2016) Conservation and sustainable use of medicinal plants: problems, progress, and prospects

([313]) Marden (2018) International agreements may impact genomic technologies

least one important source of drug every two years[314]), and the projected increase in disease vectors and outbreaks can be foreseen to increase hospitalisation and healthcare admissions. In turn, associated health insurance claims can be expected, reducing the affordability of healthcare insurance (through adjusted premium rates). Disruptions to supply chains, particularly in the pharmaceutical industry, can be very costly. The pharmaceutical supply chain accounts for approximately 25% of total costs, whereas (on average) 75 days of replenishment time is required from pharmaceutical plants to distribution centres. ([315]) This emphasises that any disruptions to such supply chains could result in considerable costs to such industries. The negative feedback loops with nature loss and climate change impacts can thus lead to significant risks inflicted on pharmaceutical value chains.

3.4.1.4. Identifying key mitigation measures

As highlighted earlier (see section 2.4.3), the initial stride towards crafting a robust risk mitigation strategy begins with cultivating a heightened awareness of the existing risks. Subsequently, it encompasses the anticipation and evaluation of these risks, a process inherently reliant on transparent disclosure conforming to industry best practices. The mounting importance of Environmental, Social, and Governance (ESG) criteria for investors underscores the need for accurate and comprehensive disclosure, facilitating informed decisions concerning nature-related risks. While financial institutions can take steps to impose stricter measures for investment and client acquisition, substantial transformative change towards effective mitigation must emanate from within the sector itself.

The healthcare sector, integral to human well-being, is intricately intertwined with nature, evident through its utilization of natural resources in therapeutics, but also its through packaging and manufacturing. However, transparency within pharmaceutical supply chains is severely lacking, rendering the assessment of risks and long-term viability exceedingly challenging ([316]). The absence of standardization further hampers risk comparison, as firms historically struggled to accurately quantify physical impacts and their corresponding financial implications ([317]). The first step in mitigation is therefore for the healthcare and pharmaceutical sector to embark on a comprehensive risk inventory, gauging the likelihood and potential impact of these risks. This information forms the bedrock upon which robust risk management strategies can be built. The obtained insights are critical to incorporate into companies, as well as financial institutions, risk appetite framework to enable informed risk decisions and resource allocation for

[314] Neergheen-Bhujun et al., (2017) Biodiversity, drug discovery, and the future of global health: Introducing the biodiversity to biomedicine consortium, a call to action

([315]) See: https://vamstar.io/my-resources/covid-19-supply-chain-risk-in-europe/

([316]) Pinchot and Christianson (2019) What Investors Want from Sustainability Data; World Resources Institute: Washington, DC, USA.

([317]) Deweerdt et al (2022). How Will the TNFD Impact the Health Sector's Nature-Risks Management?

monitoring and mitigation, culminating in sound strategic choices encompassing capital allocation and investments ([318]).

To holistically evaluate nature-related risks and opportunities, healthcare firms must acknowledge and account for dimensions encompassing raw materials, manufacturing, and packaging. Disclosing the provenance of raw materials and associated supply risks becomes pivotal, as these factors directly influence accessibility and pricing. However, the pharmaceutical sector's historical reluctance to disclose financial and climate data has led to diminished investor confidence and subsequent impacts on financial institutions' decisions ([319]). Some of the larger pharmaceutical companies have begun taking pro-active steps in mitigation, through institutional transformation: Bayer has articulated strategies that incorporate biodiversity conservation into their corporate agenda, including protecting forest ecosystems, reducing their impacts on biodiversity and supporting smallholder farmers. ([320])

The health and pharmaceutical sector not only rely on medicine and therapeutics from nature, sources from plants, animals and minerals, but also rely heavily on petroleum-based chemicals in their manufacturing process ([321]). These not only require significant amount of water, but also generate high level of waste. Contamination of pharmaceutical in ecosystems, specifically in soil, water and air, have been extensively studies and reported. ([322]) ([323]) Discussion around pharma and health care sector's responsibility to pay for environmental damages relating to environmental pollution and thus adverse impacts on ecosystem health has been an ongoing debate, in particular under the EU's Polluter Pays Principle ([324]). As such, the responsibility and necessary actions pharma and health care sector in their waste management, development of 'green pharmaceuticals, proper disposal of pharma products is essential, and presents a timely mitigation strategy for the industry. Proper waste management practices are also necessary to minimize among others increasing drug resistance in organisms, and contamination of clean water and soil.

Finally, the health of our environment is intrinsically intertwined with human health, as evidenced by the COVID-19 pandemic. With merely 20% of human health attributed to clinical care, the remaining 80% hinges on social, economic, and environmental factors.

([318]) ECB (2020). Guide on climate-related and environmental risks – Supervisory expectations relating to risk management and disclosure.

([319]) KPMG (2011). Biodiversity and ecosystem services: Risk and opportunity analysis within the pharmaceutical sector. Available here: https://www.fauna-flora.org/app/uploads/old-images/Biodiversity-and-Ecosystem-Services-Risk-and-opportunity-analysis-within-the-pharmaceutical-sector-NVI-KPMG1.pdf

([320]) Bayer (2023). Conservation and restoration of biodiversity in agriculture and forestry. Available here: https://www.bayer.com/en/sustainability/position-biodiversity

([321]) Deweerdt et al (2022). How Will the TNFD Impact the Health Sector's Nature-Risks Management?. Int. J. Environ. Res. Public Health, 19(20.

([322]) Wilkinson et al (2022). Pharmaceutical pollution of the world's rivers. PNAS, 199 (8).

([323]) Gworek et al (2021). Pharmaceuticals in the Soil and Plant Environment: a Review. Water, Air, & Soil Pollution volume 232

([324]) OECD (2022). Background note: The implementation of the Polluter Pays Principle - For the thematic workshop on 29 – 30th March 2022. Available here: https://www.oecd.org/water/background-note-polluter-pays-principle-29-20-march-2022.pdf

Acknowledging this symbiotic relationship, the healthcare sector not only has the potential to promote sustainable lifestyle choices but also possesses the financial means to reinvest in education, nature restoration, and sustainable practices ([325]). As global healthcare spending continues to rise, now at an estimated USD 9 trillion annually which represents 10% of global GDP, there is a pivotal opportunity to redirect financial resources towards preserving the environment, creating a direct connection between nature and human health ([326]). The role of financial institutions and policy mandates emerges as pivotal, with active obligations on the pharmaceutical and healthcare sector offering a route to reinvest in nature, biodiversity, and curbing their GHG emissions.

3.5. Key conclusions and recommendations

A sectoral approach to assessing biodiversity and nature related risks is crucial in the current landscape, primarily due to the limited availability of micro-level data, which is both reliable and comparable. While the TNFD and the EU's sustainability reporting framework, including the SFDR and CSRD, represent positive steps towards this goal, companies use different methods for reporting and implementation of ESGs. Hence at this stage it may take some time to achieve the right quality of data (standardized and comparable) to accurately quantify the risks financial institutions are exposed to. Even when such comprehensive data becomes accessible, it's important to acknowledge that resource constraints could make an in-depth analysis challenging. In such scenarios, adopting an iterative approach where materially exposed sectors engage in additional risk identification and assessment methods could be practical. This implies that risk frameworks must be adaptable, facilitating both complex micro-level analyses and sectoral assessments. Ultimately, promoting accessibility to a nature-related risk framework across the board will not only standardize nature risk assessments but also enhance our collective comprehension of these risks.

Existing approaches to identify and rank sectoral sensitivity to biodiversity and nature risks encounters a range of limitations. Many of the examined references utilize a somewhat ad hoc approach to pinpoint sectors that are vulnerable to these risks. One common approach is to investigate existing literature and engage experts to delve deeper into the impacts on specific sectors, a method exemplified by initiatives like the TNFD. On the other hand, some financial institutions have already taken on assessment tools, though these methodologies are not without their own inherent constraints. The most commonly implemented tools that allow for a quantitative component in the assessments were covered under Task 1. Despite their popularity, these tools share common issues and limitations.

Our methodological approach in Task 2 focused on ENCORE, one of the prevailing tools in use, to gauge sectoral sensitivity to biodiversity and nature risks. However, this

([325]) King et al (2023). An Urgent Call to Integrate the Health Sector into the Post-2020 Global Biodiversity Framework. Int J Environ Res Public Health. 20 (1).

([326]) World Health Organization (WHO) Global Spending on Health: Weathering the Storm. World Health Organization (WHO); Geneva, Switzerland: 2020

investigation uncovered a series of constraints associated with the data provided by ENCORE including:

- The materiality assessment provided offers a rudimentary ranking at best, underscoring the need for more refined evaluation methods.
- The sectoral classification employed diverges from widely accepted classification systems, which undermines comparability and alignment with industry standards.
- It overlooks the critical interplay across sectors and the significance of location-specific factors, essential for a comprehensive understanding of biodiversity and nature risks.
- It also fails to consider feedback loops from the economy and financial sectors to the environment, contagion effects, etc.
- The transition of biodiversity and nature risks into financial risks is still in its formative stages, signifying an area that requires further development to comprehensively gauge potential impacts This requires, for example, greater emphasis on forward looking assessments, with a focus on the development of scenarios tailored to sectoral exposures and financial stability that could be integrated into the financial institutions' risk management approaches.
- ENCORE's assessment framework does not encompass the mitigation measures that businesses and sectors may have already adopted to address their exposure to these risks.

A comprehensive literature review reinforces the notion that transmission channels and mitigation measures are inadequately incorporated within empirical studies, reports, and methodological approaches at the sectoral level. Addressing these limitations requires ongoing enhancements in assessment methodologies and tools, aimed at achieving a more nuanced understanding of sectoral sensitivity to biodiversity and nature risks.

Finally, in our methodological approach to determine the most sensitive sectors, encompassing quantitative materiality analysis and industry case studies, we encounter analogous limitations to some extent. Utilization of ENCORE for dependencies and impacts assessment primarily aimed to assess the feasibility of current methods and information, and to shed light on persisting challenges stemming from existing data constraints. When attempting to contextualize the ENCORE global data to the European context, we found additional limitations in the materiality analysis, notably the difficulties in alignment with NACE sectoral classifications and deficiencies in considering inter-sectoral (value chain), locational, and temporal factors. Lack of information on variability of risks was also reviewed in Task 1 and determined as a key limitation in today's existing frameworks and tools.

The development of industry case studies served to further highlight the complexities encountered at sectoral level assessments. These case studies also aimed to provide empirical insights into inter-sectoral linkages, transmission channels, and mitigation strategies—areas that are notably complex and often not adequately captured by general tools like ENCORE due to their intricate nature. The industry case studies ultimately

unveil three critical findings: 1) the significance of so-called "hidden risks," through biological and macroeconomic feedback loops 2) the substantial impact of inter-sectoral linkages that can amplify risk propagation across various sectors, thereby generating more pronounced financial risks than commonly estimated, and 3) the current deficiency in comprehending transmission channels and mitigation measures at the sectoral level. Given these findings, further exploration in this realm is imperative for future analysis, as sector-level transmission channels frequently serve as vital mediators bridging micro and macro level transmissions.

4. Task 3 -Developing an applicable methodological framework

4.1 Introduction

This section provides a methodological framework to guide financial institutions and financial supervisors to identify and assess potential financial risks associated with biodiversity loss and ecosystems degradation.

Over the past two years, several frameworks have emerged to provide initial guidance on nature risks assessment for financial institutions and financial supervisors. These include the OECD's "Supervisory framework for Assessing Nature-related Financial Risks" ([327]), and the NGFS Conceptual Framework on Nature-related Risks ([328]). Both of these frameworks are directed at financial supervisors and central banks. However, there is currently limited methodological guidance that can be used more broadly across financial institutions and financial supervisors. The Taskforce for Nature-related Financial Disclosures (TNFD) also presents detailed guidance under its "LEAP" approach but is primarily tailored for the corporate sector, with some high-level guidance aimed at financial institutions. ([329]) This framework aims to fill this gap by providing methodological guidance for financial institutions on how to assess the financial implications of these risks.

This framework sets out an overall approach and step-by-step methodology that **financial institutions can use to assess the financial impacts of biodiversity and nature-related risks**. It sets out a common and adaptable approach that financial institutions can use to quantify these risks. It defines the key components of a biodiversity and nature-related risk assessment and details step by step actions that can be expected from financial institutions for their identification and measurement of nature-related financial risks.

The framework does not make recommendations on specific tools, metrics and models that should be used by financial institutions to undertake nature-related risk assessments**.** Rather, throughout the framework we emphasise that the choice of when to utilise a specific tool, approach or metrics depends on the purpose, specificities and starting point of assessment. At several points in the framework, we include an in-depth discussion of the spectrum of different approaches financial institutions could use to carry out assessments at different levels of granularity and detail. To supplement this, an in-

([327]) OECD (2023) A supervisory framework for assessing nature-related financial risks, Available at: https://www.oecd.org/finance/a-supervisory-framework-for-assessing-nature-related-financial-risks-a8e4991f-en.htm

([328]) NGFS (2023) Nature-related Financial Risks: a Conceptual Framework to guide Action by Central Banks and Supervisors. Available at: https://www.ngfs.net/sites/default/files/medias/documents/ngfs_conceptual-framework-on-nature-related-risks.pdf

([329]) TNFD (2023). Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.4. Annex 4.6 Guidance on LEAP: Methods for assessing nature-related risk

depth review of available tools is included in Annex A (table 5.1) of this report. In addition we provide an brief summary of available tool and guidance at every step of the method framework.

The framework aims to guide financial institutions in answering four key questions:

- What are the main components of a risk assessment framework that financial institutions can put in place to help them identify, measure and mitigate nature-related risks ?
- How can risks can be identified and measured?
- How can risks be quantified into financial terms?
- How to integrate a forward-looking perspective?

The framework was developed to equip financial institutions with a general approach that can be applied for different use cases, resource constraints and data availability. It aims to help financial institutions work towards best practice in a data challenged environment, with the focus on being flexible in the context of improving data. The framework provides starting points for financial institutions across different level of capabilities and data availabilities. It aims to help them overcome gaps and get started with nature risk assessment in many contexts.

4.1.1. Methodology and key considerations

4.1.1.1. Approach used to develop this framework

This framework was developed based on an in-depth review of existing climate and nature risk assessment frameworks as well as an extensive consultation with key stakeholders across European financial institutions.

Existing frameworks on climate-related risk assessment were used as a main reference to frame key structural components and define essential concepts and terminology. Climate risk assessment methodologies current best reflect what financial institutions already do and understand and share some fundamental components with other nature-related risk assessments. Risk categorizations (e.g. physical and transition risks) are likely to be broadly consistent across climate and nature. Additionally, there are multiple interactions between climate and nature that require an integrated approach to the climate and nature transition. ([330]) Finally, financial institutions have already established risk management processes for climate, and as identified in Task 1, have signalled the intention to use climate frameworks as a basis for assessing nature-related risk. Therefore, constructing a framework aligned with climate frameworks make it easier for

([330]) European Commission, 'Nature and climate crises: two sides of the same coin' (2021)

these institutions to integrate biodiversity and nature assessments into existing processes.

However, the framework departs from climate frameworks in important ways due to the specific nature of biodiversity risks and their differences from climate risks. Existing guidance on biodiversity and nature-related risks were also used as a reference to develop the detailed content of this framework. The framework also extensively draws from case studies of financial institutions that have already conducted nature-related risk assessments. It integrates key learnings and considerations to overcome the challenges faced in these initial assessments.

The framework is therefore aligned with the overall approach of climate risks framework but differs where needed and remains nature specific in content.

To understand climate and nature risk assessment, a three-step process was used to screen available climate and nature risk assessment frameworks for financial institutions, building on the literature review outlined in Task 1. The process followed is summarised belsow:

1. **Identification** – 100+ sources located as part of the literature review in Task 1 were used as a basis for compiling a long-list of climate and nature risk assessment frameworks and guidance. This was augmented with a search identifying climate specific frameworks, and case studies of nature related risk assessments such as UNEP-FI TNFD pilots, Dutch Central Bank's "Indebted to Nature" report, and Banque de France "Silent Spring" assessment. ([331]) ([332]), ([333])

2. **Applicability to a broad range of financial sector institutions** – the literature review described in Task 1 identified guidance applicable to the final sector. Guidance applicable to the range of institutions within the scope of this study was selected.

3. **Detail** – the field was narrowed to the best available guidance based on having sufficient information on *how* to conduct a nature related risk assessment.

Three sources of existing methodological guidance on biodiversity and nature-related risk assessment were identified as major references for the financial sector, the NGFS conceptual framework (), the OECD supervisory framework and the TNFD LEAP approach. In line with findings of Task 1, the main steps and concepts used in this framework are aligned with these existing guidance documents/frameworks. The current framework was developed to provide an additional layer of detail on practical steps to help financial institutions better understand how to implement a biodiversity and nature-

([331]) DeNerderlandscheBank (2020). Indebted to Nature: Exploring biodiversity risks for the Dutch financial sector available at: https://www.dnb.nl/media/4c3fqawd/indebted-to-nature.pdf

([332]) UNEP-FI (2023) Unboxing Nature-related risks:Insights from the UNEP-FI-led TNFD Piloting Programme available at: https://www.unepfi.org/publications/unboxing-nature-related-risks-insights-from-the-unep-fi-led-tnfd-piloting-programme/

([333]) Banque de France (2021). A "Silent Spring" for the Financial System?

related risk assessment framework and carry out the risk assessments. Table 4-1 provides an overview of the main area of alignment and differences with these 3 frameworks of references.

Table 4-2 Comparison with existing guidance on nature related risks for financial institutions

	Description	*Targeted parties*	*Key elements covered*	*Direct alignment*	*Main differences*
Current framework	Practical guidance through a step-by-step approach, providing distinct building blocks to understanding and assessing nature risks	Financial institutions, namely banks, asset managers, asset owners and insurers	Risk identification, exposure estimation, risk quantification, business responses, financial impact estimation and mitigation actions		
OECD supervisory framework (2023)	A supervisory framework to assess biodiversity-related financial risks, impacts and dependencies.	Central banks and retail banks	Overview of biodiversity-related financial risks; data, metrics and indicators; measurement approaches; Approaches to Translate Exposure into Risk; Public policy for biodiversity	Modelled metrics and indicator corresponds to Step 1.1 on unit of analysis and Step 2.1 on modelling physical and transition risks Measurement approaches corresponds to step 2.2; on impacts and dependencies exposure Approaches to Translate Exposure into Risk corresponds to steps 2.3, 2.4, 3.1, and step 2.1 on forward looking analysis	Focused more on data sources, tools and metrics considerations than step-by-step; Risks identification and linkages between steps not covered in as much detail
NGFS conceptual framework (2023)	A conceptual framework on nature-related financial risks to guide action by central banks and supervisors	Central banks and supervisors	Identify sources of physical and transition risk; Assess economic risks; Assess risk to, from and within the financial system	Phase 1 corresponds to step 1.2 on risk identification; and step 2.1 on modelling sources of financial risks Phase 2 corresponds to step 2.3 on risk materiality and 2.4 on business response. Phase 3 corresponds to step 3.1 on financial impact assessment	Adopts a more integrated approach, where climate-related risks are considered to be part of nature-related financial risks; Steps to quantify exposure and risks materiality not discussed in as much detail
TNFD (2023)	A risk management and disclosure framework to report and act on evolving nature-related risks, with the ultimate aim to support a shift in global financial flows toward nature-positive outcomes	The TNFD framework is intended for use globally by non-financial (' real-economy') companies and financial institutions of all sizes.	The LEAP (Locate, Evaluate, Assess, Prepare) approach for nature risks assessment; Disclosure recommendations	The Scoping step of LEAP-FI corresponds to the scoping phase of this framework The "Evaluate" E3 and E4 step corresponds to step 2.2 on impacts and dependencies exposure assessment The "Assess" A1 step in LEAP, corresponds to 2.1 on sources of financial risks, and A4 to 2.3 on risk materiality, 2.4 on response and 3.1 on financial impact The "Prepare" step corresponds to 3.2 on mitigation actions	Covers 'opportunity' (and just downside risk) materiality assessment; Dedicates a step to location identification and prioritisation while this framework trickles it down across multiple steps

4.1.1.2. Key design considerations in an evolving field

Nature-related risk assessment is an emerging area of interest for financial institutions. A multitude of actors are developing various initiatives, tools, and data solutions to help support this. This framework was developed with the aim of presenting what current best practice could be while taking into account existing limitations and the rapidly changing data landscape.

Three key design considerations have shaped the overall structure and content of this framework:

1. **This framework closely aligns with existing climate risks frameworks at high-level, but its content is specific to nature and biodiversity**

This framework uses key structural components, concepts and terminology developed by climate frameworks. However, the content detailed under each main phases of the risk assessment presents some fundamental differences accounting for specificities of nature-related risks.

2. **This framework is a middle ground between a prescriptive step-by-step guidance and a high-level conceptual guidance**

This framework aims at providing applicable and practical guidance through a step-by-step approach when most relevant. However, the steps of the framework can be considered as distinct building blocks to understanding and assessing nature risks which don't necessarily need to all be carried out in the early phases of establishing and implementing the risk assessment framework. The framework aims to describe potential best practice approaches for developing these building blocks without prescribing a restrictive methodology. In order to reflect the variety of use cases, capability building needs and resource differences, this framework presents different kinds of tools suitable for different cases and does not provide specific recommendations on which tools to use – as the most appropriate tools might vary between use cases and financial institutions. Moreover, it should be noted that this framework does not recommend specific tools to carry out assessments but rather provides examples of tools as an illustration of what could be used.

3. **The framework's main components are adaptable to future developments in data and capabilities**

The framework provides suggested approaches which are applicable with different data and methodological capacities, and therefore adaptable to future developments. The practical guidance within each step reflects best practice while building in different data and methodological options – from most ambitious to most common practice.

4.2. Overview of the framework

This framework covers the key components of nature risk assessment for financial institutions from defining the appropriate assessment scope, to quantifying transition and physical risks, estimating impacts and dependencies exposure and translating exposure

and risks into financial impacts at entity and financial level, to then informing actions for financial institutions

For each main structural step of a nature risk assessment, the framework details how specific actions can be carried out. It also includes discussions around key challenges, synergies and design decisions that arise when undertaking these actions. This includes discussions around synergies and divergence with climate risks assessment approaches and metrics.

For each step involving quantification, this framework provides a discussion around current data challenges and approaches to overcome them.

4.2.1. The 3 phases of nature risks assessment

Nature-related risk assessments can be structured around **three fundamental phases** which are aligned with climate risk assessment practices, and also reflect emerging best practices used in other nature frameworks as discussed in Section 2. It also follows the basic structural logic of broader risk management frameworks such as the Enterprise Risk Management framework from the Committee of Sponsoring Organizations of the Treadway Commission (COSO). ([334])

The three fundamental phases are:

Phase 1- Scoping

This is the initial preparation that financial institutions need to conduct before carrying out an assessment. This involves establishing the purpose and unit of analysis of the assessment and laying out potential risks and sectors to prioritize.

The scoping phase can provide a preliminary view into the exposure of the financial institutions to specific sectors and risks, which will support decisions on risks or sectors to prioritize and help define data needs in more details. This phase does not involve quantification but can require some initial knowledge of nature-related risks.

Phase 2 - Entity-level ([335]) risk assessment

This includes the measurement of all key components of nature related risks for entities within the real economy. It is the core of the quantitative analysis covering the quantification of both physical and financial metrics which will lead to estimates of financial outcomes at entity level. This also covers the potential integration of forward-looking scenarios into the risk assessment.

The entity-level assessment involves an estimation of the main sources of risks and their materiality in monetary terms, as well as an assessment of the exposure of the entities to a set of impacts and dependencies on nature. Depending on the scope defined in

([334]) See: https://www.coso.org/guidance-erm

([335]) The word "entity" is used throughout this framework to refer to the businesses supported by financial institutions through lending, investments or insurance. These businesses can be analysed at different levels: sector, subsector, company, asset-level.

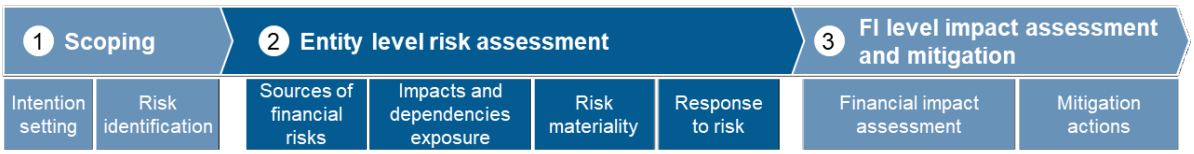
Phase 1, financial institutions can decide to simplify the assessment by only carrying certain steps of this phase (e.g. only focusing on transition risks and impacts, or not including entities' responses to risks).

Phase 3 - FI-level impact assessment and mitigation

This phase consists in the translation of entity-level financial risks in the real economy into financial risks for the financial sector, and specifically the financial institution carrying the assessment.

It focuses on the aggregation of entity-level risks and present how financial modelling and risk classification can be used to translate these into risks for financial institutions. After this, potential mitigation actions can be defined by financial institutions to reduce the risks identified and measured.

Figure 4-2 Overview of the three phases of nature risk assessment



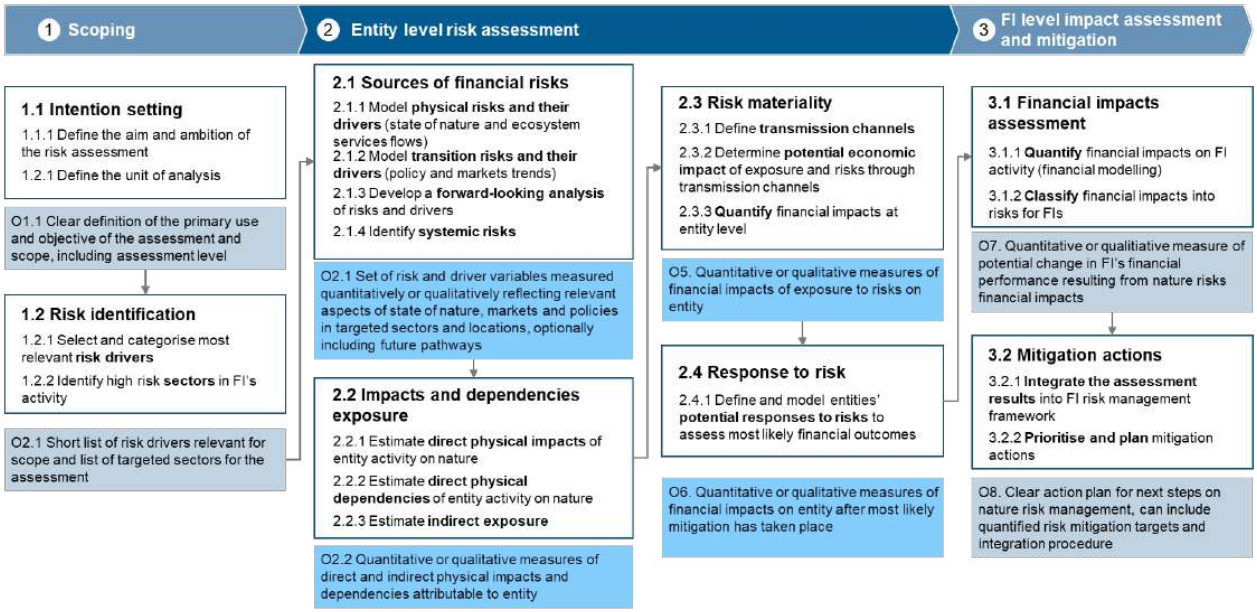
Each phase is broken down into several steps (eight in total) which have each a set of actions that can guide financial institutions on how to reach the targeted output of each step.

The next section provides an overview of each step of the framework and specific actions.

4.2.2. The 8 steps of nature-related risks assessment

Financial institutions can structure their assessment around 8 main consecutive steps. Each step generates an output that feeds into the next step.

Figure 4-3 Steps, actions and outputs of nature-related risks assessment



Step 1.1 – Intention setting aims at producing a clear definition of the primary use and objective of the assessment. Based on this, financial institutions can then establish the scope and level of assessment needed, including the unit of analysis (e.g. sector or counterparty-level analysis).

Step 1.2 – Risk identification is a step further into the scoping phase, during which financial institutions can get a high-level view of their exposure to different sectors and risk drivers and narrow the scope to sectors that are likely to present the most material risk.

Step 2.1 Sources of financial risks lays the basis for the quantification of risks through the definition and measurement of key variables reflecting relevant aspects of state of nature, nature-related policies and regulations, and market dynamics across different locations and sectors. These variables contribute to the measurement of physical, transition, and systemic risks and can be projected under different scenarios if financial institutions decide to carry a forward-looking analysis.

Step 2.2 Impacts and dependencies exposure consists of the measurement of the entity's interaction with nature through physical impacts on nature and level of dependencies to ecosystem services. This can also cover attribution of impacts and dependencies through entities' supply chain – or indirect exposure.

Step 2.3 Risk materiality combines measures generated in step 2.1 and 2.2 and translate these into financial impacts at entity-level. This includes the definition of transmission channels through which sources of risks materialise into economic impact and the translation of economic impacts into impacts on the entities' financial performance.

Step 2.4 Responses to risk consists in assessing how entities could mitigate some of the financial impacts, providing a more realistic view of financial risks at entity-level.

Step 3.1 Financial impacts assessment focusses on the translation of entity-level financial impacts into financial risks for the financial institution through aggregation and financial modelling, and the classification of these risks.

Step 3.2 Mitigation actions presents how financial institutions can use the results of the nature-related risk assessment to develop a plan for the management and mitigation of these risks.

Each step can be conducted with different levels of complexity, including varying levels of location specificity and sectoral granularity. The assessment can also be undertaken with different drivers' coverage and integrate forward-looking projections. The next section will present each action in detail and discuss different modelling and design considerations.

4.3. Detailed step-by-step approach

This section describes each step of the nature-related risk assessment framework through a set of key actions that can guide financial institutions towards best practice. For each step, key design questions and considerations are highlighted, and when available, relevant measurement and identification tools currently available are presented.

This approach also explores solutions to overcome existing gaps and challenges, especially around data and location-specific analysis, acknowledging that implementation of the best practice approach will rely on improving capabilities and data in the near future.

4.3.1. Phase 1 – Scoping

During the scoping phase, financial institutions can answer a set of fundamental questions, which will frame the risk assessment and help define the outputs and outcomes expected from it.

These questions include:

- What is the specific purpose ('use case') of the risk assessment?
- What areas of activities should it cover?
- What is the appropriate level (granularity) of analysis for this assessment?

4.3.1.1. Step 1.1 Intention setting

This first step covers the key elements that need to be considered to define what is the main purpose of the assessment and understand what kind of outputs are needed to achieve this purpose.

Action 1 - Define the aim and ambition

Financial institutions can initiate the scoping of the risk assessment by defining a clear aim for the risk assessment which should directly inform what outputs and outcomes are expected to be produced.

Firstly, financial institutions can list what the risk assessment will be used for. This intention can be formalised into a primary use, which could relate to compliance with policy or legislation, or to operational or strategic goals. Examples of main use cases for a risk assessment can be (i) compliance with disclosure requirements such as the SFDR or CSRD, (ii) impact analysis to inform capital allocation or pricing strategy, (iii) stress-testing to review risk appetite, risk management approaches and comply with supervisory requirements.

Key consideration – Is the assessment meant to be used internally at operational level or will it be used in external reporting? This will directly influence the flexibility in the type of outputs required. For operational use, the risk assessment could help inform nature strategy, develop nature-related product, improve risk management procedure, etc.

After establishing the primary use, the aim of the assessment can be further refined by reviewing regulatory frameworks (emerging or currently in place) that could create additional use cases for the assessment. Financial institutions can review nature frameworks and regulations relevant for their country and sector of operations. This can directly inform what outputs are generally required or expected by different institutions, for example the type of data and metrics which need to be disclosed. This could be for instance Taskforce on Nature-related Financial Disclosures (TNFD), Corporate Sustainability Reporting Directive (CSRD), Regulatory Technical Standards (RTS) of the Sustainable Finance Disclosure Regulation (SFDR), European Banking Authority (EBA) requirements on Capital Requirements Regulation (CRR) mandate, EU Taxonomy reporting requirements, etc.

Based on this review and the identified primary use case the scope of the assessment can be established.

Action 2 - Set the unit of analysis

When the scope of the assessment is established, financial institutions can define the unit of analysis required for the rest of the assessment.

Nature risk assessments can be done at different levels of granularity, ranging from sector-wide analysis to asset-level assessment. The more specific the unit of analysis is, the higher potential understanding of heterogeneity in the nature risks between units and locations. However, increasing the specificity of insights substantially increases the data and modelling challenges. It is therefore key for financial institutions to understand the different options and their implications to clearly define the scope and level of granularity early on in the assessment and align it with their use cases.

Table 4-2 below presents the three main levels of analysis which can be considered for a risk assessment: sectoral level, company level, or asset level.

Table 4-3 Overview of assessment levels of analysis

Unit of analysis	*Description*	*Benefits of analysis*	*Limitations*	*Data needs and sources*
Sectors or subsectors	Sectors defined by global framework such as ISIC e.g. agriculture sector	Wide range coverage, consistent data across sectors, existing knowledge	Low granularity of estimated risks, lack of heterogeneity/ insights on company and location specific risks	FI's exposure by sector, financial data (quantity, revenue, profit) by sector and by location (region, country)
Companies	Individual companies operating within each sector	Account for differences in company heterogeneity location activity	Limited spatial granularity, lack of insights on location specific risks	FI's exposure by company, company financial data by area of activity (subsector, product) and location (production and selling locations), production data (quantity, production type and processes), quantity or value of main inputs into production process
Asset level	Specific assets for the company of interest, e.g. buildings for a real estate company	Ability to carry sophisticated spatial analysis at ecosystem level, understand exposure to location specific risk	Limited access to data (especially production and econ data for assets), inconsistent data across sectors and companies, difficult to tie assets back to company	FI's exposure by asset, asset level financial data, production data, quantity or value of main inputs into production process

The decision can be directly informed by the use cases established for the assessment in the previous step, as well as a review of capabilities and data available. The definition of the appropriate level of analysis can also be guided by the sectors of focus for the analysis. If the main nature impacts are associated with the companies own activities/operating sites (e.g. mining) then an asset-level of granularity would be appropriate. For sectors where nature risks are associated with the use of their products (e.g. active ingredients in pharmaceuticals that find their way, after use, into aquatic systems or pesticide and biocides manufacturers) then the company-level assessment (product design, extended producer responsibility systems, etc,) might be the better level to focus on.

Table 4-4 Example Action 1 and 2 – An asset manager based in the EU

Description	*Asset manager looking to launch funds that promotes ESG goals*
Main use case	Disclose sustainability related information and ESG management Comply with Sustainable Finance Disclosure Regulation (SFDR)
Reporting/disclosure regulations of interest	Regulatory Technical Standards (RTS) of the SFDR, which require Article 8 funds ('…promotes environmental or social characteristics… ') to disclose ESG indicators of invested companies.

Scope	All funds under management classified as Article 8 under SFDR
Unit of analysis	Company level to comply with SFDR and to balance the level of detail and modelling challenge

4.3.1.2. Step 1.2 Risk identification

This step indicates how financial institutions can further refine the scope of the nature-related risk assessment by prioritizing a set of risk drivers and sectors that are most relevant to their activity, based on high-level research and overview of their business.

Risk identification and prioritization can be a helpful step to handle the complexity of nature risk modelling, enabling clear and accurate definitions of variables in the following phases of the risk assessment. However, it is recognized that in some cases, such as for the assessment of systemic risks, considering a wide variety of drivers and sectors might be necessary.

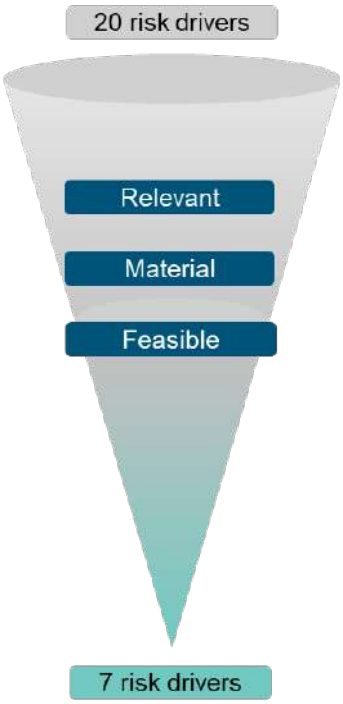
Action 1 - Prioritize risk drivers

Nature related risks result from a large array of impacts and dependencies on nature, for instance ENCORE classifies 21 dependencies and 11 impact categories. Prioritizing a subset of risk drivers can allow financial institution to reduce the complexity of their risk assessment.

Financial institutions can create a shortlist of risk drivers that are feasible and most relevant to their activity to further refine the scope of their analysis. It is important to highlight however that in the longer-term financial institutions would incrementally explore a wider range of risk drivers to ensure a complete view of nature related risks.

Firstly, a long list of risk drivers for transition and physical risks can be collected from global frameworks. Financial institutions can use existing frameworks summarising long lists of ecosystem services, nature impacts and dependencies which drive nature risks – for instance IPBES biodiversity assessment reports, the ENCORE database and TNFD guidance. These drivers of transition and physical risks can be a level more detailed than the risk drivers defined by Task 2 (refer to 2.2.2 of this).

Key consideration - **What are the main risk drivers for physical risks?** Drivers of physical risks are reflected in ecosystem services, an initial understanding of the main ecosystem services underpinning economic activity will be useful when selecting physical risks drivers. Resources such as ENCORE and the Millennium Ecosystem Assessment can support this understanding.



Secondly, financial institutions can select risk drivers that are most likely to be material. Based on established knowledge in resources, financial institutions can identify which drivers are most likely to be linked to translate into real-world implications of significant magnitude. Financial institutions can conduct an initial review of nature regulations and trends in state of nature to inform their selection.

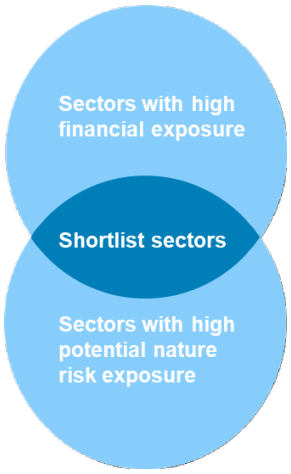
Then, risk drivers can be shortlisted based on their relevance to the core activities of the financial institution. Financial institutions can prioritize the risk drivers which are most likely to be linked with targeted entities' activities. This can be informed by a high-level review of the financial institutions' exposure to specific sectors or activities. Main sectors invested in, or credit exposure at financial institutions can be used as an initial indicator of relevance.

Finally, a shortlist of risk drivers can be defined by reviewing the feasibility of quantitative modelling for each driver. This requires understanding how easily quantifiable each risk driver is based on its complexity, data availability and existing scientific knowledge. In the case that a risk driver has been identified as highly relevant and material for the financial institutions' activities, but has a low feasibility, the institution should consider maintaining this risk driver for a qualitative analysis, to ensure it does not leave a significant gap in the institutions' risk profile.

Key consideration - **What is the right amount of risk drivers to select to inform a risk assessment?** There are no pre-defined ideal set of risk drivers as this will be guided by the specific activities and locations targeted by the assessment. It is advisable to start with a wider set of well-understood risk drivers and eventually filtering them further down the process if needed.

Action 2 - Prioritize sectors

Financial institutions can also prioritise specific sectors in the real economy that are most likely to be driving risks for their activities. This can be done based on an overview of the financial institutions' exposure and the level of nature-related impacts or dependency associated with each sector.



To prioritize a subset of sectors, financial institutions can first compile an initial qualitative view on sectors' potential exposure to nature risks. Financial institutions can rely on existing analysis to understand which sectors are most exposed to nature risks globally and what are the main risks each sector is exposed to. This can be carried using qualitative assessment tools such as ENCORE, or WWF's biodiversity risk filter, or refer to the assessment done in section 3.3.2 of this report.

Then financial institutions can identify sectors where most financial exposure is concentrated. Financial institutions can prioritise sectors for which they have the highest exposure, e.g. sectors with concentration of loans from bank or heavily invested/insured by investors/insurers, and their upstream/downstream activities. For EU, the most relevant sectors are real estate, health care, construction & engineering, and agriculture.

This information can be combined to shortlist sector(s) for further assessment. Financial institutions can combine the view of financial exposure to sectors and each sectors' potential exposure to impacts and dependencies (qualitatively reviewed as described above). This can be done using a heatmap which will then provide a clear view of concentration of exposure that can guide the shortlisting of sectors for the risk assessment and materiality.

Table 4-5 Tools and guidance for risk and sector identification and prioritization

Data sources and tools	• ENCORE materiality database by sector and subsectors • WWF biodiversity risk filter • SBTN materiality heatmaps
Guidance	• ECB good practices for climate and environmental risk management, • TNFD V1.0 (step E1 of LEAP) • Banque de France (2021), • IUCN sector specific review of nature risks and opportunities (e.g. Apparel sector guidance)

Box 4-1 How to manage location-specific variations in nature risk assessments?

The consideration of the location is central to a robust nature risk assessment. The functioning and health of ecosystems and services are often **distinct for each location** and as a result **impacts and dependencies can significantly differ between ecosystems** and their location. There can thus be stark differences in risks depending on the location of the entity's activity assessed and the location of impact on nature – which can travel away from the activity's site to other ecosystems such as pesticides across aquatic systems. Location is a central component of nature risk assessment.

The stage at which the location targeted should be defined **depends on the scope of analysis**. For instance, if only direct risks are considered for a portfolio that is highly concentrated in one area, this location can be targeted early on during the risk identification phase. However, **most analysis will require some level of flexibility in location coverage since high-risk locations will be identified when exposure and risk materiality are assessed** (see table below). The analysis can be simplified by starting with a selection of key locations allowing for adjustments or additions as needed.

Although this will vary depending on the unit of analysis and the scope of the risk assessment, different sub-steps can require more or less granularity depending on their aim. As detailed below

Step	Application of location	Recommended level	Data availability	Considerations
Risk identification	Identify a selection of most relevant locations for the rest of the assessment	Depending on unit of analysis and FI scope of activities, but usually country, region or global	Good	Simple approach is recommended at this stage
Physical risks modelling	Modelling changes in the state of nature (ecosystem services) to assess physical risks	Ecosystem level or more granular	Average	High level of granularity available for some nature variables e.g. water availability
Transition risks modelling	Modelling changes in demand, regulations and technology to assess transition risks	Country level or more granular	Low	Regional regulations/commitments can used as proxy, especially in the EU
Systemic risks	Understanding contagion channels	Global or country level	Low	Some elements feeding into systemic risks (e.g. ecosystem collapse) would need to be modelled at higher granularity
Scenario analysis	Assessing baseline values of key drivers and risks variables	Regional level or more granular	Average	Projecting variables at high level of granularity can be computationally intensive
Impacts exposure	Assessing entity's impacts on an ecosystem	Ecosystem level or more granular	Average	The exact location of the impact can significantly change the consequences of it
Dependencies exposure	Assessing entity's dependencies on an ecosystem and its services	Ecosystem level or more granular	Low	The boundaries of an ecosystem are not always clear and need to be informed.
Indirect exposure	Mapping entity's upstream and downstream value chain	Global or regional depending on value chain	Low	Some value chains could be very localized but in most cases they are international

4.3.2. Phase 2: Entity level assessment

The entity-level risk assessment covers the core quantification of nature-related risks from their drivers to their financial consequences in the real economy.

During the entity-level assessment phase, financial institutions will have to make numerous modelling and design decisions such as:

- What level of granularity should each risk be modelled at, and when can proxies be used?
- When to consider using scenarios for a forward-looking risk assessment and which scenarios to use?
- To what extent should the entity's value chain be included?
- Which are the most likely transmission channels that will lead nature impacts and dependencies to materialise into economic risks?
- Which level of entity response can be considered as most likely?

The current approach provides an initial guidance to support these decisions and clear steps on how to carry the analysis according to best practice.

4.3.2.1. Step 2.1 Sources of financial risks

This step consists in the definition and assessment of key variables that will affect the magnitude of nature-related transition, physical and systemic risks for the entity. Financial institutions can define key variables and collect data on state of nature, nature-related policies and regulations, and market dynamics across different locations and sectors. These variables can also be projected in the future according to different scenarios and can be combined to monitor potential systemic risks.

Action 1 - Model physical risks

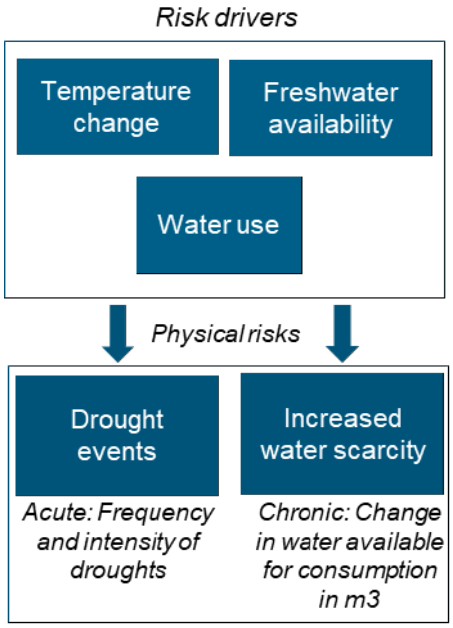
Modelling physical risks requires financial institutions to first understand the changes in state of nature and ecosystem services likely to drive these risks. Then a list of variables to monitor or project these changes can be defined and data can be collected to measure these variables and combine them into an overall physical risk variable.

1. UNDERSTANDING PHYSICAL RISKS AND THEIR SOURCES

Financial institutions can start by identifying a list of physical risks that could result from the pre-selected short list of risk drivers. Two categories of physical risks need to be considered:

— **Acute physical risks**: short term event-based risks such as droughts, floods **exacerbated by** the degradation of ecosystem services (e.g. coastal protection from mangroves) disrupting operations such as manufacturing facilities

— **Chronic physical risks**: issues arising from long-term environmental changes and gradual loss in ecosystem services (e.g. pollinator decline)



For each physical risk financial institutions can then identify the macro, meso and micro changes in the state of nature (e.g. climate change, river basin water flow) and drivers of nature change (e.g. water consumption at macro level) that generate this risk. These changes reflect the sources of risks which need to be quantified.

For the agriculture and farming sector, for example, typical chronic physical risks include the loss of pollinators and degrading soils, and typical acute risks include droughts and pest invasion. The sources of risks that will need to be monitored will include pollinator abundance, temperature change, aridity levels, drought and rainfall frequency.

2. QUANTIFYING PHYSICAL RISKS VARIABLES

To quantify physical risks, financial institutions can establish a list of measurement variables for all risk drivers and resulting physical risks to be modelled.

For each variable, the most relevant data needs to be collected, in line within the spatial scope of the assessment (see Box. 4-2 on location-specific variations)

Key consideration - **What are the appropriate metrics to use?** The choice of metrics can be guided by the end use of each metric, existing frameworks (e.g. TNFD and SBTN) and data availability. If using an external integrated modelling tool, specific metrics will be given.	Key consideration - **What is the appropriate level of spatial granularity?** The spatial granularity can be guided by the initial location scoping of the assessment (e.g. country or sub-country activities). It is important to note that spatial data availability and quality vary greatly and very granular data might not be available for all risks.

When relevant, the variables can be combined to estimate physical risks, this can be done through (i) using an existing integrated model, (ii) building an in-house simple model (e.g. water use and temperature change in targeted location combined into water availability), (iii) using externally modelled physical risk data (e.g. water risk data).

Risks can be interlinked and share common risk sources, these interlinkages can be modelled by using common variables feeding into different risks. For instance,

temperature change and water availability will impact water scarcity and pollinator's abundance.

Key consideration - **Do I need a model to estimate physical risks?** Physical risks result from a wide array of complex interactions between nature and human systems, when available, integrated models can significantly increase the accuracy of estimates. The use of such models should be guided by their accessibility and practicality for the aim of the assessment. A simple estimation may be sufficient when no established integrated model is readily available.

Table 4-6 Data sources and guidance to model physical risks

Data sources and tools	• Platforms providing targeted physical risks variables: Aqueduct WRI, Ecolab Water risks, WWF Biodiversity risk filter • State of nature and ecosystem variables from EEA indicators repository • Integrated physical risks model (e.g. Earth-Economy model World Bank)
Guidance	• IPBES Biodiversity Assessment (trends in ecosystem services), • ENCORE ecosystem services list, • ECB good practices for climate and environmental risk management, • TNFD V1.0 (Guidance on the identification and assessment of nature-related issues)

Key consideration - **What is the main modelling difference with physical risks?** Transition risks are often better captured by a combination of quantitative and qualitative data, as there is often only limited quantitative data currently available.

Action 2 - Model transition risks

Modelling transition risks requires financial institutions to understand the market and policy context that could drive risk exposure. A list of variables to monitor or project economic activity, market trends and policy trends can be defined to capture these potential risks. Data can then be collected to measure these variables and combine them into an overall transition risk variable.

1. Understanding transition risks and their sources

Financial institutions can start by identifying a list of transition risks that could result from the pre-selected short list of risk drivers. Four categories of transition risks should be considered:

— Policy or legal risks: e.g. ban of certain pollutants, water use restrictions, or restoration requirements

— Technological risks: e.g. limited availability of low impact alternative to pesticides

- Market risks: e.g. consumers shifting away from meat products
- Reputational risks: e.g. consumers boycotting brands linked to pollution

For each transition risk, financial institutions can then identify the macro, meso and micro changes in local state of nature, policy trends and implementation, supply and demand for goods and services, consumer behaviour, that generate this risk. These changes will be the sources of risks that will need to be quantified.

For example, construction and operating real estate can result in significant waste generation and pollution (air, soil and water) which may lead to increased regulation costs. In this case the sources of risk include the pollution levels, and the regulations on pollution in the locations targeted.

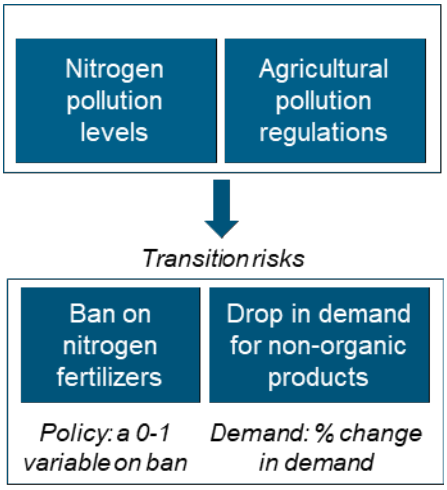
Key consideration - **What level of analysis is appropriate?** At this stage the analysis can mostly focus on macro and meso trends, but when relevant some micro risk drivers can be identified (e.g. local communities pressure on pollution issues).

2. QUANTIFYING TRANSITION RISKS VARIABLES

To quantify transition risks, financial institutions can establish a list of measurement variables for all risk drivers and resulting transition risks to be modelled. For each variable, the most relevant data needs to be collected, in line within the spatial scope of the assessment (see Box. 4-1 on location-specific variations).

When needed, the variables can be summarised or combined to get a quantitative measurement of transition risks. These variables can take different forms:

- A purely quantitative continuous estimate e.g percentage change in demand for a commodity
- A categorical estimate e.g. binary variable indicating that a policy has been implemented



Key consideration - **To what extent transition risks overlap with climate?** Some policy, market and reputational risks identified for climate are also relevant for nature risks analysis, such as meat consumption, deforestation regulations and the phase out of coal mining. However, some trends will have opposite risk outcomes between nature and climate (e.g. increased renewable energy capacity putting pressure on land) and some transition risks are specific to nature (e.g. protected areas expansion).	Key consideration - **How to account for interlinkages between physical and transition risks?** Risks can be modelled in an integrated way by linking key drivers to one another (e.g. water use policies improving water availability).

Table 4-7 Data sources and guidance to model transition risks

Data sources and tools	• Policy indices and trackers (e.g. EU quality of government index, OECD PINE database), EEA – EU Protected areas and pollution maps, and associated site specific conservation objectives (SSCOs) • Market trends analysis / Demand analysis: e.g. EU Annual single market report
Guidance	• Global biodiversity frameworks – Kunming Montreal, and local commitments such as NBSAPs • Nationally Determined Contributions, Biodiversity pledges, • EU Green Deal regulations, • ECB good practices for climate and environmental risk management,, • TNFD V1.0 (Guidance on the identification and assessment of nature-related issues)

Action 3 - Develop a forward looking analysis

Financial institutions can enhance the relevance and accuracy of their risk assessment by integrating future pathways. Scenario-based analysis can help financial institutions better understand risks in a context of uncertainty and is also a common practice in climate risk assessment. To model all key variables feeding into transition and physical risks in a forward-looking way, financial institutions will have to use scenarios reflecting different trajectory of policy, market, and state of nature.

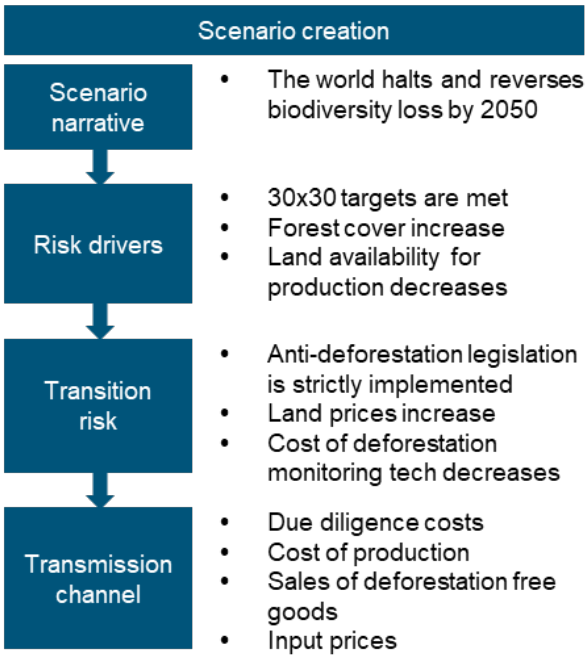
Although it is expected that nature scenarios will be developed in the future, there only a very limited existing nature specific scenarios of reference available – the main reference is the UN PRI – IPR Forecasted Policy Scenario for Climate and Nature. Climate scenarios can also be used as a starting point for some variables of interest for nature, but should be adapted to nature specificities (e.g. temperature change and water availability can be extracted from some climate scenarios and be used to help project nature related risks).

A forward-looking analysis first requires financial institutions to establish the future pathways that are most relevant for their analysis, and then model these pathways using existing data or developing projections.

1. DEFINING FUTURE PATHWAYS

First, financial institutions can establish the aim of the forward-looking analysis, for instance, extreme risk testing or realistic risk forecasting.

Example – Scenario creation process



Then a time horizon can be set, that is most appropriate for the targeted assessment (e.g. up to 2050 for strategic planning long-term modelling, up to 2030 for medium-term capital allocation decisions)

Key consideration - **What is a useful time horizon?** The time horizon chosen should be guided by the aim of the assessment, existing risk assessment practices within financial institutions but also taking into account policy timelines (e.g. 30x30). 2030 and 2050 are generally used in climate analysis.

Then the future pathways can be developed around a set of plausible qualitative narratives. These narratives explicitly define the trajectories of change for each priority risk driver, physical and transition risk selected for the analysis.

2. MODELLING FUTURE PATHWAYS

The narratives and trajectories defined for each risk and key drivers can then be translated into quantitative assumptions. These quantitative assumptions can then feed into the projections of physical and transition risks.

Different modelling approaches can be used to generate the projected values of key variables:

- Using **integrated models** such as economic-land use models to model drivers of risks and transmission channels
- Developing a **simpler in-house modelling** for a targeted set of transition or physical risks variables, using off-the shelf variables for drivers

Integrated models can provide financial institutions with more comprehensive view taking into account interdependencies between variables. However, the outputs of these models can sometimes be complex to explain and communicate, and this may be further complicated by financial institutions using a wide variety of different models and approaches to evaluate future risks.

In the short term, most financial institutions may have to focus on developing our own capabilities to evaluate these future risks, such as through in-house modelling tools that can fulfil their own risk assessment requirements. .Over time, as the availability of more harmonised publicly available scenarios increases (e.g. NGFS scenario outputs become available for nature as are currently used for climate modelling), financial institutions and supervisors may seek to adopt scenario approaches that are consistent across institutions. This may confer several benefits including increasing standardisation across institutions, increasing transparency and lowering the cost of model deployment.

Key consideration - **Which systems or sectors need to be incorporated in the model?** The sectors and system incorporated in the model should at least include the selected sectors and locations defined during the risk identification process.	Key consideration - **Should climate considerations be incorporated?** There are strong interlinkages between climate and nature Key drivers such as temperature change, water availability or demand for critical minerals should be integrated using existing climate-related assumptions.

Table 4-8 Data sources, providers and guidance on scenario analysis

Data sources and scenario providers	• Inevitable Policy Response FPS+Nature scenario , • NGFS scenarios, • International Energy Agency (IEA) scenarios, • IPBES also compiles different scenarios for drivers of biodiversity loss, impacts on nature and consequences for human activity such as the VOLANTE European VISIONS on sustainable land use, • Globiom (IIASA)
Guidance	• Kunming-Montreal Global Biodiversity Framework targets can serve as thresholds, • Network for Greening the Financial System (NGFS), • TNFD guidance on scenarios

Action 4 - Identify systemic risks

Systemic risks result from a complex combination of events that are difficult to predict. There are no established methods and models that reliably assesses systemic risks for climate or nature. However, it is possible to assess exposure to some key drivers of systemic risks by focusing on 3 different systems: (i) nature systems, (ii) industrial systems and (iii) economic and financial systems. This approach is based on the definition of systemic risk presented in Section 2.2.2. This framework approaches systemic risk in a way that can be used for specific quantification exercise, allowing for stress-testing of specific systems independently or jointly depending on data and modelling capabilities.

The collapse of a natural ecosystem, the aggregation of risks and the potential for contagion are all key drivers of systemic risks which can be assessed using outputs and data generated in other components of the risk assessment.

Nature systems	Industrial systems	Economic and financial systems
Ecosystem collapse	Aggregation of risks	Contagion
Combine with physical risk assessment (step 2.1), focusing on critically important ecosystems.	Consider potential compounding effects of physical and transition risks and how they cascade within value chains (after step 2.1 and 2.2)	Consider risk of contagion across financial institutions in step 3.1, and potential feedback loops with the real economy through transmission channels identified in step 2.3

Specific analyses and monitoring can be conducted to evaluate some aspects of systemic risks at different stages of the risk assessment and integrate the results into the overall risk assessment outputs. Some approaches are detailed below:

1. Sensitivity analysis for risk across systems

Across each system, a systemic risk analysis can start by **identifying and assessing the key drivers of chain reactions** (e.g. keystone species, food prices), and **estimate the expected reach** of the contagion (e.g. global, sectoral, local).

Financial institutions can also conduct a worst-case scenario stress-test by developing a scenario of **extreme risks** to reflect one aspect of systemic risk and understand the order of magnitude of potential financial effects (see step 2.1.3 on scenario analysis).

2. Monitoring nature systems

To monitor risks of ecosystem collapse within nature systems, ready-made tools and data can be used for the tracking of indicators of ecosystem health. This can be done at micro, meso or macro levels depending on the unit of analysis and location targeted. Indicators can include population of keystone species, or freshwater availability. Then information on thresholds indicating potential tipping points (physical risk modelling) needs to be collected. Financial institutions can also explore their **exposure to potential major contributors to an ecosystem tipping point** – if identified. One example would be the contribution of a sector to some of the planetary boundaries (see step 2.2 for more details on impact exposure assessment, and section 2.2.2 of this report for the full description of planetary boundaries).

3. MONITORING INDUSTRIAL SYSTEMS

To monitor likelihood of risk aggregation in industrial systems, financial institutions can assess their exposure to sectors that have significant interactions with nature. These would be sectors that are both highly dependent on nature's ecosystem services and highly impacting nature, as these are likely to be at the forefront of systemic risks (step 2.2.).

4. MONITORING ECONOMIC AND FINANCIAL SYSTEMS

To monitor the risk of contagion in economic and financial systems, financial institutions can stress test major contagion channels such as inflation and interest rates, using extreme assumptions. The cumulated exposure of financial institutions to financial risks can also provide an indicator of likelihood of contagion.

Table 4-9 Data sources and guidance to model systemic risk

Data sources and tools	• Planetary boundaries indicators as drivers of systemic risks • IBAT, IUCN Red List of threatened species as a tool to assess ecosystem health • ENCORE as an indicator of sectors with highest dependency on nature
Guidance	• European Systemic Board advice on prudential treatment of environmental and social risks • International risk governance council's guidance on the governance of systemic risks • European Central Bank, paper on nature physical risk implications for financial stability

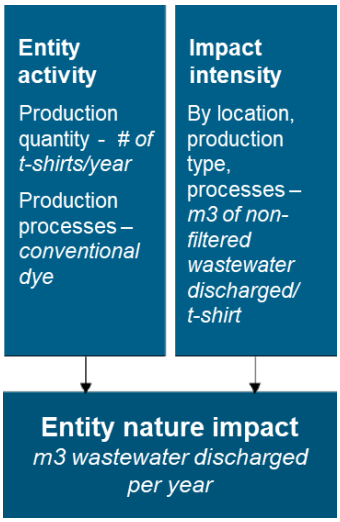
4.3.2.2. Step 2.2 Impacts and dependencies exposure

This step focusses on the assessment of entities' impacts and dependencies on nature, which will influence the level of exposure of the entity to risks associated with these impacts and dependencies.

Entities' indirect exposure via their value chain can also be assessed in this step, attributing to them a share of the impacts and dependencies of sectors or products in their value chain.

Action 1 - Estimate direct physical impacts on nature

Financial institutions can assess entities' impacts on nature by estimating their footprint across a set of physical metrics which are most relevant to the transition risks within the focus of the assessment.



Financial institutions can start by identifying the set of nature impacts linked to transition risks. This consists in listing the impacts on nature that are likely to expose a company to the transition risks selected and modelled in previous stages. For example, an established impact of the construction sector is the creation of large material waste, which could expose companies in this sector to stricter recycling and reuse regulations. Guidance and evidence on quantifying activity-specific nature impacts is emerging. The main references available presented in Table 4-9 below can be used a starting point.

For each impact identified, footprint data can be collected or estimated. For some impacts, data at entity-level can be derived from corporate sustainability reporting (see for example CSRD metrics, but also GRI and SASB reporting). If data is unavailable or complex to compile **impacts can be estimated** based on economic activity (e.g. total production by company) and impact intensity factors (emissions per ton of products by type of activity and processes). This is further detailed in Box 4-2. below.

Key consideration - **What impact metrics should be used?** The choice of metrics should be guided by the end use of the impact assessment: (i) if used for reporting or disclosure it should align with main guidance or requirements (SFDR's principal adverse indicators, TNFD metrics), and (ii) it should be adequate to use as an input for further modelling of risk materiality if part of a broader risk assessment. Some studies by central banks – DNB, Banque de France - have used biodiversity metrics such as Mean Species Abundance to estimate their impacts, which provides a good reference point for comparison across institutions or entities but can be difficult to link to transmission channels and financial risks in the following steps.

Key consideration - **What level of granularity are appropriate for intensity factors?** This will depend on the initial level of analysis set during the scoping phase. It is important to consider variation of intensity within a sector of activity. In order to increase accuracy, intensity factors can be collected for specific products and processes, however these might not always be available.

Table 4-10 Data sources and guidance to quantify entities impact

Data sources and tools	• EU Life-cycle impact assessment databases for process specific impact intensities • Ecoinvent or EXIOBASE environmentally extended tables for impact intensities at sector level (averages) ([336])
Guidance	• PBAF v2023, biodiversity impact assessment • SFDR Principal Adverse Impact indicators, • TNFD v1.0, (LEAP step E.2 and E.3) • ENCORE for impact levels

([336]) See Section 2.3.1 of this report, Table 2-1 for more details different data sources such as EXIOBASE and Ecoinvent

Box 4-2 How to manage nature footprint data limitations?

What is footprint data used for?

Footprint data is used to understand the impact of an entity's activity on nature, across a wide range of impacts which then can be linked to transition risk assessment. It helps understanding the sources and magnitude of entities' exposure to nature risks. It is a key input into impacts and dependencies exposure assessment.

What is the current state of data?

Most large companies report on some impact variables in their sustainability reporting frameworks (e.g. CDP Water, CSRD). Currently these frameworks only cover some nature impacts such as water use and air pollution (e.g. ESRS does not include deforestation). Moreover, access to a compilation of these reported metrics across all companies can be limited and compilation can be a tedious exercise. Additionally, smaller, and non-listed companies are less likely to report their footprint, leaving a gap for financial institutions exposed to mostly smaller companies. The implementation of nature-related reporting regulations such as the CSRD are likely to increase the availability and quality of footprint data in the coming years.

Different approaches to impact exposure assessment can be used depending on the granularity and coverage of footprint data:

1. High data quality – Entity-level footprint data

When entity level footprint data is available this can be directly used as an input into the exposure assessment.

Ideally the data would provide not only the magnitude of impacts (e.g. total NOx emissions/year) but also the location of impact (from geospatial point for asset-level analysis, to country or region for sector-level analysis). As there can be high variation in transition risks between locations. If location of impact is not available, assumptions can be made based on the entity's production quantity by locations.

2. Partial availability – Entity-level production data with proxies for impact intensity

When only entity economic activity data is available (location, production, processes) but no footprint data is available, impact intensity proxies can be used to estimate footprint. Average impact intensity factors by activity (product, sector, subsector), location (country, region) and processes (production type) can be collected from life-cycle impact assessment databases such as OpenLCA, Ecoinvent, and scientific literature.

Impact intensity factors are highly dependent on production processes rather than just product categories. If the entity's main production process is known, impact intensity factors corresponding to that process would be preferred (e.g. conventional vs drip irrigation for wheat production) otherwise an average can be used.

3. Low data quality – Sector or country level footprint data

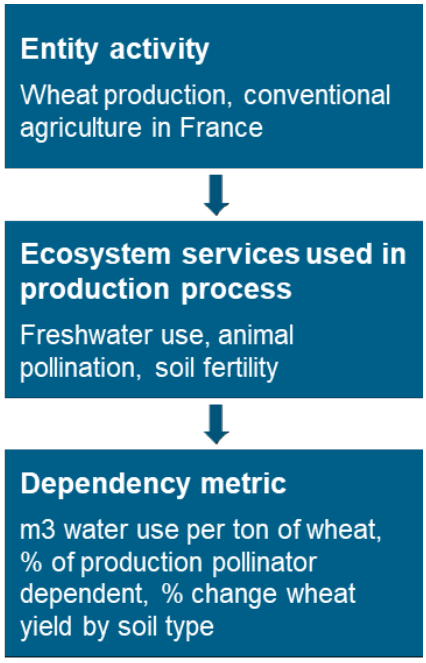
When footprint data is only available at a very high level (e.g. a country or a sector from public databases), footprint can be downscaled. In this case. the share of entity economic activity over a higher level sector activity can be used as a proxy for the share of footprint that it is attributable to (e.g. wheat = 10% of agricultural production in volume or area, wheat = 10% of agricultural water consumption).

This approach is only recommended for specific cases where there is expected to be little variation in impact intensity between different activity within a sector/subsector of activity.

Action 2 - Estimate direct physical dependencies

Financial institutions can assess entities' dependencies on nature by estimating their use of ecosystem services which are the most relevant to the physical risks in focus.

Dependencies are sometimes the result of complex interactions between ecosystem services and production processes which are difficult to reflect in one quantifiable metric. Unlike impacts which are supported by a wide knowledge on life-cycle impact assessment, dependencies have not been modelled on a systematic basis. Financial institutions might need to start with most commonly estimated dependencies (e.g. water availability) or use qualitative inputs to define dependency levels before more data and tools become available.



Financial institutions can start by identifying the set of nature dependencies linked to physical risks within the focus of the assessment. The list of ecosystem service dependency associated with physical risks identified and modelled in previous stages can be used as a starting point. This list can be enhanced by looking into additional analysis specifically focusing on the area of activities in which the entity operates. Each entity or group of entities can then be associated with a set of ecosystem services dependency based on their activity and locations.

The dependencies listed can then be linked to entities' production processes through a quantifiable metric. For each combination of dependency and entity, specific metrics that reflect the use of an ecosystem services in an entity production process can be defined. For instance, the share of entity's total crop production that are animal pollinated, or the volume of water used per ton of production.

Then the values of these metrics can be estimated based on entities' location and production data, and external studies. Some of this data can also be collected from sustainability reports for resource use metrics such as water use.

Key consideration - **How can qualitative dependency indicators be integrated in the analysis when data is limited?** If dependency modelling is unfeasible due to data complexity or limitation, it is possible to use qualitative data to build a dependency metric which can then feed into the risk assessment. For instance, entities could be tagged with numbers indicating high, medium or low dependency to soil quality. The transmission channel metric (defined in step 2.3 below) associated with this dependency might have to be adapted to this type of variable (e.g., % change in productivity by dependency level).

Table 4-11 Data sources and guidance to quantify entities' dependencies

Data sources and tools	• EU Life-cycle impact assessment databases • LCIA databases (e.g. ecoinvent) or EXIOBASE for resource use • Water Footprint Network for crop specific water consumption data
Guidance	• PBAF Standard v2023, assessment of dependencies, • TNFD v1.0, (LEAP step E.2 and E.3) • ENCORE for dependency levels

Action 3 - Estimate indirect exposure

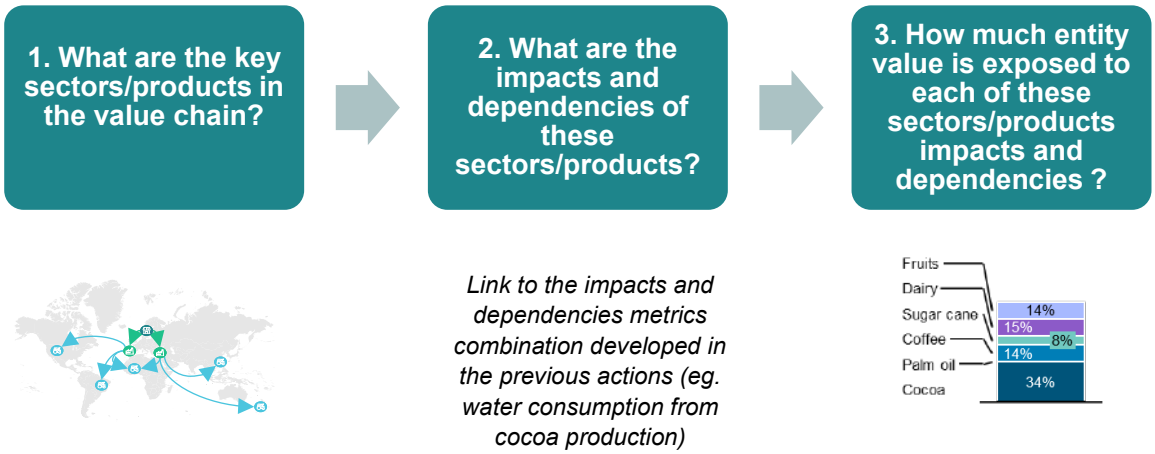
Financial institutions can include value chain related risks within their risk assessment by assessing entities' exposure to impacts and dependencies within their value chain. More details and examples of indirect impacts and dependencies can be found in Section 2.2.2. 2.2.3 and 2.3.1 of this report (under Task 1 – Understanding the types of risks associated with biodiversity loss). It is important to note that this section refers to the entity's impacts on nature, which can be direct or indirect. For the financial institutions most of its impact on nature will be indirect – i.e. through the entity's impacts.

The financial effects of nature-related risks are likely to flow down the value chain as cost, revenue or productivity shocks on primary commodities which will translate into increased prices or disruptions to supply. This can create significant risks for entities positioned downstream of these activities. There is also an increasing scrutiny from regulators and consumers on value chain related impacts on the environment especially deforestation and pollution - as reflected in the EU Deforestation Regulation recently adopted. ([337]) Regulations on value chain impacts might pose direct risk to entities.

Financial institutions can have higher exposure to entities in manufacturing and services sectors, which are likely to be mostly exposed to value chain related risks. Therefore, financial institutions wanting to get a comprehensive view of their risks should consider investigating value chain impacts and dependencies.

Estimating indirect exposure aims to provide a clear picture of the entities' value chain, allowing to link impacts and dependencies of other activities within this value chain to the entity's exposure to risk. This requires answering the following three questions:

([337]) See https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en for more details



Firstly, the entity's value chain needs to be mapped. This mapping consists in identifying key products or sectors within the entity value chain, focusing on most relevant inputs and outputs and classifying into a 2 to 3 steps chain. This can be collected directly from entity data or estimated using I-O tables and trade data (see Box 4-3 below on value chain data for more details).

For each key sector or product in the value chain, financial institutions can use the outputs of the direct impact and dependency exposure assessment. Following the same process as detailed in Action 1 and 2 above, the direct impacts and dependencies of main activities in the entities' value chain can be estimated.

Then these impacts and dependencies can be weighted by the entities' value chain exposure to these key sectors or products. This can be done by estimating the shares of entity revenue or production dependent on value chain products/sectors and apply these shares to impacts and dependencies estimates.

Key consideration – **At what stage should value chain mapping be conducted?** Although quantitative value chain estimates are only needed for the quantification of exposure to risk, a high level value chain identification at the beginning of the assessment phase can be useful for location and sector scoping to make sure all necessary sectors are included in the direct modelling to feed into the value chain modelling.

Table 4-12 Data sources and guidance to assess indirect exposure

Data sources and tools	• Input-Output tables such as EXIOBASE, EU FIGARO to link upstream to downstream • EU Trade databases to link production and import locations • Trase for deforestation in value chains
Guidance	• TNFD v1.0 • EFRAG's value chain implementation guidance • Align recommendations for corporate biodiversity measurement • Finance for Biodiversity guidance on biodiversity measurement approaches

Box 4-3 How to manage value chain data limitations?

What is value chain mapping and when is it needed?

Value chain mapping refers to the identification of upstream products and processes necessary for an entity's activity, and its downstream destinations. Value chains are central to understanding cascading effects from nature risks from upstream sectors – primary goods often being the most exposed to nature risks due to their high impact and dependencies. They can be used to assess indirect exposure to physical and transition risks and to quantify their second-order economic impacts such as changes in prices. Given the complexity of value chains, a mapping exercise will require some level of simplification, for instance by focusing only on 2 steps within the value chain (upstream and downstream) and concentrating on the value chain sectors with the highest revenue dependency to the entity's activity (e.g. main input sector to food manufacturer is agricultural products).

What is the current state of data?

Increasingly, trading in sensitive commodities integrates tracking systems to allow monitoring along the value chain route from harvesting site to final selling points (e.g. timber). However, these remain scarce, and most indirect exposure assessments rely on proxy data from inputs-outputs tables. I-O tables provide harmonized and detailed supply-use tables at country level and at sector or subsector levels (See Section 2.3.1 of this report, Table 2-1 for more details). Eurostat compiles the 'Full international and global accounts for research in input-output Analysis' (FIGARO) tables representing the EU inter-country supply, use, and input-output tables (IC-SUIOT). It covers 64 products (NACE Rev.2), 27 EU countries and 18 EU trade partner countries.

Different approaches to value chain mapping can be used depending on the granularity and coverage of value chain data:

1. High data quality – Entity-level value chain data
   When entities can provide a detailed breakdown of their value chains including traceable production and selling locations and trade routes, this can be directly used as an input into the exposure assessment.
   Specific risks and responses assessed for these products and locations can then be applied to the entities' upstream products and translated into second order impacts by modifying price or available quantities accordingly.
2. Partial availability - E**ntity's activity data and production locations**
   When entities main production locations are available, country-product level inputs-outputs tables can be used as a proxy for value chain. A 2-3 step (upstream, midstream, downstream) value chain can be built using inputs-outputs table which will provide an indicator of the value of product consumed for the production of one unit of a downstream product/service – which corresponds to the entity's activity.
   Specific risks and responses assessed for upstream or midstream products can then be applied to then entity's proxied upstream value chain (as detailed above). Location granularity can be further enhanced using trade data to identify where upstream products could be imported from.
3. Low data quality – Entity activity data only

When entities production locations are not available global or EU-level inputs-outputs tables can be used as a proxy for value chain. Global or regional inputs-outputs table will provide less granular averages of transmission factors between upstream and downstream sectors than country-level but are still useful to identify major upstream to downstream relationships.

4.3.2.3. Step 2.3 Risk materiality

This step focusses on the assessment of the likely financial impacts of nature-related risks on entities. This assessment relies on the estimations of sources of risks (Step 2.1) and impacts and dependencies exposure (Step 2.2) conducted in previous steps. The combination of these outputs together with an estimation of transmission channels allows financial institutions to quantify the potential financial risks to the entity, providing an indicator of the materiality of nature-related risks.

When identifying and quantifying transmission channels and resulting risks, financial institutions might want to consider the time horizon in which risks are most likely to arise. For instance, for transition risks the schedule of regulations and global agreements might be a good indicator of timeline for materialisation of risks for entities. For physical risks timelines can be indicated by most up-to-date scientific evidence on species decline and ecosystem services loss. Although most physical risks can already be seen at micro-level (e.g. droughts, lowering because of pollinator decline), these risks are expected to become larger and more durable in the coming decades.

Action 1- Define transmission channels

Transmission channels can be defined as the linkages between transition and physical risks and economic impacts on entities. These can be used to quantify risk materiality through the definition of metrics linking each risk to an economic impact at macro, meso or micro- level.

Financial institutions can identify a long list of variables which reflect how nature transition and physical risks can materialize into an economic risk and could affect entities. They can rely on existing examples of economic impacts from nature changes (e.g. drought events leading to drop in production of wine), as well as compile common transmission channels used in other risk assessment such as climate assessments. Some common transmission channels include: change in production processes, fees and fines, litigation costs, productivity, input prices, and sales.

Key consideration – **How to prioritize a subset of transmission channels for the quantitative assessment?** Each risk could be associated with a wide variety of transmission channels, the selection of most relevant channels can be guided by (i) an analysis of existing market behaviours – especially looking into current economic impacts of climate change, (ii) the complexity of modelling required and data available, (iii) the sectoral scope of the assessment.

Table 4-13 Examples of transmission channels

Risk	*Transmission channel*	*Metric*
	Physical risks	
Drought events	Supply disruption	% drop in production
Increased water scarcity	Productivity shock	% change in productivity
	Transition risks	

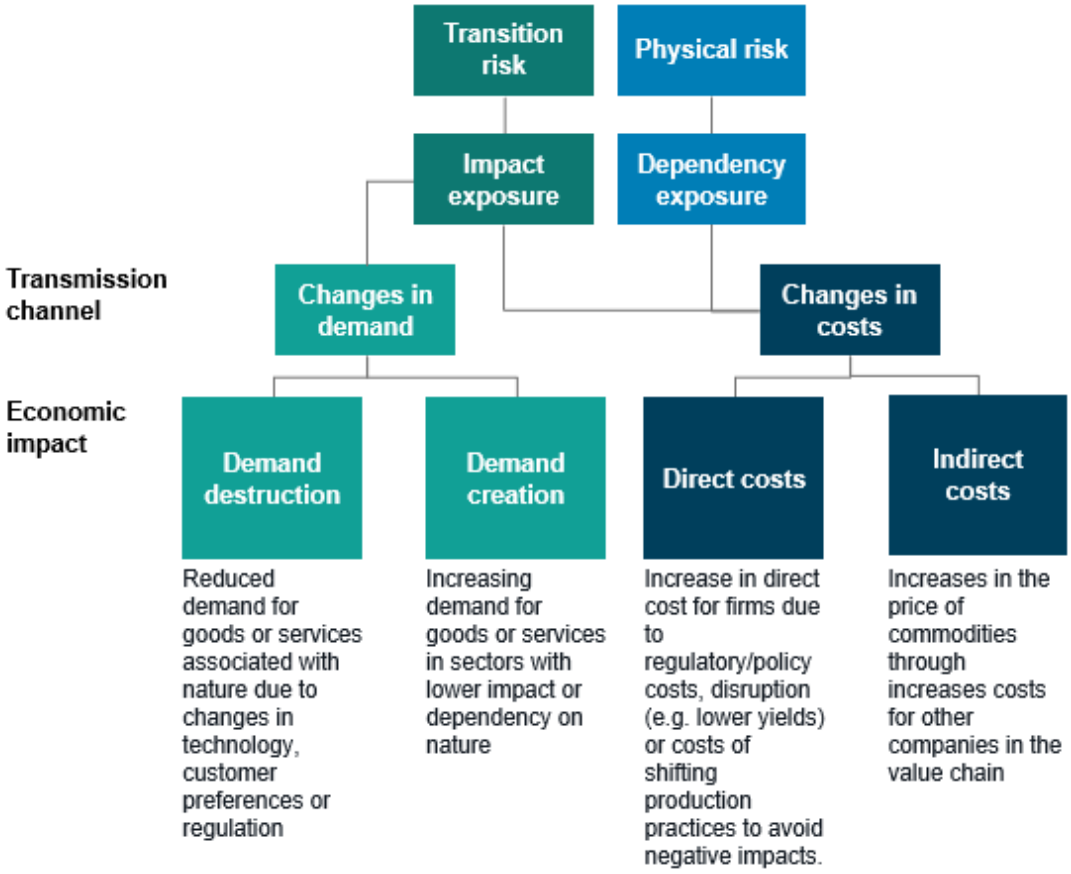
Ban on nitrogen fertilizers	Change in production processes, input prices	% increase in costs

Key consideration – **Which level of transmission channels is most appropriate?** All levels of transmission channels are relevant in a risk assessment. However, a focus on specific levels (micro, meso, macro) can be guided by the risk category itself and the potential reach of the risk (across a whole sector, for specific companies only). The transmission of major market trends should be captured at macro level while policy related transmission channels would tend to be assessed at meso or micro levels.

Action 2 - Determine potential economic impacts

Financial institutions can then quantify the transmission channel identified and the resulting economic impacts by combining the estimates of sources of risks (Step 2.1) and of impacts and dependencies exposure (Step 2.2). The magnitude of economic impact will thus result from (i) the level of initial risk, (ii) the level of exposure to impacts and dependencies, (iii) the influence of the transmission channel on economic outcomes.

This step consists in mapping each transition and physical risk with a set of economic impacts, through transmission channels, and calculating these impacts.



Transmission channels can be used as a starting point to define the source of the economic impact which is then quantified via the change in key economic variables such as demand and costs.

Assessing changes in demand may involve using several different types of tools and data sources, including forecasted changes in price and quantity demanded under different scenarios. Demand impacts could be both positive and negative depending on market dynamics.

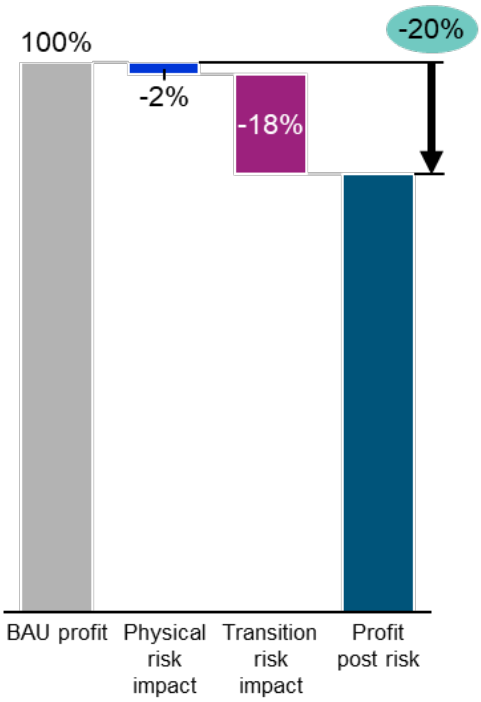
Estimating changes in costs could be done in several ways. For direct transition costs, these could occur both for companies producing and selling in the EU. For instance, increased costs may accrue due to regulation of water pollution impacts for some companies. Alternatively, companies could face new financial penalties in some selling markets (e.g. EU) if they have deforestation in their supply chain.

Table 4-14 Data sources and guidance to define transmission channels and assess economic impacts

Data sources and tools	• Market analysis and economic theory (e.g EU energy market analysis) • Key references in transmission channels definition include Svartzman, R. et al. (2021) and CISL (2021) Handbook for Nature-related Financial Risks
Guidance	• ECB good practices for climate and environmental risk management, • NGFS conceptual framework • TNFD V1.0 (Step E.4 and A.1, A.3 and A.4)

Action 3 - Quantify financial impacts at entity level

Economic impacts on entities calculated in the previous action can then be applied to entities' financials to estimate the impacts of nature-related risks on their financial performance.



Financial institutions can start by establishing the baseline performance of each entity. This will allow financial institutions to understand where the entity is/or will be under a business as usual (BAU) context. It will also provide all necessary variables to calculate financial performance post impact.

Then a new financial performance can be calculated by integrating nature-related economic impacts into entities' financials. The estimated economic impacts generated in the previous action can be aggregated across exposure to all risks into a set of metrics that can be integrated in entities financial data. These metrics could be changes in revenue, profitability or market value.

Finally, the new financial performance can be compared with the baseline performance to assess the magnitude of financial impacts from nature-

related risks. The financial impacts are reflected by the difference between entities' BAU financial performance and post alteration (taking nature risk into consideration) financial performance (e.g. difference in profit).

Key consideration – **What financial variables can be considered?** The financial variables used for this quantification should be common variables of financial performance modelling, they also need to be aligned with the metrics generated in the previous step.

Table 4-15 Data sources and guidance to quantify financial impacts

Data sources and tools	• Financial data service providers • Entities' business models
Guidance	• ECB good practices for climate and environmental risk management • TNFD V1.0 (Step A.4)

4.3.2.4. Step 2.4 Response to risk

Financial institutions can then adjust the financial impacts estimates at entity-level by estimating how entities are likely to mitigate these impacts in the short-term. This aims to provide a more realistic view of financial risks at entity-level, as revenue and cost shocks can usually be mitigated to some extent through operational, market or strategic responses.

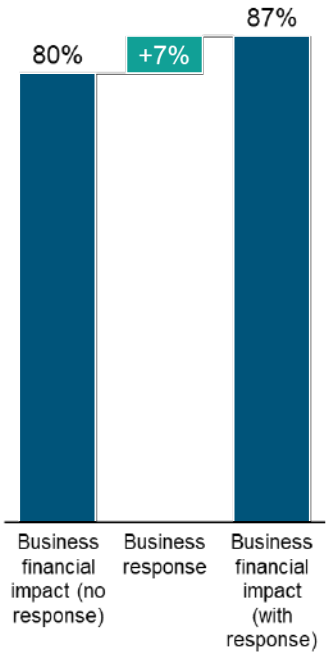
Action 1 - Define and model potential responses to risk

Although it is likely that financial institutions might not be able to access precise information on entities actual response to financial impacts, economic analysis can support the modelling of some of these responses using assumptions.

Firstly, the field of potential responses to nature-related risks needs to be identified. Financial institutions can conduct literature review and counterparty interview to understand the actions entities could take to respond to nature risks. This could include:

- **Operational response:** Companies could take cost-efficient actions to mitigate the impact on nature e.g. Promote a regenerative agriculture programme to reduce agricultural impact footprint.
- **Market response:** Companies could work with suppliers to reduce regulatory risks or pass the costs down the value chain by increasing their prices.
- **Strategic response:** Companies could shift business activities away from nature risk e.g. changing production locations, offering new product lines.

Some key factors should be taken into consideration to understand the likelihood of response, these includes (i) the level of substitutability between ecosystem services and technology, (ii) the cost-efficiency of response options, and (iii) entities' profit margins and investment capacity.



Then financial institutions can use economic model to estimate the impact of these responses on entities' financial performance. For instance, the financial impacts of entities increasing their prices can be investigated and applied to the financial performance estimates.

Key consideration – **How can financial institutions assess the economic effects from companies' responses?** Entities' sensitivity to the shock and their ability to adapt will largely influence the magnitude of their response and it impact it can have on their financial performance. Key factors to consider include: Market structure (how much competition is there in the market?), elasticity (how does demand shift with price change?) and ability to shift production locations.

Key consideration – **How can scenario analysis be used to model response?** A forward-looking analysis can provide estimates for key drivers of responses such as technology availability and prices – influencing operational response, or state of nature and ecosystem services in different locations – influencing market and strategic responses.

Table 4-16 Data sources and guidance to determine entity level response

Guidance	• ECB good practices for climate and environmental risk management • TNFD V1.0 (Step A.2) • NGFS conceptual framework

4.3.3. Phase 3: Financial institution level risk assessment and mitigation

The last phase of the nature-related risks assessment covers the estimation of the financial impact of real economy risks on financial institutions. The approach to financial institution-level risk assessment is similar to what already exists for climate, which includes using existing financial modelling and risk classification to translate entity-level risks into risks for the financial institutions.

This phase also includes the potential next steps for financial institutions on how to use the risk assessment results to mitigate and better manage nature-related risks.

This phase covers a set of key questions which can guide financial institutions:

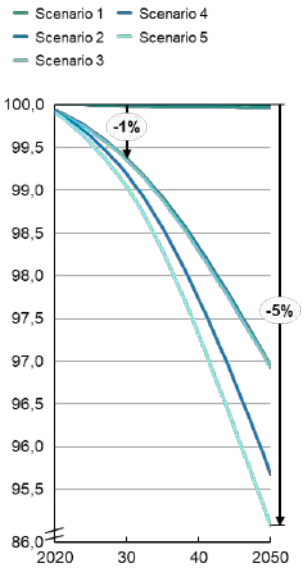
- What types of risks do nature-related risks fit in, within the common financial risk classification?
- What are the indicators already in use to assess risks?
- How could nature-related risks be further integrated into risk management decisions and risk modelling?
- What are the first potential response to mitigate nature-related risks?

4.3.3.1. Step 3.1 Financial impacts assessment

This step focusses on the translation of entity-level financial impacts into financial risks for the financial institution through aggregation and financial modelling, and the classification of these risks.

Action 1 - Quantify financial impacts on financial institutions' performance

Using the results from the entity-level financial impact and financial modelling tailored to their activities, financial institutions can conduct an assessment of risks to their performance.



Firstly, the entity-level results generated in the previous stage can be aggregated at the level most appropriate for the financial institutions' needs. This will guide the level of analysis for financial performance, which could be an investment portfolio, a loan book, or an aggregation of all national-level operations.

Aggregated results can be translated into financial performance indicators using financial models already in use by financial institutions to estimate other financial risks. For example, banks could estimate changes in default probability based on entity level financial results. It can also prove useful to refer to relevant guidelines like the European Banking Authority (EBA) final guidelines on high-risk exposures under Capital Requirements Regulation (CRR) ([338]), to define the level required.

Financial institutions can then estimate exposure to nature-related risks based on estimated financial impacts. For example, for banks, changes in loan book value can be estimated with the cumulative impact of changes in annual expected losses due to nature-related risks.

Key consideration – **Which financial impact metrics are relevant for financial institutions risk management?** For banks, metrics typically used to assess credit risk (e.g. probability of default) are relevant as it can drive other types of financial risks e.g. market risk and liquidity risk. For investors, valuation model would depend on counterparties financial metrics. For insurers, nature risks might have an impact on number and value of claims.

Key consideration – **How should systemic effect be taken into account?** It could be important to recognise and model the interconnectedness between risks and channels through which nature risks translate into financial impact. Financial institutions can consider conducting a downside case where nature events might lead to a systemic effect and stress their financial performance indicators according to this extreme case.

Table 4-17 Data sources and guidance to quantify financial impacts on financial institutions' activity

Data sources and tools	• Financial market data and analysis (ECB financial market data)
Guidance	• ECB good practices for climate and environmental risk management • TNFD V1.0 (Step A.4) • NGFS conceptual framework • ECB guide to internal models • EBA guidelines on stressed value-at-risk

([338]) For more details see https://www.eba.europa.eu/regulation-and-policy/single-rulebook/interactive-single-rulebook/504

Action 2 - Classify financial impacts into risks for financial institutions

The results of the financial impact assessment can be linked to specific types of risks usually managed by financial institutions, namely:

- Credit or underwriting risk
- Market risk
- Liquidity risk
- Operational risk

This action aims to provide clarity and alignment on what nature-related risks represent for the financial institutions, and under which framework they can be apprehended and managed, along with other risks.

Entity-level changes in financial performance due to nature risks are most likely to lead to credit (for banks), underwriting (for insurance) and liquidity risk (for all financial institutions), while financial impacts on the value of financial institutions' products could materialize into market risks (for all, especially asset managers and investors). This framework focusses on these 3 types of risks as they appear to be the most relevant for financial institutions.

Financial institutions can analyse their nature-related credit risk using the metrics quantified during the financial impact assessment. They can also identify other factors that could affect credit risks factors (refer to 2.2.4 of this report for micro and macro factors). The credit risk analysis can be conducted by sector and location to inform operational decisions.

Key consideration – **How can nature risks translate into credit risks?** Consider the impact from physical drivers, through the damage/destruction of assets, and transition drivers, through increasing credit costs in polluting industries following legislation. At a macroeconomic level, the loss of nature could subsequently increase sovereign risk through reduced economic performance.

Financial institutions can estimate their market risk based on changes in product rating and reputation trends. They can build on existing capabilities to analyse how changes in product rating and reputation resulting from their exposure to nature-related risks could negatively affect their market valuation.

Financial institutions can investigate their liquidity risk and other risks that may arise from nature-related risk exposure. Liquidity/refinancing risk can arise from default, drop in value, or increase in claims resulting from broader nature risks' impacts across a sector or an economy; other risks include operational risk, and reputational risk.

Financial institutions can also explore the likelihood of systemic risk in the financial industry. They can conduct stress testing on major contagion channels such as feedback loops between financial sector/real economy, inflation and interest rates for sectors with high exposure to nature-related risks.

Key consideration – **How can financial institutions take macroeconomic factors into considerations?** The modelling of macroeconomic impact could present challenges, particularly in terms of substitution within a computable general equilibrium framework. Thus financial institutions could try to understand qualitatively how changes in macro environment (e.g. shift in customer demand, change in economic activity) affect financial risks, leveraging external resources.

Table 4-18 Guidance on risk classification

Guidance	• ECB good practices for climate and environmental risk management • NGFS conceptual framework • TNFD V1.0 (Step A.4) • EIOPA staff paper on nature related risks for insurance • Finance for Biodiversity, Nature Loss and Sovereign Credit Ratings

4.3.3.2. Step 3.2 Mitigation actions

This final step focusses on how financial institutions can use the learnings and outputs of the risk assessment to start acting on nature-related risks. This covers the integration of nature-related risk assessment/management into broader risk management frameworks, and the development of an initial plan for risk mitigation actions.

Action 1 - Integrate the assessment results into management frameworks

Using key learnings from the assessment, financial institutions can get started with the integration of nature considerations into risk management frameworks to build their resilience to nature-related risks.

Financial institutions can initiate this process by identifying the key entry points for nature in their risk management frameworks. This can involve the review of existing policies, procedures and processes for risk management, in particular for climate risk if available. Potential entry points include: risk appetite framework, credit policies, rating, underwriting, pricing, stress testing, capital estimation, reporting and disclosure.

Key consideration – **To what extent does the nature risk consideration align with existing climate risk management frameworks?** Many financial institutions have incorporated climate metrics and considerations into their risk management model. A natural move would be to build from existing climate models and expand to model the wider nature metrics. However, some aspects of nature might require separate initiatives and assessments as nature risks might have to be integrated in sectors and areas where climate risks are not material.

Financial institutions could then establish an integration roadmap with clear action points. The roadmap can set out key actions to gradually integrate nature risks into existing frameworks with dedicated teams to provide oversight on their implementation. For instance, financial institutions could start integrating nature-related

metrics and KPIs, developing screening and exclusionary policies for high- and adverse-impact activities, adjusting their pricing models to include nature-related profit impairments.

Financial institutions could also integrate nature-related disclosure and reporting within their systematic reporting processes. This could involve integrating nature-related risks exposure and risk management framework adjustments into regular annual reporting, considering both regulatory requirements, e.g. SFDR, CSRD and ECB risks disclosure, and voluntary frameworks like TNFD.

Table 4-19 Examples of entry points for nature-related risks integration

Potential entry points	*Potential actions*
Risk appetite framework	Include financed deforestation metrics
Credit policies	Sustainable supply chain sourcing policy
Capital allocation	Maximum exposure to uncertified agricultural companies
Rating	Incorporate nature risk exposure into credit models
Underwriting	Revenue and profit impairments
Pricing	Existing risk pricing schedule
Stress testing	Expected credit losses
Capital estimation	Nature risk-weighted assets

Table 4-20 Guidance on nature-related risk management

Guidance	• ECB good practices for climate and environmental risk management • TNFD V1.0 (Step A.2, P1-4), • ECB guide on climate and environmental risks • TNFD guidance for financial institutions

Action 2 - Prioritise and plan mitigation actions

Financial institutions can start identifying and planning key actions to mitigate their exposure to nature-related financial risks.

Financial institutions could develop a plan towards specific and quantified objectives for mitigation. This would consist in the definition of clear actions, such as minimising expected losses from credit risk through capital reallocation or reducing reputational risk through communication. Section 2.3.1 of this report provides insights into potential mitigation actions for financial institutions. Two types of actions can be considered: (i) **programme-level actions** such as working with counterparties to reduce nature exposure, through lending policies, due diligence, and environmental impact assessments requirement, and (ii) **institution- level actions**, such as reallocating capital to low-impact clients, or carrying operational transformation such as ESG integration.

Where possible, financial institutions can then analyse the expected impact each action would have on their exposure to key nature-related risks, and group actions into sets that would maximise the integrated benefits.

The actions with most promising impacts can then be further shortlisted based on their feasibility. Depending on data and capacity, financial institutions could analyse the feasibility to implement each action based on a review of capabilities and needs.

The mitigation plan could then be developed by phasing the prioritised actions. This plan could include targets and metrics to monitor progress and a communication strategy for stakeholders.

Key consideration – **What is the ambition level of the mitigation plan?** The ambition level could be guided by risk metrics like expected loss from nature as guidance e.g. aim for 30% reduction, or by exposure metrics e.g. % share of investments exposed to high water risks.

Key consideration – **To what extent should nature-related mitigation actions align with existing climate actions?** Nature strategy goes beyond climate considerations; While the objectives of nature and climate actions are aligned most of time, complexity exists where there are conflicts between climate and nature impacts.

4.4. Illustrative case studies

This section presents different examples of how financial institutions can implement the framework for assessing nature-related risks. It provides a framing of key design choices for different use cases spanning from a high-level qualitative assessment to a detailed asset-level quantification of nature-related risks across different scenarios. These illustrative case studies aim to show how specific assessments in the three most exposed sectors in the EU, as identified in section 3.3, could be conducted. This section aims to give financial institutions concrete examples of how to apply the framework, present different use cases, aims, capabilities and levels of analysis. It should be noted that these are indicative and do not present all the different ways in which the framework can be used.

The case studies were chosen to provide insights on the variety of potential uses of the framework and include 4 different approaches:

- Case study 1: Bank portfolio qualitative heatmap of nature-related risks
- Case study 2: Asset manager's counterparty-level assessment for portfolio of investments in apparel sector
- Case study 2: Quantitative risk assessment for an investment into a real estate project
- Case study 3: Quantitative risk assessment for an investment into a farm asset

Each case study covers a different level of spatial and sector granularity, as well as different levels of quantification and forward-looking projections. In some cases, steps of the framework are combined. The overall assessment can be carried using qualitative

risk metrics (see Case Study 1). The level of complexity and risk coverage will depend on the initial use case of the assessment. In some cases, quantitative data and forward-looking analysis is necessary (Case Study 2 to 4), but in many cases a static qualitative view can already provide a good starting point to financial institutions.

4.4.1. Case study 1 : Qualitative heatmap assessment

In this case study, the financial institution is a national bank, for which it is the first effort to assess nature-related risks associated with its corporate lending operations. It covers the key steps and design choices to identify and assess risks through a qualitative analysis which is then presented as a heatmap across sectors and drivers of risks.

1.1 Intention setting

The national bank first defines the main purpose of this nature-related risks assessment. Given the current findings of the European Central Bank (ECB) on financial institutions' dependency to nature, the bank's board has asked to get an initial view of the nature-related risks that the bank is exposed to. The outcomes of the assessment should help the bank define its strategy on how to go forward and start including nature issues into its activities in the coming year.

The bank would also like to be able to report to the ECB initial requirements on environmental risks as well as making a voluntary report of its nature-related risks under the TNFD initiative.

The bank has all its operations in France and provide corporate loans for a wide range of companies across different sectors of activities. The banks' analysts decide to carry an assessment at sector-level to get a full view of the bank's exposure to nature-related risks, focusing on corporate lending which represents more than 70% of its activity. The approach used will be a qualitative heatmap assessment, as it gives the bank an opportunity to easily produce an initial view of its nature-related risks, and identify hotspots for future, more in-depth, assessments. The heatmap will require minimal resource to produce and will be a good tool to onboard the bank's staff on nature-related risks.

1.2 Risk identification

Based on the aim of the assessment, a broad coverage of nature-related risks, the analysts decide to include all major sectors of the economy covered by the banks' corporate lending books. These sectors include **financial services, electronics manufacturing, agricultural production, wholesale and retail trade (food and apparel), utilities and power generation, and education**.

The analysts review different sources to understand what kind of nature-related risks exist for these sectors. They look into publicly available resource such as the IPBES

Global and Regional assessment reports on biodiversity and ecosystems ([339]), ENCORE materiality ratings ([340]) and TNFD sector guidance ([341]) to define a long list of potential risk drivers. They decide to select the risk drivers which have only high or very high materiality ratings in the ENCORE database for the sectors listed initially.

This includes:

- Land use change
- Water pollution
- Water availability
- Soil quality / Erosion control
- Pollination services

These risk drivers were prioritized as they reflect 3 of the 5 key drivers of biodiversity loss (change in land use, pollution and exploitation of nature resources), and are relevant to the sectors which the bank lends to. They are also highly relevant for France, based on the regional assessment of IPBES, analysts see that soil quality, water availability and pollination services are threatened in France. They also see that regulations around water pollution and land use are likely to tighten, and therefore are more likely to lead to transition risks. This information is collected through a literature review of evidence on biodiversity loss and its drivers globally and in France, as well as a review of EU and French regulations on key drivers of nature loss (eg. Nature Restoration Law, Green Deal).

2.1 Sources of financial risks

After having identified a set of key risk drivers for the sectors of interest to the bank, the analysts collect further information to identify the potential magnitude of different drivers of risks for the bank's counterparties.

To do this, the analysts start collecting actual data on the state of nature in France, for areas relevant to the drivers selected. This data will support the assessment of physical risks by giving an indication of the location and magnitude of risks. The data collected includes:

- ()Water availability: map of water scarcity levels in France (WRI Water Risk Atlas ([342]), WWF water risk filter[343])

([339]) Available at: https://www.ipbes.net/global-assessment

([340]) Available at: https://www.encorenature.org/en

([341]) Available at: https://tnfd.global/tnfd-publications/?_sft_framework-categories=additional-guidance-by-sector#search-filter

([342]) Available at: https://www.wri.org/applications/aqueduct/water-risk-atlas/#/?advanced=false&basemap=hydro&indicator=w_awr_def_tot_cat&lat=30&lng=-80&mapMode=view&month=1&opacity=0.5&ponderation=DEF&predefined=false&projection=absolute&scenario=optimistic&scope=baseline&threshold&timeScale=annual&year=baseline&zoom=3

[343] Available at: https://riskfilter.org/water/explore/scenarios

- Soil quality: map of soil organic carbon levels in agricultural land in France, soil erosion risk in France from publicly available sources such as the EEA database ([344])
- Pollination services: map of pollinators abundance from academic paper

The analysts can then assign different scores for each risk drivers, based on the data collected. For some sources, the risk levels might already be assigned at granular level (eg. Water Risk Atlas), in that case the analyst can derive a score by aggregating to a less granular level (eg. if more than 50% of data points for France are scored as high for water scarcity, the aggregation for France could be high). If there are no pre-established scores, analysts can refer to experts to understand what thresholds could be defined to assign the scores (eg. soil erosion is evaluated in mega grammes (Mg) of soil loss per hectare per year, a threshold for high erosion rate is above 40 Mg per hectare per year, as detailed in the European Soil Data Centre[345]). The analysts can assign a score for the average across France.

Analysts can decide to use this data to get more granular view of risks, by assigning scores for each region within France, following the same approach as above but averaging the data at regional level.

In order to explore the sources of transition risks associated with the banks' counterparties' activities, the analysts collect information on (i) regulations and policies related to land use change and water pollution in the EU and France, (ii) market trends for potentially sensitive sectors associated with high environmental impact such as food, apparel and electronics consumer goods.

To collect information on regulations and policy, the analysis team can refer to ongoing work under different initiative of the EU including action plans and policies developed under the Green Deal – for instance on pollution reduction targets. ([346]) The analysts can look for records of cases of large companies having to pay fines related to pollution in France, as well as details about the water pollution thresholds in French regulations, directly from government websites. Similarly, analysts can get a sense of future developments around land use regulations including expansion of protected areas and associated regulations, and restriction in land use by exploring regulations such as the EU Nature Restoration Law, and cases of restriction in land use in France affecting companies' operations.

Based on the likelihood of stricter regulations to be implemented in France in the next 5 years, as well as records of existing cases of fines and restrictions on operations, analysts can establish a score for water pollution regulation and land use change regulation risks in France. This can be further refined by consulting legal experts.

([344]) Available at: https://www.eea.europa.eu/

([345]) See: https://esdac.jrc.ec.europa.eu/content/global-soil-erosion

([346]) More details on pollution action plan at https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en

At the end of this process the analysts have produced data-based qualitative scoring of sources of risks for France and in some cases for different regions within France. These scores will be combined with exposure scores in step 2.3 to provide a full view of the magnitude of risks.

2.2 Impacts and dependencies exposure

At this stage the analysis team is trying to assess how exposed each of the sectors targeted are to nature-related risks. This can be directly reflected in the magnitude of impacts and dependencies on nature of each sector.

The analysts start by collecting materiality ratings for each sector and risk driver combination from the ENCORE database (see above). However, since this database is not region or country-specific, the team decides to tailor the scores further to the French context. To do so they collect data relevant to the risk drivers targeted. This could include the average water consumption per ton of product or € of revenue generated for each sector, and water pollutants emissions for each sector, derived from Life-Cycle Assessment databases. ([347]) Comparing this data between France and other countries, analysts estimate if these impacts and dependencies scores are likely to be higher or lower than the global average provided in the ENCORE database.

2.3 Risk materiality

In this step the analysis team combines the impacts and dependencies exposure scores by sector (step 2.2) with the magnitude of sources of risks scores assessed in step 2.1. For instance, in the case of water pollution, if regulations around water pollution were scored as high in France during step 2.1, the sectors scored as medium on water pollution globally could be considered high for France. The final score for the water pollution-electronic manufacturing score could for instance be “high”. Conversely if land use regulations have been scored as low under step 2.1, the score for land use-agriculture might be downgraded from high (step 2.2) to medium.

After combining each qualitative scores based on a pre-established decision rule (e.g. high+medium = high, low+high = low), the results can be summarised in a two-entry table with all sectors and risk drivers.

([347]) See for example EU Life-cycle impact assessment databases

Illustrative output - Example sector-driver heatmap

Sectors	Land use	Water pollution	Water scarcity	Soil quality	Pollination	Sector score
1. Agriculture	High	High	High	High	High	High
2. Electronics manufacturing	Low	High	Moderate	Low	Low	Moderate
3. Wholesale and retail trade	Low	Moderate	High	Low	Low	Moderate
4. Utilities and power generation	Moderate	Low	High	Low	Low	Moderate
5. Education	Low	Low	Low	Low	Low	Low
6. Financial services	Low	Low	Low	Low	Low	Low

3.1 Financial impacts assessment

In order to understand how the risk scores by sector translate to potential financial risks for the bank, the analysts need to understand the exposure of the banks corporate lending activity to each sector and combine it with the sector-level nature risks scores established in step 2.3.

The team first collects data on the bank's activity, getting loan books exposure by sector from different teams across the bank and making sure all sectors match the same categorisation as used for the sector-level scoring of nature risks. To do this the bank can use sector correspondence tables such as the EU NACE sector categories. ([348]) The team can then get a view of the value of loans by sector for a specific representative year (or time in the year).

A financial risk score is then derived from the combination of the financial exposure of the bank to each sector and each sector's nature risks scores. A set of decision rules can be established to define how to calculate the final score. For instance, if the financial exposure is higher than 10% of the total loan book value, then the final score is equal to the sector's initial nature risk score, and if the financial exposure is lower than 5% then the final score is one rank below the sector's nature risk score (eg. high becomes medium).

This can be compiled into a heatmap to give a transparent view of nature risk scores, financial exposure and final financial risk scores.

([348]) See : https://ec.europa.eu/competition/mergers/cases/index/nace_all.html

Illustrative output - Example financial risk heatmap

Sectors	Land use	Water pollution	Water scarcity	Soil quality	Pollination	Sector score	Book exposure	Financial risk score
1. Agriculture	High	High	High	High	High	High		Moderate
2. Electronics manufacturing	Low	High	Moderate	Low	Low	Moderate		Low
3. Wholesale and retail trade	Low	Moderate	High	Low	Low	Moderate		Moderate
4. Utilities and power generation	Moderate	Low	High	Low	Low	Moderate		Moderate
5. Education	Low	Low	Low	Low	Low	Low		Low
6. Financial services	Low	Low	Low	Low	Low	Low		Low

The heatmap produced provides an initial understanding of how the bank is exposed to nature risks. Its lending to wholesale and retail trade counterparties and utilities and power generation counterparties exposes the bank to moderate risks, mostly related to potential disruptions in these counterparties' financials due to water scarcity and regulations on pollution and land use in France.

Although, the bank has little exposure to companies in the agriculture sector, it still needs to pay attention to any counterparty in this sector given the high nature risks associated with these activities.

This provides the bank with valuable insights on where it could focus its attention for further assessment of risks and engagement on nature with clients.

3.2 Mitigation actions

Based on the results of the heatmap the bank can initiate some actions to start mainstreaming nature-related risks into its activities and meet regulatory requirements. The bank can use the heatmap as an initial submission on environmental risks to the ECB and to TNFD.

Further assessment will be required to fully meet regulatory requirements, and this will include the quantification of nature-related financial risks. The bank could start building capabilities to quantify risks for the three sectors which were considered as moderate risk for the bank lending portfolio.

The bank could also decide to start engaging with counterparties in this sector to get a view on ongoing actions to mitigate their impacts on nature, and to collect any relevant data.

The sustainability team of the bank also takes the opportunity of the release of the nature heatmap to identify where the bank already has policies to exclude harmful activities (for example on deforestation).

4.4.2. Case study 2: Comprehensive counterparty level assessment

In this case study, the financial institution is an asset manager, which has never conducted a quantitative nature risk assessment of its portfolio but had in the past developed qualitative heatmaps. It covers the key steps and design choices to identify and assess risks through a quantitative analysis of risks for a large set of companies within a portfolio, relying on company-level financial data and nature data at country and regional levels.

1.1 Intention setting

This asset manager would like to focus on its largest portfolio of investments, in the apparel sector, which includes companies operating across the world, and with global value chains. The asset manager needs to assess nature-related risks to inform its investment strategy in the apparel sector.

The main aim of the assessment is therefore to inform investment decisions across the next 5 years and include nature-related risks into portfolio risk assessment procedures. On top of this, the asset manager sees the opportunity to use the assessment to start integrating nature into investment due diligence processes for apparel companies. The assessment should also be compliant with reporting requirements from the ECB on environmental risks, and aligned with TNFD so that the asset manager can report on its nature-related risks under these frameworks.

The assessment is conducted at counterparty-level to get results that are specific to the asset manager's portfolio and reflect variation in counterparties' risk profiles.

1.2 Risk identification

More than 50% of the asset manager's targeted portfolio concentrate on global apparel companies. The analysis team decides to focus on the apparel segment of the portfolio as it most relevant to the asset manager and is known to have material impacts and dependencies on nature. Focusing on a specific sector will reduce the complexity of the assessment and associated data requirements. However, the analysis team notes that other sectors within the apparel sector's value chain need to be included in this analysis. Moreover, remaining sectors covered by the portfolio will need to be assessed later in the year during another effort.

The assessment will span across apparel companies' value chains, as significant risks are expected to be stemming from upstream sectors with larger nature impacts. The team identifies three main components of the apparel sector value chain:

- Upstream materials: fibers – cotton, leather, Polyethylene terephthalate (PET)
- Midstream processing: textile manufacturing (spinning, weaving, dying, finishing)
- Downstream: Retailers

The team reviews key sources to establish a list of relevant risk drivers for the apparel sector. This includes ENCORE, SBTN materiality screening tool ([349]) and other reports such as CISL's primer on apparel sector targets ([350]) and IUCN guidance. ([351]) They define a long list of risk drivers including:

- Three impacts: land use change, water use, water pollution
- Two dependencies: water availability (quality and quantity), flood protection

These risk drivers were identified as highly material for the apparel sector companies and their value chains. Expected impacts on land use water use and water pollution are expected to be large, and the vulnerability to lower water availability and floods is expected to be high in many locations for upstream products and manufacturing sites.

2.1 Sources of financial risks

After having identified a set of key risk drivers, the analysts collect data that will inform the potential magnitude of different drivers of risks for the portfolio companies.

To do this, the analysts start collecting data on the state of nature globally, at country level or, when available, at higher granularity. This data will support the assessment of physical and transition risks by giving an indication of the location and magnitude of risks. The data collected includes:

- Water availability: Water scarcity levels in different river basins, at subcountry level
- Flood risks maps: global coverage with high granularity, and records by country
- Deforestation rates by country
- Water pollution levels of main river basins

The analysts compile the data into quantitative variables with baseline values – e.g. water availability gap by river basin (in m3), flood risk score by country (high, medium, low).

The team collects further qualitative and quantitative information on potential sources of transition risk, specific to the apparel sector, including:

- Policy/regulations: review of emerging regulations on water pollution thresholds from azo dyes and heavy metals, review any regulations on water use and recycling for industry, regulations on deforestation
- Demand: review historical market trends for cotton and leather, and expert insights on current and future trends in sustainable apparel (vegan apparel demand, organic apparel demand)

([349]) Available at: https://sciencebasedtargetsnetwork.org/resources/

([350]) See: https://www.cisl.cam.ac.uk/news-and-resources/publications/raising-ambition-nature-fashion-apparel-and-textile-sector-primer

([351]) See: https://portals.iucn.org/library/efiles/documents/Rep-2016-001.pdf

- Technology: review trends in availability and cost of alternative man-made fiber, natural dyes, wastewater treatment technologies

The analysts compile and combine data into quantitative variables with baseline values: e.g. % growth in demand for sustainable apparel, cost difference between organic and traditional natural fibers, cost of wastewater treatment for apparel manufacturers, environmental policy index by country.

The team also decides to include a forward-looking analysis for the assessment to integrate potential future risks to the apparel sector and better inform future decisions. For this they decided to compare 2 scenarios with a business-as-usual case. They take the following steps to define scenarios and project relevant variables:

1. Define scenarios: 1. business-as-usual, 2. rapid nature and climate action, 3. extreme risk scenario, and associate narratives for each.
2. Project key variables using collected data or estimating based on research:
   (a) Use PRI IPR FPS scenario value drivers for projections on cotton and leather related transition risks,
   (b) Project other quantitative variables based on expert insights and scenario narrative (e.g. doubling BAU values of physical risks for extreme risks scenario, larger demand for sustainable apparel under the rapid nature and climate action scenario)

The variables reflecting the different sources of risks are projected for the different scenarios studied and will be used as a main component of the quantification of risks in step 2.3.

Systemic risk at industrial system level: The team also aims to consider how water scarcity and flood risks in main cotton and leather production location could significantly disrupt the supply chain and lead to yearlong shortages on essential inputs for the apparel sector. Then assess potential impacts through an extreme risk scenario analysis, with extreme pressure on input prices for apparel manufacturer and retailers.

2.2 Impacts and dependencies exposure

At this stage the analysis team is trying to assess the level of impact and dependencies of apparel sector companies to nature. This can be assessed using company specific data or sector averages.

For assessment of companies' impact the team collects counterparty level footprint data on water use, water pollution from sustainability reports. For companies not reporting on these metrics, the team decides to use life-cycle-assessment databases to collect average values on water use and water pollution of apparel manufacturer and combine with revenue or production data at counterparty level.

The team collects data on main production locations of counterparties, directly from counterparties or from third party provides. They overlay this location data with water scarcity and flood risks maps, to identify potential hotspots of dependency-related risks.

For the assessment of indirect (value chain) exposure, the team collects data on counterparty suppliers and customers (location of sales, purchase and sale quantity and revenue by supplier/customer). When this is not available, they decide to estimate the quantity of upstream material (fiber) used per year (e.g. cotton, leather) and assume potential production locations based on trade data. Using these sources, they then estimate footprint of upstream products, using average fiber land use and water footprint, and average PET production water footprint from LCA databases.

The team also collected data on main production locations of primary commodities – cotton, leather – and overlaps this information with deforestation rate data by country to flag potential for deforestation impact by country of production in the apparel value chain – this can be compiled in a qualitative variable.

2.3 Risk materiality

In order to estimate the economic impacts of counterparty's nature-related risks, the team defines the list of transmission channels which reflects how sources of risks and exposure can translate into economic impacts for companies. This includes an increase in cost of production due to strict water pollution regulations, an increase in cost of production due to decrease in water availability, a drop in demand due to exposure to deforestation in supply chain. They combine data on risks, exposure and transmission channels to quantify economic impacts for each counterparty.

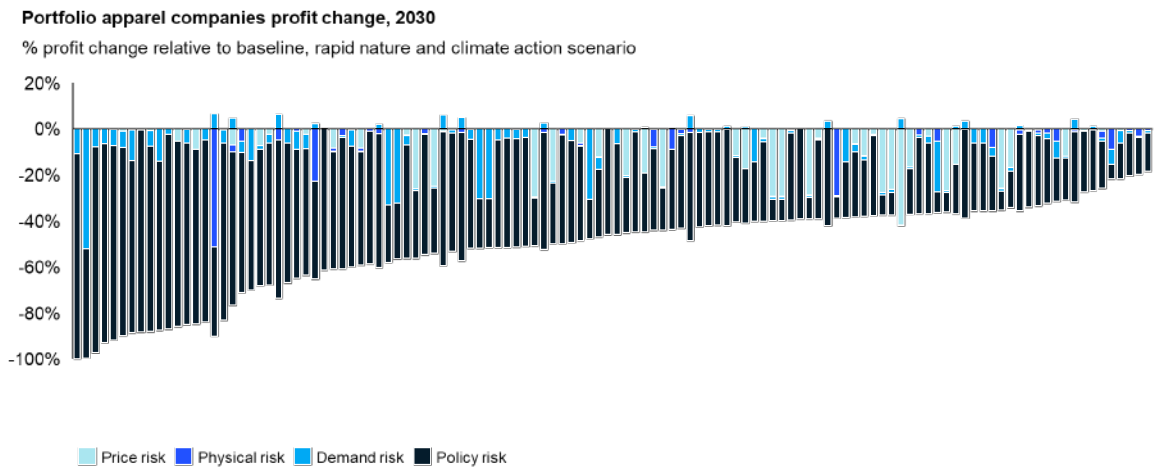
For instance, they combine the following data:

- Water pollution risk - combining % production in high regulation country, m3 wastewater produced per t-shirt, cost of additional wastewater treatment per m3 = % increase in cost of production
- Water scarcity risks = combining % of fiber input is water intensive (eg, leather), % of water intensive fiber is produced in water stressed area, % increase in price of leather due to water scarcity = % increase in cost of production of leather products

As the input data varies across scenarios and time, the outcomes of this analysis will provide different costs and revenues estimates for the 2 scenarios analysed.

The team had initially collected revenue, cost and profit data for each counterparty. They then apply the change in costs and revenue data to calculate new profits for each counterparty.

Illustrative outputs – counterparty-level profit impacts



2.3 Response to risk

The analysts observe that many apparel sector companies have the capacity to mitigate some of the economic impacts of nature-related risks through market and operational responses which can be implemented rapidly. They identify price increase and alternative sourcing as most likely short-term response from counterparties to mitigate risk. They collect data on price elasticity of main apparel products and costs of alternative sourcing to estimate new cost and revenue after mitigation.

They then apply new cost and revenues variables, integrating changes from mitigation actions to counterparty profit estimates, to get a mitigated view of profit impacts of nature-related risks.

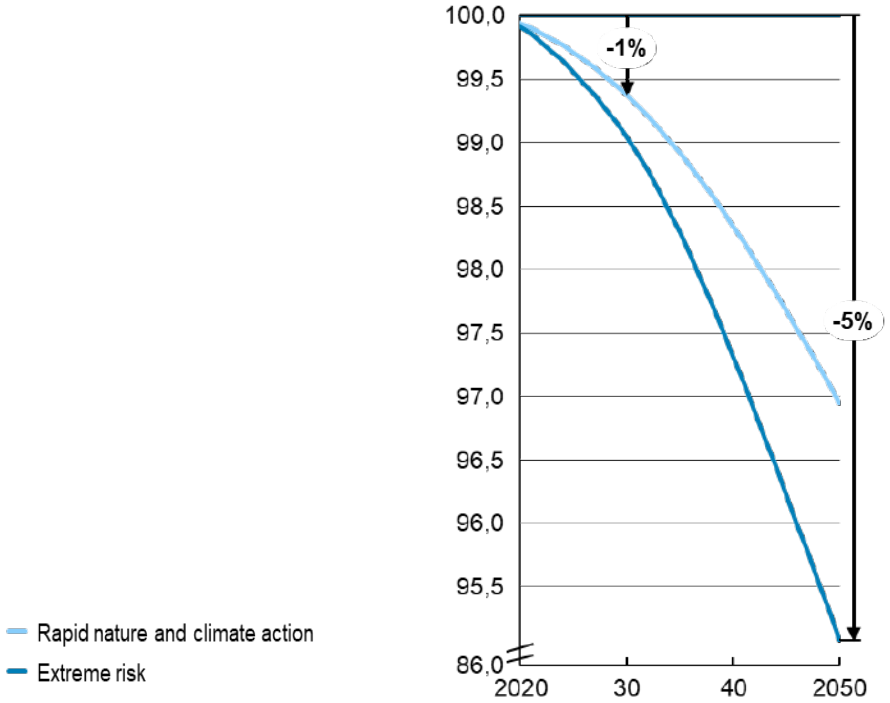
3.1 Financial impacts assessment

The analysis team then integrates the counterparty-level financial impacts into a portfolio-level financial analysis, to get an estimate of the changes in value of the portfolio for different scenarios. To conduct this part of the analysis they follow three main steps:

1. Assess potential portfolio valuation change based on counterparty value analysis using internal portfolio valuation tool and quantify resulting value at risk.
2. Based on the nature and magnitude of the risk, classify the outcomes of the value-at-risk analysis as a credit risk.
3. Stress-test the potential for contagion using the results of the extreme risk scenario, extrapolating across the whole sector.

The analysts compile the outputs of the financial assessment into a set of metrics commonly used within the risk framework of the asset manager.

Illustrative outputs – portfolio value projections compared to baseline



3.2 Mitigation actions

Based on the outputs of the assessment the asset manager decides to start engaging with the counterparties that showed the highest risk profile. This include discussing any existing mitigation plans and policies in place to reduce their impacts and dependencies on nature.

The asset manager takes this opportunity to engage into sizing the investment opportunities for companies with low or nature positive impacts in the apparel sector, investigating client's appetite of low impact portfolios and estimating potential returns to inform product development teams.

The asset manager includes the risk assessment approach into risk frameworks for apparel sector counterparties to be used in further portfolio risk assessments within the organization. They also decide to submit the results of the assessment to the TNFD to further collaborate with peers on improvements and extension to the risk assessment approach.

4.4.3. Case study 3 : Project-level assessment in real estate

In this case study, the financial institution is an investor, which already has some experience assessing nature-related risks across its portfolio, but it is their first project-level assessment. It covers the key steps and design choices to identify and assess risks through a quantitative analysis of risks for a targeted activity, relying on highly granular data on the project's sites and financials.

1.1 Intention setting

The investor is considering financing a real estate development project across multiple cities in Italy. The investor needs to be able to report on a biodiversity risk score for this project to feed into the overall due diligence process.

- Aim of assessment: assess the nature-related risks of a specific project for investment
- Use case 1: contribute to due diligence process
- Use case 2: feed into overall nature-related risk assessment of project portfolio across time
- Unit of analysis: The assessment will be at asset-level, to account for all asset-specific risks in the project
- Scope: The investor would like to carry an assessment for all assets of this real estate project

1.2 Risk identification

The investment will be covering both the construction and management of the real estate project, the risk assessment should therefore include these two areas of activities as well as some key components of the value chain including building materials such as wood, cement and steel.

The analysis team has defined a long list of key impacts and dependencies of the construction and real estate sector including:

- Solid waste generation from construction and demolition
- Soil and water pollution from construction sites
- Air pollution from construction sites
- Land conversion and deforestation
- Water consumption and dependency for construction and management
- Flood risks for management
- Soil erosion risk for management

Based on ENCORE materiality rating and project data availability, the investor decides to focus primarily on land conversion, water consumption and solid waste generation, as these have been identified as highly material for real estate activities.

2.1 Sources of financial risks

The main physical risk identified is related to decreasing water availability, with risk of droughts and water prices increase affecting the project and its value chain (price of raw materials, construction costs, requirements to put water efficient systems within the buildings). The investor compile data on water scarcity levels in all regions of focus for the project, using projections specific to Italy, and water availability gap by site (m3) and on the cost of alternative water source.

The analysis decides to collect information on sources of key transition risks around waste, water and land use. They carry the following research:

- Policy/regulations: review Italy's plan for protected areas expansion and maps of high biodiversity areas around selected sites for the projects, review EU regulations or draft regulations on solid waste for the real estate sector
- Technology: review trends in availability and cost of water treatment technologies, water efficient building materials, and construction waste recycling options

The team compiles qualitative and quantitative data on these risks and translate them into quantitative variables with baseline values: e.g. score for vicinity to a potential protected area, cost of solid waste recycling.

FORWARD-LOOKING ANALYSIS:

The investor decides to take a forward-looking view of risks with the relevant time horizon, for instance looking into a 5 years risk assessment for risks emerging from the construction phase of the project (e.g. regulations on waste and pollution, prices of construction materials). For risks emerging in the management phase, such as water scarcity and pollution from demolition, the investor looks into a much longer time towards 2050.

For the construction phase of 5 years, a static view is used to assess nature-related risks, which means that the analysis relies on current values for water scarcity, pollution regulations and technology availability.

For the longer timeline the investor decides to compare 2 scenarios: one in which stringent regulations on solid waste and water are put into place and one where water scarcity becomes extreme in some of the targeted sites. To build the extreme water risk scenario the analysis team uses water scarcity projections under 4C climate change from the WRI Aqueduct Water Risk Atlas. To build the strict regulations scenarios the analysis team assumes all solid waste will have to be recycled and wildlife protection measures will have to be implemented on the real estate sites by 2030.

Systemic risk at industrial system level: Consider how water scarcity risks in Italy could affect real estate investments across the country, with a significant drop in demand which could lead the value of real estate in the country to collapse as it spreads across the whole sector.

2.2 Impacts and dependencies exposure

For each site the investor collects project data which will enable to estimate potential impacts of the project on nature through land use, waste generation and use of natural resources. This data includes:

- Specific locations of building sites,
- Estimated raw materials inputs needs,
- Estimated waste generated during construction and demolition phase.

Similarly, the investor collects project data on estimated water consumed during construction and by unit during management phase. This should be included in the project design documentation and will directly feed into the estimate of the magnitude of risks related to water scarcity for the project. As each m3 of water consumed could be linked to increased cost of production and operation.

2.3 Risk materiality

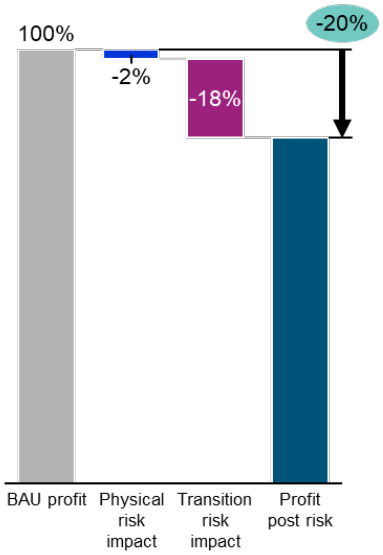
The investor then combines exposure data with risk variables to estimate the potential additional costs related to nature physical and transition risks for the project, both for the construction and management phase, and across the relevant timelines.

For instance, they combine the following data:

- Water scarcity risk: combining number of sites in high water scarcity risk area, m3 water consumed per unit for construction and management (per year), cost of alternative water source ($/m3)
- Land use risks: combining number of sites located in or near a potential future protected area, additional cost of construction for design that minimize disturbance to local ecosystem (e.g. reducing noise during construction, limiting soil disturbance around site, installing wildlife corridors on site)

The investor can combine the relevant variable and apply the additional costs estimated to the Profits and Losses (P&L) estimations of the project, including the construction and management phase. The investor can estimate cost for a business-as-usual scenario, and an “extreme risk scenario” and compare P&Ls calculated with baseline P&L for the project.

Illustrateive outputs - Project profit estimates including nature-related risks



2.3 Response to risk

The analysts then list potential actions that the real estate developer and manager could take to minimize risk of losses. This includes rent or selling price increase, water efficient building design, alternative locations. The team then collects data on potential cost, revenue implications of each of these actions.

Based on consultations with expert from the sector the analysts select the most likely response and integrate the cost and revenues variables for these responses to the project P&L estimates to get an alternative view of potential financial impacts.

3.1 Financial impacts assessment

The analysts team integrates the new estimates of profits and losses for the project into their internal valuation modelling to get an estimate of the potential return-on-investment across the two scenarios analysed. Depending on the results, the investor could classify the nature-related risks estimated for this project as potential market risk or credit risk.

3.2 Mitigation actions

The investor integrates the results of the financial assessment into the overall due diligence of the project. This will ensure that nature-related risks are taken into account in the investing decision.

Before taking a decision on the investment, the investor engages with the real estate developer and manager on their plan to mitigate nature-related risks and how it is included in the project financials. They can also discuss potential mitigation options, relying on the options selected in step 2.3.

4.4.4. Case study 4 : Asset-level risk assessment for a bank's business with an agricultural crop grower

In this case study, the financial institution is a regional bank, which already has some capabilities on nature-related risks assessment and needs to carry a more targeted assessment to make a decision on investment into a specific asset. It covers the key steps and design choices to identify and assess risks through an asset-level quantitative analysis.

1.1 Intention setting

A regional bank is planning to invest into the main asset of one of its farming clients, who is purchasing a new farm. Before investing the bank would like to assess the farm's exposure to nature-related risks. The bank will use the results of the assessment to feed into the overall risk scoring of the asset, which will guide the investment decision.

The assessment will be carried out for a farm unit with data at product and site level. After completion, this study can be used by the bank as an effective template for future assessments of similar agricultural assets.

1.2 Risk identification

The assessment will focus on the activities carried on the farm which are the growing and processing of two main crops : soybean and maize. The farm is located in the Eastern part of Brazil.

Based on TNFD sector guidance and news reports about soy and maize farming impacts on nature in Brazil, the analysis team decides to prioritize three main risk drivers: **(i) water scarcity, (ii) air and water pollution from fertilizers and pesticides, (iii) deforestation**.

A special attention in this step might be required to ensure compliance of the farmer to local nature protection regulations. Non-compliance would be an immediate indicator of excessive risk and, for that reason, would most likely imply suspending the assessment until compliance is ensured. While there might be multiple sources and particular procedures to obtain the required compliance information, in this case study we assume that the preliminary check of the farm passed successfully. The analysis team was able to access necessary information based on client documentation and government resources. ([352])

([352]) This includes reviewing the online database of the Brazilian Institute of the Environment and Renewable Natural Resources / Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, https://servicos.ibama.gov.br/).

2.1 Sources of financial risks

In order to quantify the sources of physical risks for this asset, the analysts collect geospatial data covering the asset location. The data provides insight for key state of nature variables including water scarcity levels maps and drought records. They also collect state-level future projections of water scarcity. ([353])

The analysis team uses the data to assess the levels of these risk drivers in the area relevant to the farm site and other locations for comparison. This provides an initial reference point on the positioning of the farm among similar assets regarding key nature risk drivers.

In order to better understand the sources of transition risks in the context of the farm asset, the analysts collect a set of qualitative and quantitative information on relevant policies, regulations, market trends and technologies. This includes:

- Policy/regulations: review of emerging regulations on water pollution, review restoration and protection trends in Brazil, review any restrictions on fertilizer and pesticides use in agriculture; review of official database on active environmental bans in farm's location
- Demand changes: review historical market trends and expert insights on the targeted crops: soy and maize
- Technology: review costs of low impact farming practices – e.g. available technology and cost for precision agriculture including ag tech solutions

Based on the data and information collected, the analysis team decides to establish scores for each transition risks identified – i.e. regulations on pesticides use, regulations on water pollution. They also define a set of variables to quantify additional transition risks such as shift in demand from Brazilian soy related to deforestation risks. They review their scoring and assumptions with legal and market experts.

2.2 Impacts and dependencies exposure

The analysis team is now aiming at assessing the potential impact of the farm on nature, especially for impacts directly linked with the risk drivers targeted for this assessment (pollution, land use, water scarcity). The team requires the client to provide estimates of main physical inputs and outputs of the farm including :

- Water consumption per ton of products (annual)
- Wastewater discharge per ton of products
- Pesticide and fertilizers use per ton of products
- Land used (exact location, size in ha, details of characteristics of the location before development)

([353]) Here climate projections can be used as reference points, international and national institutions can provide estimates, see for instance World Bank's climate knowledge portal: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15915-WB_Brazil%20Country%20Profile-WEB.pdf

The quantitative data obtained in this step are systematized by the bank into an input-output table for the farm on a per ton basis. The team also estimates potential air and water pollution emissions per ton of products based on pesticide and fertilizer used, using life-cycle-assessment database as reference (e.g. kg NOx emitted per kg of pesticide used).

2.3 Risk materiality

The analysis team can now estimate potential economic impacts of nature-related risks on the farm's operations, by combining data on the sources of risks and on the farm's impacts and dependencies and linking them to transmission channels variables. For instance, water pollution risks will be assessed by combining (i) the likelihood of regulations tightening on fertilizers use in Brazil, (step 2.1) (ii) the expected use of fertilizers by the farm (step 2.2), and (iii) the expected increase in cost of using fertilizers due to pollution prevention measures or risk of fines.

The analysts use integrated sector/country level forward-looking scenarios to inform pricing of inputs and outputs from step 1.2 as quantified in step 2.2. An example of such scenarios is the "IPR Forecast Policy Scenario + Nature" ([354]). Using historical baseline, the analysts calculate the relative changes of parameters of interest (step 1.2) as informed by a scenario into absolute value for estimating the materiality risk implications for each relevant input/output item.

Example historical baseline parameters and their scenario-informed projections (the numbers are used as placeholders for illustration purposes only)

Parameter	Units	Value
Soybeans price	$/t	394
Corn price	$/t	164
Wheat price	$/t	210
USD2BRL	$/BRL	0.2688
Diesel price	BRL/liter	3.40

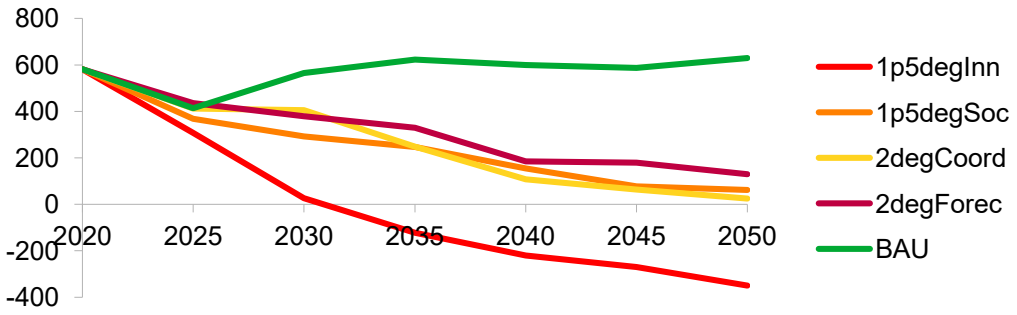
Price (relative)	2020	2030	2040	2050
Maize, $/t	100%	91%	94%	90%
Soybean, $/t	100%	76%	71%	72%
Wheat, $/t	100%	82%	72%	77%
Land, $/ha/year	100%	148%	205%	225%
GHG, $/tCO2		100%	195%	288%
GHG, $/tN2O		100%	195%	288%

At this stage the analysts compile a set of cost and price variables which reflect changing conditions due to nature-related risks for the farm. This includes increase in cost of water supply per ton of product, increase in cost of pesticides use per ton of products, changes in prices of products due to demand changes (directly derived from scenario outputs), increase in land management cost due to stricter restoration regulations.

The analysts team collect the baseline financial data from the client, to build a baseline profits and losses profile of the asset. They then adapt the profile by changing costs and revenues based on the variables modelled above. The resulting annual profit projection (see Figure below) provides information on combined environmental-economic risks implied by the considered scenario.

([354]) See: https://www.unpri.org/inevitable-policy-response/ipr-forecast-policy-scenario--nature/10966.article

Illustrative outputs - Combination of scenario-level risk indicators and asset-level financial data to estimate costs, revenues, and profits



(A) expected profits generated by the asset ($/ha) over the planning period under five scenarios

3.1 Financial impacts assessment

The analyst team integrates the new estimates of profits and losses for the asset into their internal asset valuation modelling to get an estimate of the potential return-on-investment across the different scenarios analysed above.

The outcomes of this analysis show that the asset could lose significant value under a strict regulation scenario, if the farm does not take steps to mitigate its impact on nature.

Based on the P&L and ROI profile of the asset, and an analysis of financial volatility within relevant commodity markets, the bank qualitatively estimates whether financial risk is acceptable for carry the investment forward.

3.2 Mitigation actions

The bank integrates its assessment of financial impacts of nature risks into the investment profile of the farm asset and undertake a set of precautionary actions to support the mitigation of risks for this investment. This includes:

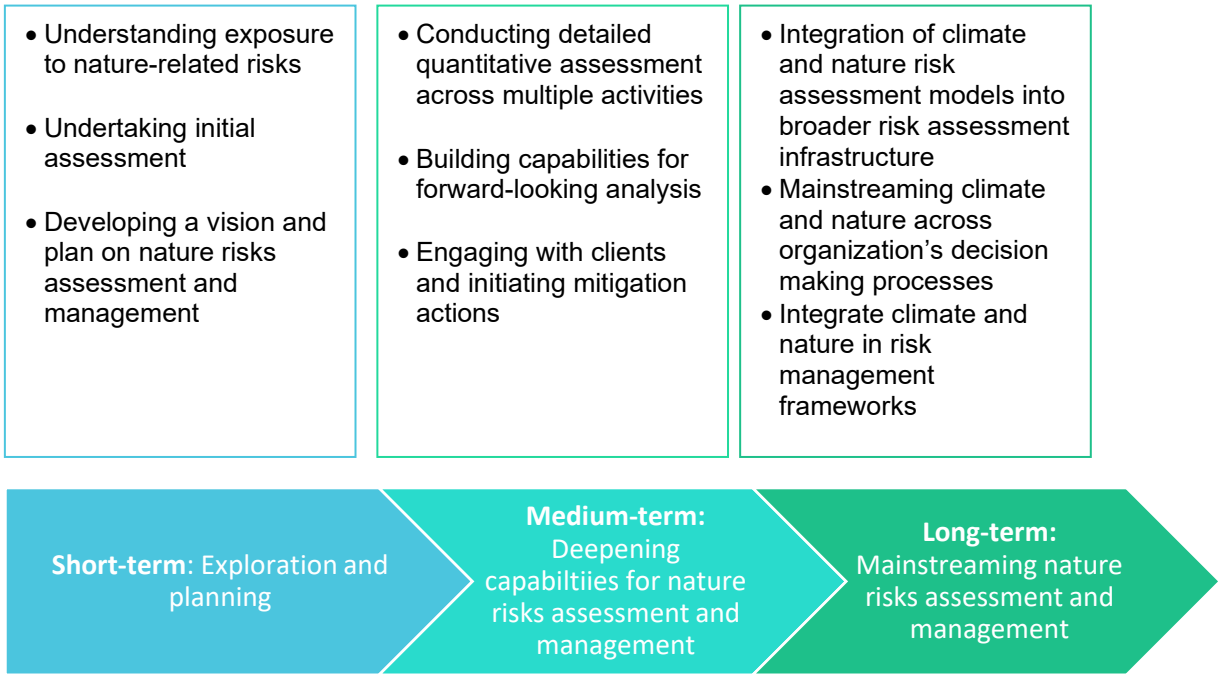
- Collecting and reviewing client's sustainability safeguards and transition planning
- Engaging with the client on specific mitigation actions to mitigate the most material risks such as water scarcity and pollution regulations; e.g. achieving fertilizer use reduction through high-precision application
- Establishing continuous monitoring and reporting on client's transition plan for the farm

4.5. Roadmap

Nature-related risks remains an evolving field, with fast-changing circumstances for financial institutions. As capabilities, data and regulations emerge, financial institutions

can build towards best practice and explore how nature-related risks assessment can support their activities and efforts towards financing a sustainable future.

This section provides an initial roadmap to help financial institutions frame plan how they can implement the risk assessment framework detailed above, through a phased approach. Financial institutions can define their next steps and structure their approach in three main phases: (i) a short-term exploratory and planning phase (~1 year), (ii) a medium-term deepening phase building strong capabilities (~3 years), (iii) a long-term mainstreaming phase integrating nature in their frameworks (~3-5 years).



4.5.1. Short-term – exploration and planning

Although alignment the data, metrics and approaches to assess nature-related risks is expected to improve over time, financial institutions can already start implementing this framework by piloting high-level or targeted assessments and building their capabilities towards best practice.

4.5.1.1. Key actions

In the short-term financial institutions can explore risk assessment methods and plan for future assessment and management through the following actions:

1. UNDERSTANDING EXPOSURE TO NATURE-RELATED RISKS

Financial institutions can benefit from getting a first view on potential exposure to nature-related risks. This would entail getting an overall view of the concentration of their activities by sectors and locations. Then financial institutions can start listing potential nature-related risks most commonly observed in the sectors and locations where their activities are most concentrated.

This high-level exposure overview can be conducted following the guidance presented in Step 1.2 – risk identification of this framework.

2. UNDERTAKING AN INITIAL ASSESSMENT

Financial institutions can learn from undertaking different approaches to nature-related risks assessment, especially identifying areas for further capabilities development. Depending on the types of activities, existing capabilities and access to data, financial institutions can decide to conduct an assessment at different levels of granularity. For instance, financial institutions interested in understanding their overall exposure and report at high level can develop a heatmap combining qualitative materiality ratings and quantitative exposure data. Financial institutions could also decide to conduct a more focused assessment integrated into a specific investment. This could take the form of a quantitative assessment for a specific sector or subsector for only one or two nature-related risk drivers (e.g. water or land use).

3. DEVELOPING A VISION AND PLAN ON NATURE RISK ASSESSMENT AND MANAGEMENT

At this stage, financial institutions can establish their ambition regarding nature risks assessment and management, defining clear objectives and timelines to reach these.

To build this plan financial institutions might have to start by evaluating their different options for quantitative risk assessment methodologies. Assessing their existing capabilities, data and synergies with ongoing climate risk assessments, they can define which methodological approach could be most relevant to develop. Based on this assessment of methodological approaches, financial institutions can also highlight which areas to focus on for future capabilities building and data acquisition.

Financial institutions could also start identifying a set of risk mitigation and management actions and prioritize them to be included into the plan. This could cover specific approaches for engagement with clients on nature-related risks, policies to be developed or reviewed.

4.5.1.2. Capabilities development

In the short-term financial institutions can focus building capabilities on data and establishing dedicated nature teams. Financial institutions could first assess their data needs and start building the data infrastructure for future collection. Establishing of small team dedicated to nature topics, or increasing the knowledge on nature within sustainability teams can also be a first step towards building organizational capabilities for nature risk assessment.

4.5.1.3. Methodological framework implementation

Financial institutions can focus on implementing Step 1.2 - Risk identification of this framework as means to understand their exposure at high-level and get started with initial knowledge on the main driver of nature-related risks.

To undertake an initial risk assessment, financial institutions can follow the 8 steps of this framework, especially phase 1 on scoping and phase 2 on entity-level assessment. This can be conducted using qualitative data or with a reduced scope.

4.5.2. Medium-term – deepening capabilities for nature risks assessment and management

In the medium-term financial institutions will want to establish robust capabilities for nature risk assessment, paving the way for a more systematic integration of nature into broader risk assessment and management approaches.

4.5.2.1. Key actions

Financial institutions can deepen their capabilities on nature-related risks assessment by conducting more comprehensive quantitative analysis, including exploring scenario analysis. They might also want to start implementing risk management measures by engaging with clients and initiate preliminary mitigation actions.

1. CONDUCT DETAILED QUANTITATIVE ASSESSMENTS ACROSS MULTIPLE ACTIVITIES

Financial institutions can refine and reproduce nature-related risk assessments across a broader set of activities and with increasing sectoral and locational granularity, as data becomes more available, and methodologies are refined.

More comprehensive risk assessments can cover a larger set of risk drivers and be applied across multiple areas of activities. For instance, all activities covered by an investor top portfolio could be assessed. A more detailed analysis could include quantitative value chain analysis using input-output tables. Financial institutions investing in projects could conduct high granularity asset-level assessments across all their new investments over a few years.

Financial institutions might also want to undertake a combined climate and nature risk assessment to evaluate the complexity of integrating both approaches into one assessment.

2. BUILD CAPABILITIES FOR FORWARD-LOOKING ANALYSIS

Financial institutions may want to start introducing forward-looking analysis in their nature-risk assessments, as the capabilities and understanding of nature risks becomes more established and scenario start to emerge.

Financial institutions can decide to use existing scenarios to undertake a forward-looking analysis for at least one sector and driver. They could also build their own in-house scenarios following the approach described in step 2.1.

3. START ENGAGING AND INITIATE MITIGATION ACTIONS

As financial institutions multiply and refine their nature-relate risks assessments, they could use the results to start engaging with clients on risk mitigation and transition

initiatives. Financial institutions could target high risk counterparties to discuss existing and additional measures put in place, and further establish timed risk mitigation targets.

Financial institutions can also start implementing mitigation actions defined previously, for instance starting to review their policies and implement nature-related exclusions or criteria in their risk management processes.

4.5.2.2. Capabilities development

During this phase financial institutions can focus on refining capabilities around locational granularity and scenario modelling to enhance the robustness of their risk assessment approach.

Financial institutions could also start integrating the different approaches developed for each sector and risk drivers into one common risk assessment model which can be reproduced across the organization.

4.5.2.3. Methodological framework implementation

At this stage all elements of the framework can be implemented, with particular emphasis on granular entity-level assessment, integration of company or asset-level footprint data and scenario modelling.

4.5.3. Long-term- Mainstreaming nature risks assessment and management

In the long-term financial institutions might work towards making nature an integrated part of their sustainability risk assessment and management, especially by integrating climate and nature models and management processes.

In the future, nature-related risks assessment could become a systematic component of risk assessment, integrated into due diligence requirements or stress-testing for instance. Financial institutions could mainstream climate and nature risk assessments across their organization by integrating them into key decision-making and reporting frameworks. This can include capital allocation strategies, lending policies, annual reporting and combined TCFD-TNFD disclosures.

Climate and nature risks assessment models could also be fully integrated into the organization’s existing risk modelling, which could then directly feed into key risk management indicators such as risk appetite and risk ratings.

Financial institutions might also consider mainstreaming nature across the organization by ensuring that nature and climate is included in decision frameworks at all levels and across all divisions, beyond risk teams.

In the long-term mitigation actions can be fully developed with effective monitoring of risk mitigation targets with clients and the development of transition opportunities.

5. Annex A – Tools and sectoral assessment

Table 5-1 Non-exhaustive overview of assessment tools principle

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE) ([355])	A tool and database to help users better understand and visualise the impact and dependencies of environmental change on the economy. By focusing on the goods and services that nature provides to enable economic production, it guides users in understanding how businesses across all sectors of the economy potentially depend and impact on nature, and how these potential dependencies and impacts might represent a business risk by means of qualitative materiality ratings.	X	X	X	✓	✓
Biodiversity Footprint for Financial Institutions Methodology (BFFI) ([356])	The tool provides a biodiversity footprint of the economic activities in which a financial institution invests and hence can be used as an investment criterion or monitoring progress. The methodology is based on Life Cycle Assessments and allows the calculation of the environmental pressures and the biodiversity impact of investments within an investment portfolio, an asset class, a company, or a project. The BFFI combines a quantitative footprint calculation (e.g. the number of ha where biodiversity loss occurs) and a qualitative analysis. In absence of company specific data, the environmental data in the EXIOBASE input/output-database (see further below) is applied for	X	X Inclusion of location specific characteristics	✓	✓	✓

([355]) ENCORE is developed by the Natural Capital Finance Alliance in partnership with UNEP-WCMC and was financed by the Swiss State Secretariat for Economic Affairs (SECO) and the MAVA Foundation.

([356]) Developed together with ASN Bank, PRé and CREM

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
	the assessment of land use, water use, emissions, etc. (pressures). EXIOBASE takes into account worldwide trade flows between countries and between sectors. ([357])		is limited			
Integrated Biodiversity Assessment Tool (IBAT) ([358])	IBAT offers visual geolocated data on global biodiversity by offering access to biodiversity datasets on 1) key biodiversity areas 2) protected areas and 3) distribution maps for IUCN Red List species. If the location of an investment activity is known, IBAT data can be helpful to inform the early-stage biodiversity risk screening and due diligence process. Ultimately, it can help to avoid investing in harmful activities in high biodiversity areas.	X	✓	✓	✓	X
Global Biodiversity score ([359])	The Global Biodiversity Score (GBS) is a corporate biodiversity footprint assessment tool which focuses on the biodiversity impacts of economic activities across their value chain. GBS's results are expressed in the MSA.km2 unit where MSA. The methodology makes it possible to quantify a business's biodiversity footprint all the way along the value chain. The CDC Biodiversité offers two types of GBS-based solutions for financial institutions. Non-listed assets (e.g, real estate, infrastructure, private equity) are grouped under the brand GBS for Financial Institutions (GBS FI). For listed assets (stocks and bonds), the Biodiversity Impact Analytics powered by the Global Biodiversity Score® (BIAGBS) database is co-developed with the data provider Carbon4 Finance (C4F). ([360])	X	Indirectly via Globio model	✓	✓	✓
Global Biodiversity Score for Financial	The tool is based on the GBS®, and hence provides information on the measured by the Mean Species Abundance. In summary, the GBSFI provides an overall and synthetic vision of the	X	Indirectly via	✓	✓	✓

([357]) Finance for Biodiversity Pledge (2022). Guide on biodiversity measurement approaches

([358]) IBAT is developed by BirdLife International, Conservation International, IUCN and UNEP-WCMC.

([359]) Developed by CDC Biodiversité's

([360]) CDC Biodiversité & Club B4B+ (2021). Global Biodiversity Score: Establishing an ecosystem of stakeholders to measure the biodiversity performance of human activities

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
Institutions (GBSFI) ([361])	biodiversity footprint of financial assets (e.g., listed equity) considering the full value chain of underlying economic activities (associated companies businesses).		Globio model			
Biodiversity Impact Analytics powered by the Global Biodiversity Score (BIA-GBS) ([362])	BIA-GBS provides an estimate of the potential biodiversity footprint of portfolios or indices considering the full value chain of underlying companies. BIA-GBS applies the GBS's Biodiversity Footprint Assessment tool which links economic activity to pressures on biodiversity and translates these pressures into biodiversity impacts. The current broad coverage of BIA-GBS makes it possible to evaluate a large number of portfolios as well as to estimate the first orders of magnitude for listed assets with sectoral benchmarks and indexes.	✓	Indirectly via Globio model	✓	✓	✓
Global Impact Database (GID) ([363])	GID provides environmental, social and economic impact estimates for countries and sectors in the global economy, for the purpose of impact reporting and impact management. GID's biodiversity model offers quantitative estimates biodiversity impact of companies, investment portfolios, and value chains.	✓	Indirectly via Globio model	✓	✓	X
The Biodiversity Risk Filter ([364])	The Biodiversity Risk Filter is a tool that enables companies and financial institutions to Inform (i.e. providing an overview of the industry-specific dependencies and impacts on biodiversity), Explore (i.e. collection of spatially explicit maps of the importance and local integrity of biodiversity), Assess	X	✓	✓	✓	✓

([361]) Developed by CDC Biodiversité

([362]) database is co-developed with the data provider Carbon4 Finance (C4F).

([363]) Developed by the Impact Institute

([364]) The BRF is developed by WWF

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
	(i.e. physical and reputational risks description), and Respond (identifying suitable actions to respond to the identified risks (under development)) to biodiversity risks. ([365])					
Biodiversity Impact Assessment Tool (BIAT) ([366])	The Biodiversity Impact Assessment Tool (BIAT) assesses the biodiversity impact of a company's business activities and supply chain, considering a set of environmental pressures on species and habitats. It enables investors to better understand and assess biodiversity risk in their portfolios in alignment with two of the most widely accepted biodiversity assessment metrics: Potentially Disappeared Fraction of Species (PDF) and the MSA.	X	✓	X	✓	X
Underpinning economic and environmental models						
ReCipe ([367])	ReCiPe is one of the most advanced and up-to-date impact assessment approaches accessible to practitioners of life cycle impact assessments. It deals with various environmental issues at the midpoint stage and subsequently consolidates these midpoints into three endpoint categories concerning the impact on Areas of Protection: damage to human health, damage to ecosystems, and damage to resource availability. ([368]) ReCipe expresses the potential disappearance of species in a certain area during a given time (Potentially Disappeared Fraction).	✓ (due to the inclusion of years as part of the Potentially Disappeared Fraction)	X	✓	✓	X

([365]) WWF (2023) Tackling Biodiversity Risk – A biodiversity risk assessment guide for companies and financial institutions, WWF Switzerland and WWF Germany in cooperation with Climate & Company, January 2023.

([366]) The Biodiversity Impact Assessment Tool is developed by ISS ESG

([367]) It was first developed in 2008 through cooperation between RIVM, Radboud University Nijmegen, Leiden University and PRé Sustainability.

([368]) European Commission and Business for Biodiversity (2021). Biodiversity Measurement Approaches – Summary descriptions. cooperation between RIVM, Radboud University Nijmegen, Leiden University and PRé Consultants (lead). The current 2016 version was developed through cooperation of Radboud University in Nijmegen, RIVM, NTNU Trondheim and PRé

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
GLOBIO Model ([369])	GLOBIO is a model used to simulate the impact of different human pressure scenarios on biodiversity, in the form of the Mean Species Abundance (MSA). It also has derivations: GLOBIO-Aquatic, GLOBIO-Species and GLOBIO-ES. All these were designed to inform and support decision-makers by quantifying global human impacts on biodiversity. The various anthropogenic pressures included are infrastructure, hunting, nitrogen deposition, habitat fragmentation, land use and climate change. The GLOBIO model calculated changes in MSA due to increasing environmental pressures over time which can be attributed to different responsible economic sectors. The model is closely connected to PBL's IMAGE model: an integrated assessment model that simulates the global environmental consequences of human activities by assessing the impacts on Impacts on climate change, land-use change, biodiversity loss, modified nutrient cycles, and water scarcity. Globio assesses the consequences of three of the Shared Socio-economic Pathways (SSPs) for terrestrial biodiversity intactness. ([370])	✓	✓	Globio: n/a Image: energy & agriculture	✓	X
Exiobase ([371])	EXIOBASE is a global, detailed Multi-Regional Environmentally Extended Supply-Use Table (MR-SUT) and Input-Output Table (MR-IOT). It was developed by harmonizing and detailing supply-use tables for a large number of countries, estimating emissions and resource extractions by industry. The MR-IOT can be used for the analysis of the environmental impacts associated with the final consumption of product groups. E.g. BFFI applies the environmental data in the EXIOBASE input/output-database to assess what land use, water use, emissions, etc. (pressures) are linked to the economic activities unless more accurate data (like company data) is available. EXIOBASE takes into account worldwide trade flows between countries and between sectors.	X	X	✓	X	✓

([369]) The GLOBIO model was developed by PBL Netherlands Environmental Assessment Agency.

([370]) See GLOBIO

([371]) See https://www.exiobase.eu/index.php/about-exiobase

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
EORA ([372])	EORA is a global supply chain database that consists of a multi-region input-output (MRIO) table model that provides a time series of high-resolution IO tables with matching environmental and social satellite accounts for 190 countries. The database includes, among others, 2720 line item environmental indicators covering GHG emissions, labour inputs, air pollution, energy use, water requirements, land occupation, N and P emissions, and primary inputs to agriculture (including 172 crops) from FAOSTAT.	X	X	✓	X	✓
	Biodiversity Metrices and Indexes					
Biodiversity Intactness Index (BII) ([373])	The Index shows how local terrestrial biodiversity responds to human pressures such as land use change and intensification. The BII is an estimated percentage of the original number of species and their abundance that remains in any given area, despite human impacts. The BII projects how index will change in response to future management decisions. This can help businesses and policymakers to evaluate different management strategies and opportunities. By combining satellite imagery, data collected in the field, existing studies, and algorithmic modelling, the BII can be applied across the world. The BII includes a baseline of the number and diversity of species at near-undisturbed sites and compares this baseline with biodiversity at sites with high human activity.	X	✓	X	✓	X
Species Threat Abatement and Restoration (STAR) Metric ([374])	The (STAR) Metric allows quantification of the potential contributions that species threat abatement and restoration activities offer towards reducing extinction risk across the world (drawing from the IUCN Red List of Threatened Species). As such, STAR helps identify actions that have the potential to bring benefits for threatened species, and it supports the establishment of science-based targets	X	✓	X	Positive impact	X

([372]) EORA

([373]) The BII is developed by the Natural History Museum

([374]) STAR is developed by BirdLife International, Conservation International, IUCN and UNEP-WCMC.

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
	for species biodiversity, and commitments relevant to the post-2020 biodiversity framework. STAR is one of the derived data layers in IBAT.					
Mean Species Abundance (MSA)	The Mean Species Abundance (MSA) metric is an indicator of local biodiversity intactness. The MSA values range from 0% to 100%, where 100% represents an undisturbed pristine ecosystem. (ratio between the observed biodiversity and the biodiversity in its pristine state). ([375]) The MSA is applied in the GLOBIO Model.	X	✓	X	✓	X
Potentially Disappeared Fraction of Species (PDF)	The Potentially Disappeared Fraction (PDF) metric quantifies the proportion of species richness that may face loss or extinction as a result of various environmental pressures, including land use changes, climate change, and other factors. The PDF can have a max value of 1 (or 100%), and all species disappeared or zero, meaning that all species are still there. Loss of species is calculated in a certain terrestrial area (hence m2) or marine/freshwater area (hence m3), during a certain time (hence the addition of years). ([376]) PDF is applied in the ReCipe model.	✓ (due to the inclusion of years)	✓	X	✓	X
Biodiversity Impact Metric (BIM) ([377])	The Biodiversity Impact Metric is a practical risk-screening tool for supply chain businesses that source agricultural commodities. For an agricultural commodity sourced from a particular location, the metric assesses impact based on: 1) the land area needed for the production of the commodity, 2) the proportion of biodiversity lost when the land is transformed to produce the commodity, related to the type of land use and its intensity; and 3) the relative global importance of that biodiversity. BIM is calculated by multiplying the three variables together. The outcome is expressed in	X	✓	X	✓	X

([375]) GLOBIO

([376]) https://pre-sustainability.com/articles/biodiversity-one-our-impact-on-biodiversity/

([377]) Developed by Cambridge Institute for Sustainable Leadership (CISL)

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
	"weighted hectares," which represent hectares weighted by biodiversity impact. Additionally, the metric can be divided by the total amount of purchased commodities to determine the impact per unit sourced. The BIM is a fully additive metric that encompasses commodities and geographies.					
Supporting databases and assessment tools						
MSCI – ESG controversy database ([378])	MSCI allows institutional investors to analyze a company's significant social, environmental, and governance impacts by identifying company involvement in major ESG controversies, adherence to international norms and principles, and assessing company performance with respect to these norms and principles. In risk assessment analyses, the database can be used to assess the reputational risk as was done in the biodiversity risk assessment by the Dutch National Bank (2020) ([379])	X	✓ (depending on relevance to report)	X	✓	X
RePRisk ([380])	RepRisk offers a largest database of ESG risks, combining advanced machine learning with human intelligence to identify material ESG risks to companies, real assets and countries. This database can support organisations in their due diligence processes and inform the reputational risk assessment	X	✓ (depending on relevance to report)	X	✓	X
Other useful tools that inform financial institutions on the drivers of biodiversity loss (but do not express it in biodiversity impact)						

([378]) MSCI (2023) MSCI ESG Controversies and Global Norms Methodology. MSCI ESG Research

([379]) DNB (2020). Indebted to nature. Exploring biodiversity risks for the Dutch financial sector

([380]) See RepRisk

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
Trase Earth tool ([381])	Trase is a data-driven transparency initiative that maps the trade and financing of commodities driving deforestation worldwide. This supply chain mapping approach brings together disparate, publicly available data to connect consumer markets to deforestation and other impacts on the ground. Trase Earth offers insights into risk management specifically for financial institutions (Trase Finance). Trase Finance uses regional and sector-level supply chain ([382]) information to assess the exposure of financial institutions to deforestation exposure. In doing so, Trase Finance brings transparency to hundreds of billions of dollars that directly and indirectly finance tropical deforestation each year. This enables financial institutions to improve the sustainability of their portfolios.	X	✓	✓	✓	✓
Agrobiodiversity Index (ABDI) ([383])	The Agrobiodiversity Index collects data on biodiversity across the often-disconnected domains of: Nutrition, Agriculture, and Genetic Resources. The Index can help Investors with rating of policies and performance of food and agriculture companies, and make appropriate decisions. ABDI assesses risks in food and agriculture related to low agrobiodiversity. The framework evaluates various facets of agrobiodiversity in consumption (healthy diets), agricultural production, genetic resource management, and relevant actions, commitments, and status through 22 indicators.	X	X	✓	n/a	n/a
READS ([384])	READS is a natural capital valuation and accounting approach that examines the connection between the activities of the energy sector and the various components of natural capital stocks (such as plants, animals, air, water, etc.) and the resulting ecosystem services. The relationship is measured in economic terms and dimensionless (no unit) Impact Units.	X	✓	X	✓	✓

([381]) Trace is a partnership between the Stockholm Environment Institute and Global Canopy

([382]) Note that only specific commodities and countries are included, such as Soy in Brazil and Beef in Paraguay.

([383]) ABDI is developed by Alliance of Bioversity International and CIAT

([384]) READS is developed by Repsol

Tool	Description	Temporal	Spatial	Intersectorality	Negative Impact	Dependencies
Integrated Valuation of Ecosystem Services and Tradeoffs (INVEST) ([385])	InVEST is a collection of models employed to map and value the goods and services from nature that sustain and fulfil human life. It enables the examination of the impacts of alterations to ecosystems on the provision of diverse benefits to people. The suite includes distinct ecosystem service models designed for terrestrial, freshwater, marine, and coastal ecosystems, as well as a number of "helper tools" to assist with locating and processing input data and with understanding and visualizing outputs.	X	✓	X	Positive impact (e.g., tons of carbon sequestered	✓
The Biodiversity monitor for Dairy Farms ([386])	The Biodiversity Monitor for Dairy Farming employs Key Performance Indicators (KPIs) to measure the impact of individual dairy farms on biodiversity, both on and beyond the farm. This standardized approach allows for the monitoring of dairy farmers' contributions to the preservation of the landscape. In addition to providing a metric for assessing the impact on the environment (both positive and negative), the Monitor proposes specific measures dairy farmers can take to improve biodiversity.	X	✓	X	✓	X

([385]) INVEST is developed by Stanford University

([386]) The Biodiversity Monitor is developed by FrieslandCampina, Rabobank and World Wide Fund for Nature.

Table 3-1A: Alignment of affected industries with NACE codes, complemented by corresponding data on gross capital formation, employment and gross value added

Industry	NACE codes	Gross Capital Formation (2021), in millions of Euros	Employment (2021), in thousand persons	Value added, gross (2020) in millions of Euros	EU economic relevance (%)
A. Agriculture, Forestry and Fishing					
Agriculture and Farming	A1: Crop and animal production, hunting and related service activities	65,012	6,388	191,232	2.28%
Forestry	A2: Forestry and logging	8,660	451	24,482	0.23%
Fishing and Aquaculture	A3: Fishing and acquaculture	2,462	140	5,448	0.06%
B. Mining and Quarrying					
Metals and Mining	B7: Mining of metal ores	1,714	53	6,797	0.05%
Oil and Gas	B6: Extraction of crude petroleum and natural gas	1,714	57	6,797	0.05%
C: Manufacturing					
Automobiles and Components	C29: Manufacture of motor vehicles, trailers and semi-trailers	12,487	3,210	249,055	1.53%
	C30: Manufacture of other transport equipment	2,449	837		
Biotechnology and Pharmaceutics	C21: Manufacture of basic pharmaceutical products and preparations	22,346	881	95,400	0.64%
Chemicals (and Biofuels)	C20: Manufacture of chemicals and chemical products	12,891	1,225	131,644	0.70%
Household and Personal Products	C22 Manufacture of rubber and rubber products, including C22.2: manufacture of plastic plates, sheets, tubes and profiles;	4,406	1,450	92,384	0.90%
	C32: Other manufacturing, except for C32.5	2,200	1,245	44,518	
Construction Materials	C23: Manufacture of other non-metallic mineral products	3,756	1,149	70,551	0.43%

Industry	NACE codes	Gross Capital Formation (2021), in millions of Euros	Employment (2021), in thousand persons	Value added, gross (2020) in millions of Euros	EU economic relevance (%)
Electronics	C26: Manufacture of computer, electronic and optical products, except for C26.6	35,902	1,126	82,627	1.40%
	C27: Manufacture of electrical equipment	10,879	1,435	94,863	
Food and Beverages	C10: Manufacture of food products	19,269	3,977	251,278	1.63%
	C11: Manufacture of beverages		396		
Machinery and Equipment	C28: Manufacture of machinery and equipment n.e.c	12,337	3,132	211,882	1.24%
Medical equipment and supplies	C32.5: Manufacture of medical and dental instruments and supplies	3,084	311	7,420	0.22%
	C26.6: Manufacture of irradiation, electromedical and electrotherapeuthical equipment	5,129	161	11,804	
Metal processing	C24: Manufacture of basic metals	5,224	1,003	54,870	1.50%
	C25: Manufacture of fabricated metal products, except machinery and equipment	6,355	3,466	172,606	
Oil and Gas - Mid and Downstream	C19: Manufacture of coke and refined petroleum products	3,568	145	8,791	0.09%
Pulp and Paper products	C17: Manufacture of paper and paper products	3,867	612	44,918	0.27%
Textiles, Apparels, Footwears and Accessories;	C13: Manufacture of textiles	2,093	588	59,109	0.52%
	C14: Manufacture of wearing apparel		940		
	C15: Manufacture of leather and related products		426		
D. Electricity, Gas, Steam and Air Conditioning Supply					
Energy Production	D35.11: Production of electricity	13,485	249	41,627	0.29%
Transmission and Distribution	D35.12 and 13: Transmission and distribution of energy	6,743	125	20,814	0.15%
Water and Waste Services / Water Utilities	E: Water supply, sewerage, waste management and remediation activities	37,140	1,617	118,097	0.98%

Industry	NACE codes	Gross Capital Formation (2021), in millions of Euros	Employment (2021), in thousand persons	Value added, gross (2020) in millions of Euros	EU economic relevance (%)
F: Construction					
Construction and Engineering	F41: Construction of buildings	83,195	3,932	118,097	3.38%
	C43: Specialized construction activities		7,649		
	C42: Civil engineering		1,294		
G. Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles					
Retail sale	G47: Retail trade, except of motor vehicles and motorcycles	35,994	16,198	528,146	4.58%
H. Transportation and Storage					
Air Transportation	H51: Air transport	8,985	341	11,734	0.18%
Water Transportation	H50: Water transport	2,582	284	26,685	0.15%
I. Accommodation and Food Service Activities					
Hospitality, Food and Beverage Services	I56: Food and beverage service activities	9,769	5,959	107,810	1.41%
Hotels and Lodging / Accommodation	I55: Accommodation	9,769	1,816	107,810	0.71%
J. Information and Communication					
Media and Communication / Digital Communication	J60: Programming and broadcasting activities,	1969.35	277	26,707	0.96%
	J61: Telecommunication	24,712	1,073	139,876	
Real Estate and Services	L68: Real estate activities	939,576	1,609	1,360,049	13.65%
Health Care Delivery	Q86: Human health activities	55,661	12,179	646,558	4.42%
Total		3,208,103	192,846	12,094,234	99.00%

6. Annex B – Stakeholder interview synthesis report

Introduction

This report provides an overview of approach, responses and results of the interviews conducted as part of this study. They key objectives of the interviews were:

- Task 1 – to identify methodologies deployed by financial institutions to integrate nature-related risk to risk their risk assessment frameworks. This includes their approaches to risk exposure (physical and transitional) and materiality analysis, gaps in these approaches, and key data sources which are fed into these analytical procedures. In addition, mitigation practices will be sought.
- Task 2 – to assess the materiality exposure of sectors and understand how exposures to the physical and transition risks that highly sensitive sectors are exposed to, transmit into financial risks for financial institutions.

In the selection of interviewees, two types of stakeholder groups were taken into account:

1) International organisations working on nature-risk assessment frameworks. These organisations have an overview of what is happening in the financial sector with respect to nature-risk assessments and have experience in developing (conceptual) frameworks applicable to various financial institutions. This type of organisation also includes non-governmental organistations (NGOs)
2) Financial institutions developing and implementing nature-risk assessment frameworks. They will have detailed knowledge about the challenges and opportunities in developing and applying the nature-related risk assessments and can inform us on how this study can support their work.

A long list with potential interviews was collected based on the project's team knowledge of the active players in this field, and complemented by stakeholders identified in the literature. The list was presented and discussed with, and approved by, the commissions.

The interview questions were developed based on the extensive literature that was conducted as part of Tasks 1 and 2. Interview questions served to validate findings as well as to inform any information gaps. While the interview questionnaire aimed to ensure the comparability of interview outputs, it was also customised to suit the specialisms and backgrounds of each stakeholder or stakeholder group.

The draft interview questions were shared with DG ENV prior to interviewing.

In total, 7 interviews were conducted between May and August 2023. The interviews have provided a variety of interview minutes, written feedback, and additional attachments and studies. All of this information is synthesised and analysed in the sections below to contribute to the interim report.

Risk definition and identification

Response to the question of importance of nature-related risk assessment approaches, now and for the future

The interview responses underscore the importance of a nature-related risk assessment frameworks for both the short and long term. It is also recognized that nature plays an important role in mitigating climate change. For Central and National Banks it is part of their mandate to maintain price stability, and hence it is important to understand both the financial and economic risks of climate change, biodiversity loss, and ecosystem degradation.

The primary drivers pushing financial institutions to adopt such risk frameworks are regulatory and stakeholder pressures. Upcoming regulations like the ERSS, along with voluntary standards like TCFD and TNFD, further drive the adoption of nature-related risk assessments. In addition, the ongoing work by financial institutions and voluntary standards shows the significance of raising awareness within the banking community about the existence of (e.g., physical, transitional, and systemic) risks and their potential transmission into financial systems. The understanding of these risks at the financial sector level might help better shaping of economic sectors in face of a transition to a greener future.

Response to the question on how nature-related risks are conceptualised and what progress is made in this.

Various stakeholders are at different stages of conceptualizing and evaluating nature-related risks and appropriate assessment approaches, while the majority of stakeholders are basing themselves on definitions and conceptualisation of the TNFD, and for risk assessments on ENCORE. The concept of nature-related ecosystem services is accepted and applied in risk assessment tools such as ENCORE. In one interview it was stated that financial institutions mainly apply footprinting, rather than assessing risks related to nature dependencies, due to more emerging footprinting tools available. However, the overall understanding remains qualitative, and more empirical research and analysis are required to quantify risks effectively.

The Task Force on Nature-related Financial Disclosures (TNFD) offers practical guidance on nature-related risk assessments. These assessments can inform strategies and decision-making for financial institutions and corporates. For financial institutions, risk assessments usually informs portfolio allocation, risk management, and investment strategies, while for corporates, they can support stress test their business strategies, identify options for risk mitigation and inform peer engagement to create industry-wide initiatives with positive impacts on nature. TNFD provides practical guidance around three risk assessment methods of varying complexity, these include heatmaps, asset tagging, and scenario-based approaches, to assess nature-related risks in specific sectors or companies with financial exposure. The three risk assessment methods can accompany each component of LEAP but especially Scoping (for heatmaps) and Assess (asset tagging and scenario-based approaches)

Response to the question what are the key components of climate risk assessments which you see as aligned/ similar to nature-related assessments?

Respondents highlighted the linkages between climate risk assessments and nature-related assessments. Often climate change risks frameworks are used as a starting point. As such,

Respondents highlighted the linkages between climate risk assessments and nature-related assessments. Often climate change risks frameworks are used as a starting point. As such, the TNFD is seen as an augmentation of TCFD, building on its risk definitions. By having climate frameworks in place, organizations can be encouraged to conduct nature-related risk assessments, as the existing TCFD framework can be used as a basis, reducing the burden on resources.

TNFD is closely monitoring the work of NGFS (Network for Greening the Financial System) on nature risk definitions and concepts. They anticipate the need for further work, potentially beyond version 1, to define systemic risk and possibly litigation risk in the context of nature-related assessments.

Risk assessment approaches

Responses to question on applied metrics to assess biodiversity-related financial risks

The stakeholders use various metrics and tools to assess biodiversity-related financial risk. The tools specifically mentioned in the interviews were ENCORE & IBAT. However, it was also mentioned that banks do not select one tool, but rather base the selection of various tools on the specific needs of the assessment.

ENCORE is used by Banks and other financial institutions to assess physical risk, footprint/impact on nature, and materiality. It maps the loan-to-loan data, including borrower characteristics to ultimately maps a borrower's dependency and impact on certain ecosystem services per country. This information is important to determine the exposure of a bank. In addition, EXIOBASE is deployed to describe supply chain dependencies. If a borrower is regarded as indirectly highly dependent on certain ecosystems,, then this information is complemented by supply chain information as per the ENCORE score. In their estimations, banks can define and apply a threshold to determine what can be regarded as 'high risk'.

Another approach taken to understand the exposure of a bank or company is to apply a 'relative scoring' (see also the Biodiversity Risk Filter by WWF). In an interview, it was referred to SBTN's approach for target setting for land and freshwater. ([387])

IBAT is a tool to assess the *impacts* of financed activities in a certain location. The tool provides granular location-specific information about the importance of nature (e.g. number of species under threat levels of extinction) in a certain area.

The Global Biodiversity Framework is taken into account when focusing on transition risks, which are linked to regulatory matters. The MSCI was also mentioned in one of the interviews as an important data provider (e.g., for assessing reputational risks), although most of these databases are private.

The quantification of risks at the macro level is often expressed in percentage of likely changes in GDP and banks apply micro approaches to assess the risk at the company level, but there

([387]) https://sciencebasedtargetsnetwork.org/how-it-works/set-targets/

is a risk of double counting if used together. Tools such as ENCORE and IBAT are a good starting point to understand nature-related risks, but it is challenging to translate those risks into financial risks. For instance, ENCORE provides basic exposure level, but without showing the potential impacts on profit, nor probability of default, as these are conditional (among others) also on regulatory developments, which is another dimension to company's impacts and dependencies on nature.

Footprinting tools, such as models and estimates, require caution to prevent overinterpretation since they are fundamentally built on assumptions. Whether utilising an MSA or PDF approach, the varying assumptions can lead to distinct outcomes. Although the footprint number may appear precise, it's important to acknowledge the underlying assumptions that influence its calculation. Subsequently, it footprinting is better applicable at sectoral level to understand biggest drivers. Using these tools at a higher level, will increase the number of assumptions and reduce the quality of results.

In addition, other **challenges** related to risk assessment tools were mentioned in the interviews, namely

- One significant gap is location data that is often not disclosed by companies. Knowing the location of economic activities and protected areas is crucial in assessing dependencies and impacts.
- On the financial risk side, it is the modelling that presents challenges, particularly in terms of substitution within a CGE (computable general equilibrium) framework. The substitution can occur between ecosystems or between natural capital and produced capital. Additionally, there could be a third dimension of substitution involving consumer choices, like shifting between products, which can impact risk assessments.

To address the challenges, interviewees promote a mix of quantitative and qualitative approaches, using available data for quantification and exploring qualitative methods to fill in the information gaps. It is important to improve data quality and connect assessment with reporting data, aiming at legislation on disclosure providing aid in obtaining relevant data.

In addition, the importance of an integrated approach is emphasized during the interviews, working collaboratively with climate risk assessments due to the strong feedback loop between climate and nature-related risks. One respondent believes that a joint climate and nature framework is the way forward.

Responses on the use of biodiversity-specific indicators in risk assessment approaches.

Two respondents indicate not to use biodiversity-specific indicators but use ENCORE as a starting point. One respondent is concerned with addressing the problem of scale for biodiversity-related indicators. The very detailed ones are difficult to use and the very aggregated ones are too difficult to zoom in. It could be an option to explore indicators for specific realms (like water) and start examining each realm separately. It would be ideal if there could be the same type of indicator as for climate change, i.e., GHG emissions, but this is impossible for biodiversity.

Responses on the use of financial indicators in risk assessment approaches

While the probability of default is an important indicator of financial stability, developing reliable models for nature-related risk assessment frameworks remains a challenge due to the

multidimensionality of nature. To express the risk magnitude, it is sufficient for some banks to say “high” or “very high”. It is sometimes argued that the current nature-related risk assessment frameworks calculate exposure and not risks. Exposure does not communicate complete information to investors, and it would be best to use financial indicators like the probability of default, reduction in profit or GDP, or other financial indicators.

The probability of default is used in climate change stress testing scenarios (e.g. climate change results in a temperature increase leading to economic damage, which can lead to a drop in GDP. However, for nature and biodiversity, there are no models to estimate a change in the economics of a firm resulting from nature change e.g. -20% change in “nature” results in a +10% increase in the probability of default.

As such, one respondent indicates that monetization is meaningless due to the range of uncertainty. At the same time, for financial estimates, the information needs to be granular e.g. what are the costs if one has to artificially replace water supply or pollination?

Responses to the question on transmission channels and on what level the assessments take place

Transmission channels are important to capture supply chain effects and intersectorability. This information is required to capture the macroeconomic impacts. The macro-level assessments are most applied by National and Central Banks. One interviewee indicates that the sector level is also useful to connect the marco with the micro level. However, another interviewee is less interested in the sectoral approach and would rather focus on finer assessment at the firm level. Recent studies show that a bottom-up approach is also useful to understand how companies may affect macro-level e.g. 75 per cent of companies (corresponding to around three million individual companies) are highly dependent on at least one ecosystem service ([388]). These calculations are based on ENCORE, and the next step is to add spatial location information on firms and come up with bank-related estimates. The respondent argues that to obtain meaningful information, it is important to avoid employing too basic methods. That is the reason why they would not focus too much on sectors and see a greater value in providing more detailed examples at a sub-sectoral resolution.

Responses to the question on sector-specific approaches

The responses emphasize the complexity of sector analysis, the importance of understanding supply chains, and the need for fine-grained assessments at the company and location-specific levels. The focus on risk assessment and stress testing is central, with regulators playing a critical role in addressing the gaps in climate and nature-related risks.

The impact on the supply chain is important to include, as without supply chain impacts the overall impact is significantly lower which in turn affects the ranking across countries. In the EU, we can say that we are green, but if we consider the supply chains of our imported products, this picture will change.

On of the difficulties with sectoral approaches is that there is no common definition of sectors, and that models use different sectoral typologies, which Banks and other financial institutions needs to translate to their sectoral classification.

([388]) See https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230608~5cffb7c349.en.html & https://www.ecb.europa.eu/press/inter/date/2023/html/ecb.in230608~7247c0aaca.en.html

In response to the question of handling variability within sectors it was answered that Banks assume that on the portfolio level, there will be a representative average. One can also differentiate between companies through use of case studies. Another way to show variability is to include location-specific information.

Data gaps and limitations

The multidimensionality and over-specificity of the issue of financial risks of biodiversity loss are the main limiting factors to the development of a comprehensive framework, as it requires a lot of location-specific data per company and to track value chains which are often limited available. In addition, it required complex modelling approaches to capture the non-linearity of biodiversity loss, ecosystems degradation, and the feedback loops with climate change. Below we summarise the data gaps, limitations, and challenges in more detail:

1) Understanding dependencies and (climate) feedback loops in ecosystems is crucial for assessing their impact on the global economy. While estimations of the impact of the collapse of a single ecosystem service, such as pollination, are possible, the existence of cascading effects and interconnections with other ecosystems, like the Brazilian forest's climate effects, makes isolated estimation impractical. Incorporating trade-offs with climate change into risk assessment tools is challenging because certain strategies for climate change mitigation and achieving net-zero goals may unintentionally cause negative effects on natural systems. This is also true for nature strategies that aim to support the achievement of net-zero goals or improve climate adaptation, such as nature-based solutions. The complexity of these interactions calls for a more comprehensive and holistic approach to risk assessment and policy-making;
2) The absence of location-specific data for most companies in FIs portfolios, which does not allow proper consideration of company-level risks beyond sector-wide considerations;
3) Use of *relevant* data. While the availability of data is an issue, it was also stressed that often financial institutions do not know how to prioritize the data. This goes hand in hand with lacking expertise in financial institutions and understanding the impacts and dependencies of companies on nature (see also points 1 and 7).
4) The lack of corporate reporting is an issue as the lack of company-specific data prevents steering corporations in the right direction (due to lack of transparency and traceability) and hampers risk assessment by financial institutions due to limited available company-specific data;
5) Obtaining the right data, with barriers such as paywall data, particularly for small banks with limited resources to conduct assessments and pay for data;
6) Difficulty to develop scenarios due to the complexity of biodiversity and limited available data, as well as less concrete (inter)national biodiversity targets compared to the climate change targets (e.g. limiting global warming to 1.5°C above pre-industrial levels). The readily available scenario of 'IPR Forecast Policy Scenario + Nature ([389])', focuses on transition risk; despite the challenges associated with the

([389]) See https://www.unpri.org/inevitable-policy-response/ipr-forecast-policy-scenario--nature/10966.article

development of scenarios reflecting biodiversity and ecosystems degradation risk, there does not seem to be an alternative approach providing tractable inputs for the related financial risk assessment;

7) The lack of resources employed by financial institutions to get started with the incorporation of nature-related risks into their risk frameworks, if not via external support of consultancies or third-party data provider. Financial institutions are often occupied enough with the incorporation of climate-related risk in their overall risk assessment frameworks;
8) The need for inclusion of both impacts and dependencies in risk assessment tools (and how they relate to transition and physical risks and their inter-dependencies);
9) Sector-specific risk classifications do not account for value chain impact but only focus on direct operations (which is the case with ENCORE).

Respondents emphasised that regulation is key in addressing the above-described limitations. In addition, it was mentioned that industries and respective companies with similar or overlapping supply chains should collaborate on traceability. These collaborations are slowly starting, but there are concerns about confidentiality.

In addition, it was asked to what extent this project could be **beneficial or complementary** to the ongoing work in the development and implementation of nature-risk assessment frameworks.

One respondent expressed the need for a systematic framework that includes a step-by-step approach. Two respondents indicated the need for a European-specific nature-risk assessment framework as other frameworks under development have a more global approach.

Mitigation approaches and integration into processes

Mitigation approaches mentioned in the interviews involve client engagement, exclusion policies ([390]), and a focus on improving practices through supply chain engagement and positive investments. Asset managers take a leading role in mitigation due to their experience with client engagement, while commercial banks face challenges in assessing their clients' actions. Stakeholder pressure and the influence of multilateral development banks (showcasing best practices by project-based nature finance) are crucial factors in driving effective mitigation strategies.

Considering the early stage of nature-related risk assessment approaches and the numerous underlying assumptions, one interview revealed that no direct action (e.g., rebalancing portfolios) has been taken. Instead, financial institutions tend to emphasize raising awareness among their clients. However, they are also struggling with questions regarding how their clients can effectively manage these associated risks, in particular if they are bound to EU policies.

A bank representative noted that the focus - at this moment - is on assessing risks rather than seeking positive impacts. However, the long-term mitigation of these risks is very important. This development should go similar to climate change-related risk mitigation approaches:

([390]) Like the Do No Significant Harm principles as part of the Taxonomy regulation

starting from understanding and assessing physical risks to improving investments in positive activities.

One NGO indicates that there is no fixed pathway for mitigation, but the preference is for engaging with companies. Ideally, to engage and work along the supply chain, instead of the bad guys staying behind.

Conclusion

The responses from the interviews highlight the importance of nature-related risk assessment frameworks for both the present and the future. Regulatory and stakeholder pressures are driving financial institutions to adopt nature-related risk frameworks, with upcoming regulations like the ERSS and voluntary standards like TCFD and TNFD playing significant roles in this adoption. While progress has been made in conceptualising and assessing nature-related risks, more empirical research and analysis are needed to quantify these risks effectively. The TNFD offers practical guidance in this area and the definitions provided by the TNFD are used as a starting point.

Stakeholders employ various metrics and tools to assess biodiversity-related financial risk. Two specific tools mentioned in the interviews are ENCORE and IBAT. However, banks do not rely on a single tool; instead, they choose from a range of tools based on the specific requirements of each assessment.

Challenges and data gaps exist in quantifying nature-related risks due to the multidimensionality and complexity of the issue. Location-specific data, a lack of corporate reporting, and limited expertise and understanding of impacts and dependencies on nature are some of the hurdles faced in risk assessment. To address these limitations, interviewees advocate for a mix of quantitative and qualitative approaches, utilising available data for quantification and exploring qualitative methods to fill information gaps.

Mitigation approaches involve client engagement, exclusion policies, and supply chain engagement to improve practices. Asset managers are leading in this space due to their experience with client engagement, while commercial banks face challenges in assessing their clients' actions. Stakeholder pressure and the influence of multilateral development banks are instrumental in driving effective mitigation strategies.

Overall, an integrated approach to risk assessment, collaborating with climate risk assessments, is emphasised due to ongoing progress made in climate risks assessments frameworks and the strong feedback loop between climate and nature-related risks. The development of systematic nature-risk assessment frameworks, along with regulatory support, can address the current data gaps and limitations and guide the financial sector and corporations in mitigating nature-related risks effectively.

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