



SCIENCE FOR POLICY BRIEF

The European Commission's Knowledge Centre for Biodiversity



The EU economy's dependency on nature

HIGHLIGHTS

- DG ENV submitted a policy request to the EC Knowledge Centre for Biodiversity (KCBD) to produce an estimate of the EU economy's dependency on nature by carrying out a similar analysis to that developed by PricewaterhouseCoopers with the World Economic Forum in 2020. This work was carried out by JRC.B1 and JRC.D6.
- The study combines the use of the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) framework and of an input-output model to produce a “high-level” estimate of the dependencies of all economic sectors on ecosystem services, outlining the assumptions made.
- Depending on the version of ENCORE used and on some other assumptions, between 19% and 36% of the EU's gross value added (GVA) is found to be highly dependent on ecosystem services. The analysis further shows that the entire economy is susceptible to nature degradation, since all sectors are interconnected via supply and customer links.
- The approach is a possible entry point for more advanced analysis, which might also use regional geospatial data on ecosystem services or scenarios.

INTRODUCTION

The European Commission (EC)'s Directorate-General for Environment (DG ENV) submitted a policy request through the ticketing system of the EC Knowledge Centre for Biodiversity (KCBD) to produce an estimate of the EU economy's dependency on nature, by replicating at EU level the approach used in the 2020 analysis by PricewaterhouseCoopers (PwC) and the World Economic Forum (WEF) [1], which estimated the proportion of global gross domestic product (GDP)

that is highly or moderately dependent on ecosystem services. The objective was to inform policymakers about the importance of ecosystem services for the EU economy. To answer this request, a study was carried out by the Joint Research Centre's units JRC.B1 and JRC.D6.

Scientific evidence on the widespread degradation of nature, including biodiversity loss and the decline of ecosystem services [2], and the possible adverse effects on societies, economies and their financial

systems, have increasingly caught the attention of policymakers. This has led to ambitious commitments on nature protection and restoration, including financial commitments, as reflected in the European Green Deal, the EU Biodiversity Strategy for 2030 and, at the international level, the Kunming-Montreal Global Biodiversity Framework. Consequently, there is an urgent need to enhance our understanding and improve the integration of natural capital and its ecosystem services into economic modelling to better inform policy and decision-making⁽¹⁾. Ecosystem services can provide physical inputs to production, such as water or biomass, but also enable economic activities by creating favourable conditions, such as soil fertility or protection from floods and other natural disasters. While this relation between nature and the economy is undisputable (in particular for the primary sectors), the specific relationships between ecosystem services and economic production processes are often not immediately apparent. Furthermore, these relationships are in many cases location-specific and context-dependent, giving rise to substantial data and modelling challenges.

Approaches focusing on analysing the dependencies of economic sectors on ecosystem services can help identify the sectors potentially most exposed to nature degradation, both directly and indirectly, and assess the importance of these sectors for the economy. To this end, the study provides insights into the share of the EU's gross value added (GVA)⁽²⁾ that may be directly and/or indirectly affected by nature degradation and the disruption of ecosystem services. This corresponds to the share of GVA from economic activities for which failure to maintain the capacity of ecosystems to deliver services could entail significant costs, or even stop production.

This study replicates the approach of PwC with WEF ([1], [3]): it combines the use of the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) framework [4] and of EXIOBASE input-output tables [5] to take into account sectoral interdependencies across value chains. Such analysis, with a very stylized view in terms of economic sectors and ecosystem services covered, aims to provide a "high-level" picture of the dependencies, abstracting from geographic variation and producing a highly aggregate estimate. This study outlines the

assumptions made and conducts a sensitivity analysis to explore the implications of some of these necessary simplifications and assumptions.

DATA AND METHODOLOGY

The ENCORE approach: dependencies of economic sectors on ecosystem services

ENCORE is a holistic mapping that provides information on dependency linkages between different economic sectors and 25 ecosystem services, which belong to the broad categories of provisioning, regulating and maintenance, and cultural services⁽³⁾. The dependencies of sectors on individual ecosystem services are provided as "materiality ratings". The ratings, which are based on literature reviews complemented by expert assessment (including the use of quantitative indicators when available), range on a 5-level scale, from "Very Low" to "Very High" dependency (in addition to "No link"). "High" and "Very High" materiality ratings indicate a high potential exposure to nature-related shocks or deteriorating trends, which means that the disruption of an ecosystem service could cause production failure and severe financial loss.

The latest version of ENCORE of July 2024 (hereafter 'ENCORE 2024') follows the United Nations (UN) System of Environmental-Economic Accounting – Ecosystem Accounting (SEEA-EA) categorisation of ecosystem services and the UN Industrial Classification of All Economic Activities (ISIC) sector classification. Compared to the previous version of ENCORE, this change has the advantage, for EU-level analyses, of ensuring consistency with the NACE classification (Nomenclature statistique des Activités économiques dans la Communauté Européenne).

According to the materiality ratings for ecosystem service dependencies for different sectors as provided by ENCORE 2024 (Fig. 1), the primary sectors (agriculture, forestry, fisheries and aquaculture) are highly dependent on a wide range of ecosystem services (i.e. with a "High" or "Very high" materiality rating), while mining and manufacturing are only highly dependent on few services.

⁽¹⁾ In this regard, the European Commission has been supporting the development of ecosystem accounting since 2011, notably through the [INCA](#) (Integrated System of Natural Capital Accounts) project, using biophysical modelling and accounting procedures to compile supply and use tables both in physical and monetary terms, as well as geospatial maps.

⁽²⁾ GVA measures the total value of goods and services produced within a country, but, in contrast with GDP, it excludes taxes and includes subsidies, providing a more accurate representation of the actual production process.

⁽³⁾ The full list of ecosystem services considered in ENCORE 2024 can be found [here](#) (Dependencies/Ecosystem Services).

These materiality ratings reflect the direct nature dependencies of sectors based on their own operations, but not those that occur through value chains, both within countries and across international value chains. To have a more complete picture of how the contributions from ecosystem services diffuse via inputs to other sectors, ENCORE is applied

to EXIOBASE multi-regional input-output tables. This allows calculating both direct dependencies and indirect dependencies through value chains (upstream and downstream). While the EXIOBASE research dataset is not maintained by Eurostat, it is updated yearly with a two-year lag by the academic community. The choice of using EXIOBASE is

Figure 1 - Examples of materiality ratings for ecosystem service dependencies in ENCORE 2024

Exiobase	Exiobase	DEP_ANIMALBENER	DEP_BIOMASS	DEP_SOLIDWASTEREMEDIATION	DEP_SOILRETENTION	DEP_WATERPURIF	DEP_SOILQUALITYREG	DEP_DILUTIONBYATMOSPHERE	DEP_BIOLOGICALCONTROL	DEP_AIRFILTRATION	DEP_FLOODCONTROL	DEP_GENETICWATERIAL	DEP_GLOBALCLIMREGUL	DEP_WATERSUPPLY	DEP_NURSERY	DEP_NOISE	DEP_SENSORIALIMPACTS	DEP_LOCALCLIMREGUL	DEP_POLLINATION	DEP_STORMMITIGATION	DEP_WATERFLOWREGUL	DEP_RAINFALLPATTERNREGUL	DEP_RECREATIONRELSERV	DEP_VISUALAMENITY	DEP_EDUCATIONRELSERV	DEP_SPIRITUALRELSERV
i01.a	Cultivation of paddy rice	3	5	3	5	5	5	3	4	3	4	5	5	4	1	0	0	5	1	5	4	5	0	0	0	0
i01.b	Cultivation of wheat	3	5	3	5	5	5	3	4	3	4	5	5	4	1	0	0	5	4	4	4	5	0	0	0	0
i01.c	Cultivation of cereal grains nec	3	5	3	5	5	5	3	4	3	4	5	5	4	1	0	0	5	4	4	4	5	0	0	0	0
i01.g	Cultivation of plant-based fibers	3	5	3	5	5	5	3	4	3	3	5	5	4	1	0	0	5	5	3	4	5	0	0	0	0
i01.h	Cultivation of crops nec	3	5	3	5	5	5	3	4	3	4	5	5	5	1	0	0	5	3	4	5	5	0	0	0	0
i01.i	Cattle farming	0	5	3	5	4	4	2	3	3	3	3	3	3	4	1	1	1	3	0	4	4	5	0	0	5
i01.j	Pigs farming	0	4	3	3	4	4	2	3	3	3	3	3	3	4	1	1	1	3	0	4	4	5	0	0	5
i01.k	Poultry farming	0	4	3	3	4	2	2	3	3	3	3	3	3	3	1	1	1	3	0	4	4	5	0	0	5
i01.l	Meat animals nec	0	4	3	3	4	2	2	3	3	3	3	3	3	4	1	1	1	3	0	4	4	5	0	0	5
i01.m	Animal products nec	0	4	3	3	4	4	2	3	3	3	3	3	3	4	1	1	1	3	0	4	4	5	0	0	5
i01.n	Raw milk	0	5	3	5	4	4	2	3	3	3	3	3	3	4	1	1	1	3	0	4	4	5	0	0	5
i01.o	Wool, silk-worm cocoons	0	3	1	3	4	2	1	2	1	1	3	2	4	1	1	1	1	3	0	2	3	3	0	0	5
i01.w.1	Manure treatment (conventional), storage and land application	0	3	1	3	4	2	1	2	1	1	3	2	4	1	1	1	1	3	0	2	3	3	0	0	5
i01.w.2	Manure treatment (biogas), storage and land application	0	3	1	3	4	2	1	2	1	1	3	2	4	1	1	1	1	3	0	2	3	3	0	0	5
i02	Forestry, logging and related service activities (02)	3	5	3	5	0	4	0	4	4	3	0	0	3	0	1	1	0	0	2	3	0	0	0	0	0
i05	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing (05)	0	5	5	5	5	3	3	4	2	3	4	5	4	5	0	0	3	0	4	4	5	0	0	0	5
i10	Mining of coal and lignite; extraction of peat (10)	0	2	2	3	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i12	Mining of uranium and thorium ores (12)	0	1	2	3	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i13.1	Mining of iron ores	0	1	2	3	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i13.20.11	Mining of copper ores and concentrates	0	1	2	3	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i13.20.15	Mining of lead, zinc and tin ores and concentrates	0	1	2	3	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i13.20.16	Mining of other non-ferrous metal ores and concentrates	0	1	2	3	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i14.1	Quarrying of stone	2	2	0	4	5	0	3	0	1	4	0	4	4	0	1	2	2	0	3	4	5	0	0	0	0
i15.f	Processing of dairy products	0	0	3	2	5	0	2	1	1	3	0	1	4	0	0	1	2	0	3	4	0	0	0	0	0
i15.g	Processed rice	0	0	3	2	5	0	2	1	1	3	0	1	3	0	0	0	2	0	3	3	0	0	0	0	0
i24.b	N-fertiliser	0	0	3	3	3	0	2	0	1	3	0	1	4	0	1	1	2	0	3	4	3	0	0	0	0
i24.c	P- and other fertiliser	0	0	3	3	3	0	2	0	1	3	0	1	4	0	1	1	2	0	3	4	3	0	0	0	0
i24.d	Chemicals nec	0	0	2	3	3	0	2	0	1	3	0	1	3	0	1	2	0	3	3	1	0	0	0	0	0
i25	Manufacture of rubber and plastic products (25)	0	0	2	2	3	0	0	0	1	3	0	1	2	0	1	0	2	0	3	3	0	0	0	0	0
i26.a	Manufacture of glass and glass products	0	0	3	2	3	0	0	0	1	3	0	1	3	0	1	1	2	0	3	3	3	0	0	0	5
i26.a.w	Re-processing of secondary glass into new glass	0	0	3	2	3	0	0	0	1	3	0	1	3	0	1	1	2	0	3	3	3	0	0	0	5
i26.b	Manufacture of ceramic goods	0	0	3	2	3	0	2	0	1	3	0	1	3	0	1	1	2	0	3	3	2	0	0	0	5
i26.c	Manufacture of bricks, tiles and construction products, in baked clay	0	0	3	2	3	0	2	0	1	3	0	1	3	0	1	1	2	0	3	3	2	0	0	0	5
i26.d	Manufacture of cement, lime and plaster	0	0	3	2	3	0	2	0	1	3	0	1	3	0	1	1	2	0	3	3	2	0	0	0	5
i26.d.w	Re-processing of ash into clinker	0	0	3	2	3	0	2	0	1	3	0	1	3	0	1	1	2	0	3	3	2	0	0	0	5
i26.e	Manufacture of other non-metallic mineral products n.e.c.	0	0	3	2	3	0	2	0	1	3	0	1	3	0	1	1	2	0	3	3	2	0	0	0	5
i40.11.b	Production of electricity by gas	0	0	3	3	3	0	0	0	1	3	0	3	4	0	1	0	2	0	2	4	0	0	0	0	0
i40.11.c	Production of electricity by nuclear	0	0	2	4	3	0	1	0	1	3	0	1	4	0	1	0	2	0	2	4	0	0	0	0	0
i40.11.d	Production of electricity by hydro	0	0	2	5	2	0	0	0	0	5	0	3	5	0	0	0	2	0	3	5	0	0	0	0	0
i40.11.e	Production of electricity by wind	0	0	0	3	0	0	0	0	0	4	0	5	1	0	3	0	3	0	3	3	0	0	0	0	0
i40.11.f	Production of electricity by petroleum and other oil derivatives	0	0	3	3	3	0	0	0	1	3	0	3	4	0	1	0	2	0	2	4	0	0	0	0	0
i40.11.g	Production of electricity by biomass and waste	0	4	2	2	3	0	0	0	1	1	0	1	2	0	0	0	2	0	1	2	3	0	0	0	0
i40.11.h	Production of electricity by solar photovoltaic	0	0	0	3	0	0	0	0	0	3	0	5	3	0	1	0	3	0	3	3	0	0	0	0	0
i45	Construction (45)	1	0	1	4	3	0	2	0	1	3	0	3	3	0	1	1	2	0	3	3	5	0	0	0	0
i45.w	Re-processing of secondary construction material into aggregates	1	0	1	4	3	0	2	0	1	3	0	3	3	0	1	1	2	0	3	3	5	0	0	0	0
i50.a	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories	0	0	0	3	0	0	0	1	0	2	0	1	1	0	0	0	2	0	2	2	1	0	0	0	0
i50.b	Retail sale of automotive fuel	0	0	0	3	0	0	0	1	1	3	0	1	2	0	0	1	2	0	3	3	1	0	0	0	0
i51	Wholesale trade and commission trade, except of motor vehicles and motorcycles (51)	0	0	0	2	0	0	0	1	0	2	0	1	3	0	0	0	2	0	2	3	1	0	0	0	0
i52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52)	0	0	0	3	0	0	0	1	1	3	0	1	2	0	0	0	2	0	3	3	1	0	0	0	0
i55	Hotels and restaurants (55)	0	0	3	2	5	0	0	1	1	1	0	1	2	0	0	3	3	2	0	2	1	5	5	5	5
i60.1	Transport via railways	0	0	0	4	0	0	1	1	1	3	0	3	1	0	1	0	2	0	3	2	3	0	5	0	0
i60.2	Other land transport	3	0	0	2	0	0	1	0	1	3	0	3	1	0	1	0	2	0	3	2	3	0	5	0	0
i60.3	Transport via pipelines	0	0	0	4	0	0	0	1	3	3	0	1	2	0	0	0	2	0	2	3	0	0	0	0	0
i61.1	Sea and coastal water transport	0	0	0	2	3	0	1	1	1	4	0	3	2	0	0	0	2	0	4	3	3	5	5	0	0
i61.2	Inland water transport	0	0	0	3	3	0	1	1	1	4	0	3	2	0	0	0	2	0	3	3	5	5	5	0	0
i62	Air transport (62)	0	0	0	2	0	0	1	1	1	1	0	3	1	0	1	0	2	0	2	2	5	0	5	0	0
i63	Supporting and auxiliary transport activities; activities of travel agencies (63)	0	0	0	3	0	0	0	1	1	1	0	1	0	0	0	0	2	0	2	1	1	0	0	0	0
i64	Post and telecommunications (64)	0	0	0	1	0																				

motivated by its completeness in terms of countries, its granularity in terms of sectors and its widespread use in macroeconomic environmental analysis literature⁽⁴⁾.

Several modelling assumptions underlie this approach and may have an impact on the results. First, the qualitative ratings in ENCORE are converted into a 0-5 scale. This is commonly done in the literature, but in this application, it entails the assumption that these ratings can be interpreted as placed on a linear scale, and can be linearly averaged across production processes or sectors.

Second, the ENCORE classification of economic activities (271 sub-sectors in line with the ISIC standard) has to be converted into the 163-sector classification of EXIOBASE. This requires some choices to be made, for instance because some sectors in EXIOBASE are a combination of sectors in ENCORE. There are also differences in the sectoral classification between previous ENCORE versions and the latest one (for example, previous versions included a differentiation between small- and large-scale farming, whereas in the latest version, the division of crop production into economic activities is different). Moreover, there have been significant revisions in the ENCORE assessments of dependencies, in particular in the latest version. Furthermore, the analysis aggregates sectors into industry groups (for comparability with the PwC studies, a similar aggregation has been used). Finally, another important assumption relates to the construction of a single nature-dependency score for each sector, based on the dependency ratings for the 25 ecosystem services. In line with PwC ([1], [3]), and as implemented in other studies, the consolidated dependency score of a sector reflects three components: a) the number of ecosystem services on which this sector depends, b) the average rating across these ecosystem services, and c) the maximum dependency rating. The latter component assumes limited substitutability between ecosystem services. The three components are given an equal weighting. Moreover, this study normalises the first component using a normalisation factor⁽⁵⁾, which is necessary due to changes in the materiality ratings and in the number of ecosystem services across versions of ENCORE. Taking into account these changes (mostly increases), the following thresholds⁽⁶⁾ have been defined for ENCORE 2024 materiality

ratings: consolidated dependency scores below 2.25 are considered "Low Dependency", scores between 2.25 and 3.25 "Medium Dependency" and scores above 3.25 "High Dependency". A sensitivity analysis has been carried out for different thresholds.

It should be noted that the methodology does not include dependencies on energy or fossil fuels, except indirectly via the dependency of energy suppliers on ecosystem services. Also, the dependency scores do not include an assessment of the probability of disruption of the relevant ecosystem services, or exposure to driving factors such as climate change. This could be the subject of further research, as discussed in the conclusions.

Assessing nature dependencies along value chains through input-output tables

In order to assess how these dependencies propagate through the economy within countries and across international value chains, the information on individual sectors' dependencies has to be paired with information on the structure of value chains. Input-output tables provide information on the value chains of each production sector by country. The main analysis carried out in this study uses the EXIOBASE multi-regional input-output dataset (Version 3.7) for 2022 at basic prices with 163 sectors for 49 countries (including all EU-27 countries and the EU's main trade partners) [5].

This information allows calculating the direct nature dependency of each sector as well as its indirect dependencies through its upstream value chain (suppliers) and downstream value chain (customers). The value chain combines intra- and extra-EU components. To calculate the direct dependency, the consolidated dependency score of each sector is applied to the value added generated by its own operations. Each sector's upstream dependency is calculated as a weighted average of the direct nature dependencies of the sectors that are in its supply chain. Each sector's downstream dependency is calculated as a weighted average of the direct nature dependencies of the sectors that are its primary customers.

To obtain the direct and supply chain value added taking into account international trade, this study follows the methodology proposed by [7] and [8]. Finally, when aggregating supply chain dependencies,

nature increases in the 2024 version of ENCORE, thresholds were shifted upwards for the purpose of this study, based on sensitivity and distribution analysis performed. Further information on threshold derivation can be found in [9].

⁽⁴⁾ Updated tables can be obtained from [here](#).

⁽⁵⁾ A similar normalisation is applied, for example, in [6]

⁽⁶⁾ Dependency thresholds were initially retained from the original study, using the approach described in [3]. Since the overall dependency on

two alternative options have been applied: either excluding or including the contributions of a sector to itself, i.e. the goods or services produced by a sector as intermediate inputs in its own final production (e.g. motors and frames produced by the automotive sector for use in car assembly). This ensures comparability of the results with the original studies that apply the latter option.

Grouping the shares of value-added contributions of sectors to each other according to the dependency score of each sector, the approach finally allows obtaining the share of GVA that is generated under “High”, “Medium”, and “Low” dependency within each industry group and each upstream or downstream chain.

RESULTS

Results are presented for the nature dependencies of the EU economy, both direct and through value chains, including a sensitivity analysis. For comparison, the analysis was replicated for other economies (US, China and the world economy)⁽⁷⁾.

Nature dependency of the EU economy

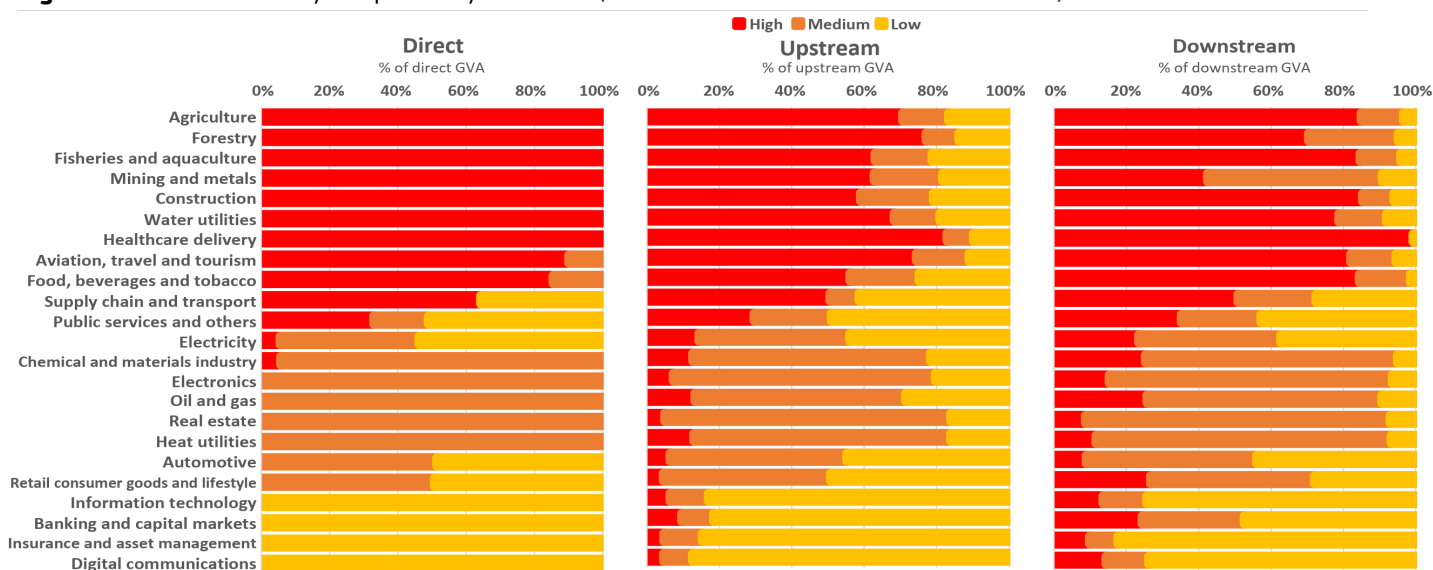
For the EU economy, Fig. 2 shows the dependency of the various industry groups on nature in terms of GVA shares, considering the direct, upstream (suppliers) and downstream (customers) nature dependencies, mirroring the analysis of PwC. The primary industry groups (“agriculture”, “forestry”, “fisheries and aquaculture”), as well as “construction”, “mining and metals”, “water utilities”, “healthcare”,

“aviation travel and tourism”, “food, beverages and tobacco”, and to a lesser extent “supply chains and transport”, all have high direct dependency on nature, based on the above-mentioned consolidated dependency score. Although the level of dependency varies between sectors, in total 19 out of 23 sectors display high or medium direct dependencies on nature for a substantial part (40% or more) of their GVA. It should be noted that, especially for service sectors exhibiting very low levels of direct and upstream dependencies, indirect dependency via the exposure of customers can be non-negligible⁽⁸⁾.

Indirect upstream dependencies through supply chains are more evenly spread across industry groups than direct ones, reflecting the fact that all sectors take inputs from the rest of the economy, and eventually depend to some degree on sectors with high nature dependencies such as primary sectors. The results suggest that all sectors are, to some extent, dependent on nature through their supply chains. Furthermore, all sectors face significant nature dependencies through their “customer base”, i.e. the sectors to which they provide their goods and services. In particular, most sectors with high direct dependencies also have high downstream dependencies. This is the case, notably, of the primary sectors, which may be because these sectors’ outputs are used *inter alia* by other primary sectors, as well as by the “food, beverages and tobacco”, and “construction” sectors.

Fig. 3 presents the results of an alternative calculation that does not include the contributions of

Figure 2 - The EU economy’s dependency on nature (incl. the contributions of a sector to itself)

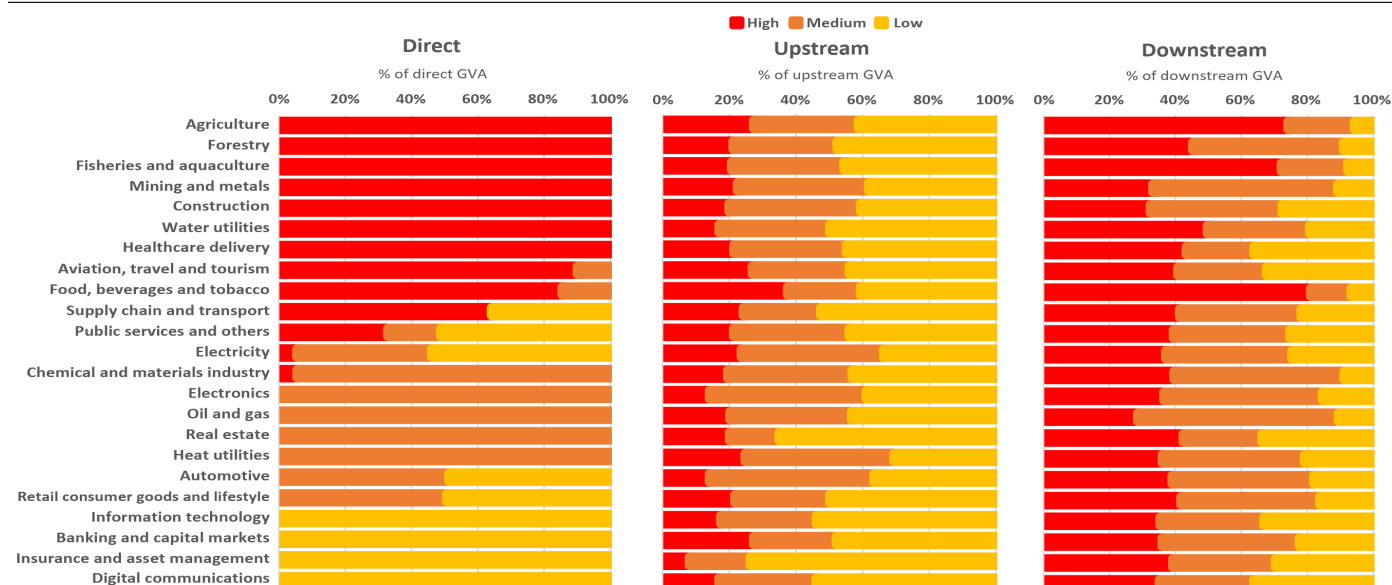


Source: ENCORE 2024, EXIOBASE 2022, JRC calculations

⁽⁷⁾ Detailed results can be found in [9] and are also available upon request.

⁽⁸⁾ For a discussion of exposure of financial services industries via their customers, see [6] and [10].

Figure 3 - The EU economy's dependency on nature (excl. the contributions of a sector to itself)



Source: ENCORE 2024, EXIOBASE 2022, JRC calculations

a sector to itself in upstream and downstream value chain considerations. The widespread nature dependencies through supply chains across the economy then become even clearer, as every sector requires inputs from nature-dependent sectors (upstream).

However, using ENCORE 2024, the overall dependency on nature is found to be of the same order of magnitude for China as for the EU, but lower for the US (Table 2), indicating that large parts of the US economy's GVA are generated in sectors that are not considered highly dependent on nature.

Table 1 - EU economy's dependency on nature

EU	Direct	Upstream	Downstream	Direct + Upstream
High	0.44	0.22	0.41	0.36
Medium	0.27	0.33	0.38	0.29
Low	0.30	0.45	0.21	0.35

Source: ENCORE 2024, EXIOBASE 2022, JRC calculations

For the EU economy as a whole, the study finds that 44% of the GVA from all sectors' direct operations (i.e. excluding suppliers) has a high dependency on nature and 27% has a medium dependency (Table 1). If considering only upstream supply chains (i.e., ignoring the contributions of a sector to itself), 22% of the GVA generated by suppliers is highly dependent on nature and 33% has a medium dependency. The overall estimate, considering both direct operations and their supply chains⁽⁹⁾, indicates that two thirds of the EU's GVA has a significant dependency on nature: a 36% share of GVA has a high dependency and 29% a medium dependency. Additionally, the results for US, China and the world economy [9] show that there are significant differences between countries in the dependencies of various sectors, in particular in supply chains.

Sensitivity analysis

The analysis aims to trace the importance of nature for different sectors and the entire economy. The results confirm the widespread nature dependencies across most sectors of the EU economy, both directly and through supply chains, in line with the findings of the original studies ([1], [3]). The estimated exposures of the world economy and the EU economy are somewhat higher than in the original studies, possibly due to the increase in the number of ecosystem services considered and the higher materiality ratings introduced in ENCORE 2024.

It should be kept in mind that there are high uncertainties in the assessment of exposure to nature-related risks, notably because of the complexity of both ecosystems and transmission channels to the economy. The ENCORE layer, the aggregation processes for economic sectors and their dependencies on individual ecosystem services, the aggregation of ecosystem services, and the level of the thresholds require strong assumptions that have an impact on the results. In particular, a sensitivity analysis has been carried out for the impact of the level of the thresholds. Table 2 illustrates how the share of the EU and other countries' economies that is considered as having high dependency on nature

⁽⁹⁾ Downstream dependencies are not added up to avoid double counting.

would vary for different values of the “High” threshold for the two latest versions of ENCORE. It can be readily seen that the choice of the thresholds has a significant impact, and that using the newest version of ENCORE (ENCORE 2024) leads to a higher share of GVA with “High” nature dependency, i.e. 36% instead of 19% for the EU.

Table 2 - High dependency share (direct and upstream)

	High threshold	Europe	United States	China	World
ENCORE 2024	3.00	0.38	0.24	0.36	0.35
	3.15	0.37	0.23	0.36	0.34
	3.25	0.36	0.22	0.35	0.33
	3.35	0.30	0.18	0.32	0.28
	3.50	0.22	0.12	0.23	0.20
	High threshold	Europe	United States	China	World
ENCORE 2022	2.75	0.25	0.26	0.30	0.29
	2.90	0.19	0.18	0.26	0.23
	3.00	0.19	0.17	0.24	0.21
	3.10	0.18	0.17	0.22	0.21
	3.25	0.06	0.03	0.13	0.09

Source: ENCORE 2024, ENCORE 2022, EXIOBASE 2022, JRC calculations

CONCLUSION

Even though the integrated assessment of economic, social and environmental impacts of projects or policies is becoming standard practice (see e.g. the European Commission’s better regulation guidelines [11]), the incorporation of ecosystem and biodiversity considerations into macroeconomic and financial risk analyses raises significant challenges. This study offers insights on assessing the dependency of the EU economy on ecosystem services, replicating the approach proposed by PwC with WEF ([1], [3]). The findings indicate that, depending on the version of ENCORE used (thus on the classification frameworks as well as data updates⁽¹⁰⁾), between 19% and 36% of the EU’s GVA is highly dependent on ecosystem services and is generated by sectors that are at particular risk of being adversely affected by nature degradation. Overall, based on the recent data from ENCORE 2024, two thirds (65%) of the EU’s GVA is

estimated to have a high or medium dependency on nature when including both direct and indirect links. The nature dependency figures for the EU are somewhat higher than those obtained for the US (between 17% and 22% of GVA highly dependent on ecosystem services), and are broadly similar to those obtained for China (between 24% and 35%).

As illustrated by the sensitivity analysis, these results should be interpreted as orders of magnitude rather than precise estimates. More importantly, the analysis shows that the entire economy is to some extent susceptible to nature degradation, since all sectors are interconnected through their supply and value chains, although the different sectors’ dependencies on nature vary.

The methodology used in this study could be a foundation for more in-depth nature-economy modelling, notably to integrate information on the state of ecosystems and geospatial data on ecosystem services, since the unmet demand for ecosystem services can vary substantially with geographical location. This could be done by using, for instance, data from the INCA (Integrated System of Natural Capital Accounts) Platform [12]. Geographical location could be easily introduced by considering smaller economic regions, e.g. at NUTS (Nomenclature of territorial units for statistics) 2 level, and making use of actual ecosystem service measurements, e.g. as described in [13]. Of course, this higher granularity would have to be complemented with NUTS 2 input-output tables. More advanced analysis could then investigate how stress on local ecosystems may affect the delivery of their services, creating potential vulnerabilities on the production side of the EU economy.

REFERENCES

- [1] World Economic Forum, ‘Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy.’ WEF New Nature Economy Report. World Economic Forum (WEF), Geneva, Switzerland, 2020.
- [2] IPBES, ‘Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.’ IPBES secretariat, Bonn, Germany, 2019.

⁽¹⁰⁾ See <https://encorenature.org/news/major-upgrade-for-encore-launches-july-2024>

[3] Evison, W., Low, L.P., O'Brien, D., 'Managing nature risks: From understanding to action.' Strategy+business: a PwC publication, 2023.

[4] ENCORE, 'ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure. [On-line]'. Cambridge, UK: the ENCORE Partners (Global Canopy, UNEP FI, and UNEP-WCMC). Available at: <https://encorenature.org>, [July 2024]

[5] Stadler, K., Wood, R., Bulavskaya, T., Soedersten, C.-J., Simas, M., Schmidt, S., Usubiaga, A., Acosta-Fernandez, J., Kuenen, J., Bruckner, M., et al., 'EXIOBASE 3: Developing a time series of detailed environmentally extended multi-regional input-output tables.' *Journal of Industrial Ecology*, 22(3), 502–515, 2018.

[6] European Commission, Directorate-General for Financial Stability, Financial Services and Capital Markets Union, Cziesielski, M., Dekker-Hufler, C., Pal, T., Nicholls, G. et al., 'Study for a methodological framework and assessment of potential financial risks associated with biodiversity loss and ecosystem degradation – Final report', 2024.

[7] Koopman, R., Wang, Z., Wei, S.-J., 'Tracing value-added and double counting in gross exports.' *American Economic Review*, 104(2), 459–494, 2014.

[8] Aslam, A., Novta, N., Rodrigues-Bastos, F., 'Calculating trade in value added.' IMF Working Papers. International Monetary Fund, 2017.

[9] European Commission, Joint Research Centre, Hirschbühl, D., Neuville, A., Petracco, M., Sanchez Arjona, I., 'The EU economy's dependency on nature', JRC140304 [in press]

[10] ECB/ESRB Project Team on climate risk, 'Towards macroprudential frameworks for managing climate risk'. December 2023.

[11] European Commission, '“Better regulation” toolbox – July 2023 edition'. Available at: https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation/better-regulation-guidelines-and-toolbox_en, [September 2024]

[12] European Commission, 'INCA Platform', European Commission website. Available at: <https://ecosystem-accounts.jrc.ec.europa.eu/>, [December 2024]

[13] Fatica, S., Grammatikopoulou, I., Hirschbühl, D., La Notte, A., Pisani D., 'European SMEs' Exposure to Ecosystems and Natural Hazards: A First Exploration.' *Sustainability*, 16(11), 4841, 2024.

AUTHORS AND ACKNOWLEDGEMENTS

This policy brief was drafted by Dominik Hirschbühl and Marco Petracco (JRC.B1), and Aude Neuville and Irene Sanchez Arjona (JRC.D6/KCBD). It was edited by Paris Vasilakopoulos (JRC.D6/KCBD).

The authors would like to thank Libby Daley and Will Evison (PricewaterhouseCoopers) for sharing many of the modelling assumptions made in their analyses. They also gratefully acknowledge the comments provided by Melina London (JRC) and Joachim Maes (DG REGIO) on an early draft of the paper, and the comments provided by Alessandra La Notte (EC consultant), as well as Kim De Ruck, Hélène Périer, Stephen White and Oliver Zwirner (DG ENV).

COPYRIGHT

© European Union, 2025.

CONTACT INFORMATION

Dominik.Hirschbuehl@ec.europa.eu



EU Science Hub

[Joint-research-centre.ec.europa.eu](https://joint-research-centre.ec.europa.eu)