

APPENDICES

Appendix 2

Methodology for
Estimating current and
future employment in
NbS (Chapter 6)

Decent Work
in Nature-based
Solutions **2022**



Appendix 2

Methodology for Estimating current and future employment in NbS (Chapter 6)

Cambridge Econometrics' global E3ME model provides an economic framework with which to evaluate the effects of a wide range of policies. Behavioural relationships in the model are estimated using econometric time-series techniques applied to a database that covers the period from 1970 onwards, on an annual basis. A core feature of the model is its treatment of technology, which will be key to meeting many of the world's policy challenges. E3ME extends its treatment of the economy to cover physical measures of energy, food and material consumption. The main data sources for European countries are Eurostat and the International Energy Agency (IEA), supplemented by the Organisation for Economic Co-operation and Development (OECD) STAN database and other sources where appropriate. For regions outside of Europe, additional sources for data include the United Nations, OECD, World Bank, International Monetary Fund (IMF), ILO and national statistics. Gaps in the data are estimated using custom software algorithms.

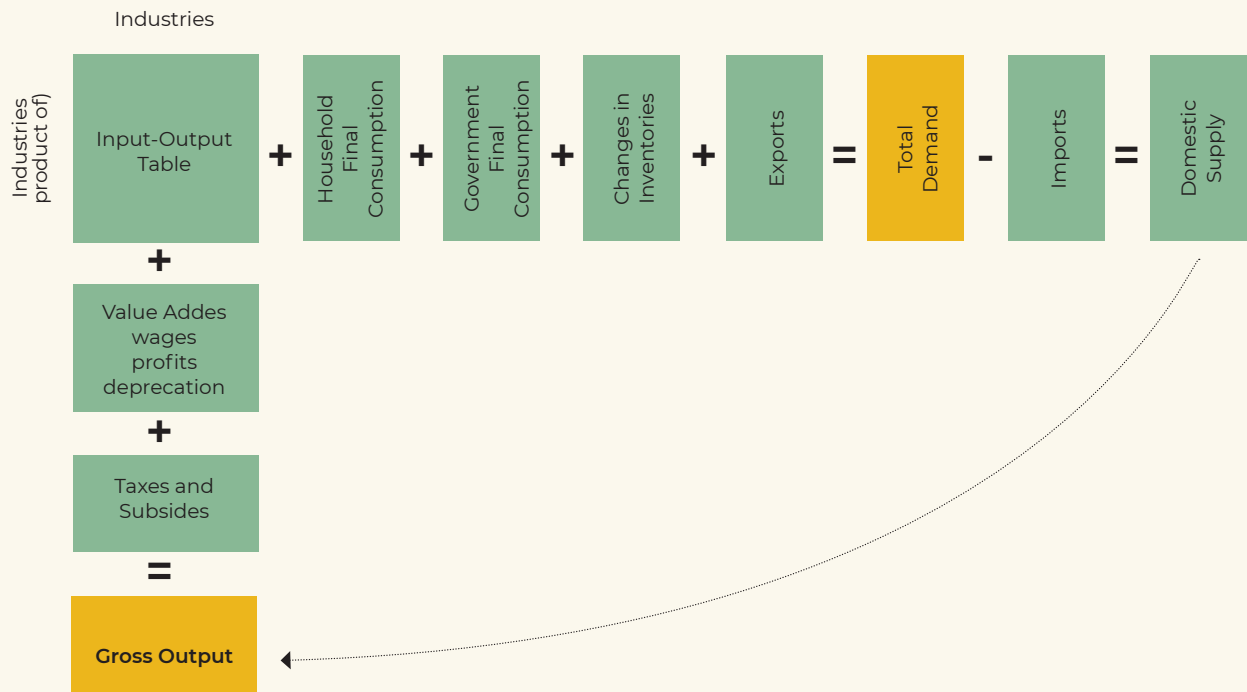
E3ME's theoretical underpinning is that economic activity undertaken by persons, households, firms and other groups in society has effects on other groups (possibly after a time lag), and the effects may persist into future generations. But there are many actors, and the effects – both beneficial and damaging – accumulate in economic and physical stocks.

The effects are transmitted through the environment, through the economy and the price and money system (via markets for labour and commodities), and through global transport and information networks. The markets transmit effects in three main ways: through the level of activity creating demand for inputs of materials, fuels and labour; through wages and prices affecting incomes; and through incomes leading in turn to further demands for goods and services. In E3ME the determination of output comes from a post-Keynesian

demand-driven accounting framework, and it is possible to have spare capacity in the economy (Figure A.1). It is not assumed that prices always adjust to market clearing levels, with the behaviour estimated based on historical data. For each region and sector, a set of behavioural equations are estimated. E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g. up to 2025) and rebound effects, which are included as standard in the model's results.

Figure A.1 Economic structure of E3ME

The Demand-Driven Structure of E3ME



SOURCE: Cambridge Econometrics.

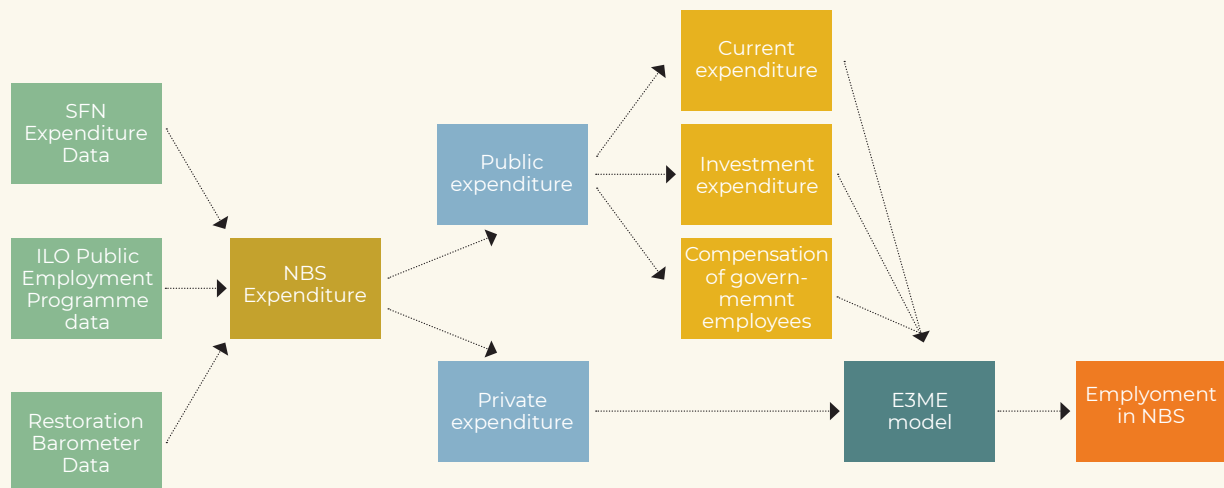
This annex sets out the main assumptions used in estimating the employment in NbS. The sections that follow set out, in turn, the assumptions that entered the E3ME model: data sources, assumptions related to public expenditure, treatment of direct employment from ILO Public Employment Programmes (PEPs), employment results, and voluntary employment.

Current employment estimation is not linked to any particular year. The dynamics in E3ME mean that it takes time for the full impact of sustained NbS expenditure to be realized. The E3ME econometric equations estimate a short-run and a long-run equation with an error-correction mechanism. Under this specification, the direct response of employment to change in

gross output is likely to be different in the short-run and the long-run. The induced impacts of NbS expenditure also take time to be fully realized in E3ME, given the short-run and long-run dynamics of, for example, change household consumption expenditure to real income changes.

The methodological approach is summarized in Figure A.2 Summary of the methodological approach.

Figure A.2 Summary of the methodological approach



SOURCE: Cambridge Econometrics.

Data sources for NbS expenditure

There are three main data sources used in the estimation of current employment in NbS: the State of Finance for Nature (SFN) report; the IUCN Restoration Barometer; and ILO PEP data. These three sources collectively give the annual expenditure on NbS.

From the SFN data, six series of data are used: IMF Classification of the Functions of Government (COFOG) from 2016, OECD COFOG from 2018, OECD ODA from 2018, CBD Financial Reporting Framework analysis from 2018 (China data), USA Spending Budget Functions from 2018, and private expenditure. Data from the IMF in 2016 is compiled with the other public spending flows from 2018; this is because the latest data from IMF is from 2016 and, in order to get a comprehensive figure for 2018 NbS spending, it

is assumed that this annual spending data remained constant through to 2018. Public spending flows are disaggregated by region, and therefore are easily mapped to E3ME regions. However, the SFN database does not provide equivalent disaggregation for private expenditure, so the percentage of public expenditure in each region is used as a proxy for private expenditure regional disaggregation. The ODA data had different sectoral disaggregation to the COFOG data; thus the ODA sectors were mapped to COFOG sectors to allow the data to be compiled. The expenditure data is deflated using the 2010 USD World Bank data on consumer prices before it is used in the modelling. Table A.1 summarizes the mapping.

Table A.1 Mapping ODA sectors to COFOG sectors

SECTOR	ODA SECTOR
Agriculture, forestry, fishing and hunting	Agricultural development Agricultural land resources Agricultural water resources Forestry development Forest industries
Wastewater management	Water sector policy and administrative management Water resources conservation (including data collection)
Pollution abatement	Forestry policy and administrative management Agricultural policy and administrative management
Protection of biodiversity and landscape	River basins development Biosphere protection Biodiversity Site preservation
Environmental protection n.e.c.	Environmental education/training Environmental research

The SFN database did not provide sectoral disaggregation for private

expenditure. For certain private expenditures, these could be mapped to a specific NbS archetype. For remaining categories, public expenditure shares by NbS archetype are used as a proxy to allocate private expenditures to each NbS.

Table A.2 details the private expenditure categories used; “General” indicates where no archetype is inferred and the proxy shares are used.

Table A.2 Mapping private expenditure categories to NbS archetype

PRIVATE EXPENDITURE CATEGORY	NBS ARCHETYPE (COFOG SECTOR)
Biodiversity offsets	Protection of biodiversity and landscape
Water quality trading and offsets	Wastewater management
PES (watersheds)	Wastewater management
Conservation non-governmental organizations	General
Equity impact investing	General
Philanthropy	General
Private finance mobilized by DAC	General
Private finance leveraged by GEF	General
Private finance leveraged by GCF	General

The SFN data is supplemented with data from the Restoration Barometer and from ILO PEP data. These expenditure data are used additionally, or in place of SFN data, where expenditure values are higher than those reported in the SFN dataset.

Modelling current NbS expenditure

The public expenditure is split across three modelling pathways for current expenditure, investment expenditure, and compensation of government employees. The share of public expenditure for each of them is based on OECD COFOG data (for the United States it is based on US Spending data¹). Where data are not available for a country in the OECD COFOG data, then the average for the euro area countries is used.

For investment and current expenditure, assumptions for the NbS supply chain for each of the five NbS archetypes were developed across current and investment expenditure. Table A.3 details the assumptions by NbS archetype and indicates the E3ME sector that expenditure on each NbS archetype is directed to across current and investment expenditure categories.

Table A.3 NbS archetype supply chain assumptions

EUROPEAN				
NbS archetype	Expenditure	E3ME sector		
Agriculture, forestry, fishing and hunting	Current	Crop production (0.4)	Forestry (0.4)	R&D activities (0.2)
	Investment	Electronics (0.5)	Construction (0.5)	
Wastewater management	Current	Sewerage and waste (0.4)	Construction (0.4)	Architecture and engineering (0.2)
	Investment	Construction (0.84)	Machinery, equipment n.e.c. (0.09)	Electronics (0.07)
Pollution abatement	Current	Sewerage and waste (0.8)	Other professional services (0.2)	
	Investment	Electronics (0.75)	Construction (0.13)	Computer services (0.12)

¹ USAspending. n.d. <https://www.usaspending.gov/>

Protection of biodiversity and landscape	Current	Crop production (0.4)	Forestry (0.4)	R&D activities (0.2)
	Investment	Electronics (0.5)	Construction (0.3)	Computer services (0.2)
Environmental protection n.e.c.	Current	Construction (0.5)	R&D activities (0.5)	
	Investment	Construction (0.8)	Electronics (0.11)	Machinery, equipment n.e.c. (0.09)
NON-EUROPEAN DEVELOPED				
NbS archetype	Expenditure	E3ME sector		
Agriculture, forestry, fishing and hunting	Current	Agriculture, fishing and hunting (0.4)	Forestry (0.4)	Professional services (0.2)
	Investment	Electronics (0.5)	Construction (0.5)	
Wastewater management	Current	Miscellaneous services (0.4)	Construction (0.4)	Professional services (0.2)
	Investment	Construction (0.84)	Mechanical engineering (0.09)	Electronics (0.07)
Pollution abatement	Current	Miscellaneous services (0.8)	Professional services (0.2)	
	Investment	Electronics (0.75)	Construction (0.13)	Computer services (0.12)
Protection of biodiversity and landscape	Current	Agriculture, fishing and hunting (0.4)	Forestry (0.4)	Professional services (0.2)
	Investment	Electronics (0.5)	Construction (0.3)	Computer services (0.2)
Environmental protection n.e.c.	Current	Construction (0.5)	Professional services (0.5)	
	Investment	Construction (0.8)	Electronics (0.11)	Mechanical engineering (0.09)

NON-EUROPEAN DEVELOPING				
NbS archetype	Expenditure	E3ME sector		
Agriculture, forestry, fishing and hunting	Current	Agriculture, fishing and hunting and Forestry (0.22)	Chemicals (0.24); Wood and paper (0.13)	Professional services (0.41) for private expenditure Or Public administration and defence (0.41)
	Investment	Chemicals (0.55)	Forestry (0.25);	Wood and paper (0.17) Metal products (0.04) Professional services or Public administration and defence (0.04)
Wastewater management	Current	Miscellaneous services (0.4)	Construction (0.4)	Professional services (0.2)
	Investment	Construction (0.84)	Mechanical engineering (0.09)	Electronics (0.07)
Pollution abatement	Current	Miscellaneous services (0.8)	Professional services (0.2)	
	Investment	Agriculture, fishing and hunting and Forestry (0.22)	Chemicals (0.24); Wood and paper (0.13)	Professional services (0.41) for private expenditure Or Public administration and defence (0.41)
Protection of biodiversity and landscape	Current	Chemicals (0.55)	Forestry (0.25);	Wood and paper (0.17) Metal products (0.03) Professional services or Public administration and defence (0.04)
	Investment	Electronics (0.5)	Construction (0.3)	Computer services (0.2)
Environmental protection n.e.c.	Current	Construction (0.5)	Professional services (0.5)	
	Investment	Construction (0.8)	Electronics (0.11)	Mechanical engineering (0.09)

NOTE: Values in parentheses indicate share of the NbS expenditure/investment allocated to the sector. Numbers in bold are provided by ILO and are based on forestry NbS project expenditure.

To model government expenditure on compensation of employees, employment is added exogenously to the public administration sector (ISIC Code O). The number of jobs created is calculated using E3ME data for employment cost (average wage and employer social security contributions) in the public administration sector.

In GDP accounting in the modelling:

1. Government current expenditure on compensation of employees contributes directly to GDP.
2. Government current expenditure on NbS contributes directly to GDP.
3. Investment expenditure on NbS – both private and public – contributes directly to GDP.
4. Current expenditure by the private sector does not contribute directly to GDP. This is intermediate consumption.

The modelling methodology does not account for the source of private expenditure; the cost of intermediate consumption is not attributed to any sector. There are no impacts on production costs, and therefore on sectoral prices. This dynamic is appropriate where private finance is sourced from philanthropy or spent by conservation non-governmental organizations. Where private expenditure should be accounted as a cost to production, the methodology does not model the cost and price implications of NbS expenditure.

Public Employment Programmes (PEPs)

The direct employment under PEPs is not modelled within E3ME, so the figures reported in Chapter 3 are added exogenously. The induced impacts of the PEPs expenditure are included within the E3ME modelling, generating further employment in the economy. The expenditure within the PEP is included in household income; that is, modelled as a transfer to households. Where financial data are missing for programmes, the methodology underestimates induced impacts of PEPs.

Modelling future NbS expenditure

Future NbS expenditure was available by type of project: forestry, silvopasture, peatlands and mangroves. Slightly different treatments have been applied to each project category, based on data available in the assumption file.

Forestry NbS allocation

Forestry NbS expenditure information was available in the assumption file by expenditure type (CAPEX/ OPEX) and MagPie region. CAPEX expenditure was treated as investment expenditure in the E3ME model, OPEX expenditure was assumed to be current expenditure. The expenditure allocation by MagPie region (Table A.4) was further disaggregated to E3ME regions using current activity shares in Forestry.

Table A.4 MagPie Regions

MAGPIE REGIONS	
Canada, Australia and New Zealand	China
European Union	Global
India	Japan
Latin America	Middle East and North Africa
Non-EU Member States	Other Asian
Reforming countries (i.e. Russia, Ukraine, Belarus and FSU countries in central Asia)	Sub-Saharan Africa
US	

The CAPEX and OPEX Forestry expenditure was further allocated to E3ME sectors as follows:

1. For EU regions, and non-EU developed regions, the sectoral allocation is **consistent** with that presented for Agriculture, forestry, fishing and hunting in Table A.3.
2. For non-Eu developing regions the allocation is consistent with the numbers provided by ILO and presented in Table A.5.

Table A.5 Sectoral allocation for Forestry CAPEX and OPEX

SOURCES: Nello et al. (2019); Raes et al. (2022); Najera et al. (forthcoming).

	CAPEX	OPEX
Public administration and defence	4%	41%
Forestry	25%	22%
Metal products	4%	0%
Chemicals	50%	24%
Wood and paper	17%	13%

Silvopasture NbS expenditure allocation

Silvopasture NbS expenditure was only available for CAPEX/OPEX at global level. The allocation to E3ME regions of the expenditure is done using the regional shares from the Forestry expenditure, as described by the E3ME model. For EU and non-EU developed countries, the sectoral allocation of expenditure is in line with Table A.3 above for Agriculture, forestry, fishing and hunting, while for developing countries the allocation in Table A.6 was used, with the added assumption that 15% of the Forestry expenditure would be reallocated to Agriculture, forestry, fishing and hunting.

Table A.6 Silvopasture sectoral shares for developing countries

	CAPEX	OPEX
Forestry	29%	25%
Metal products	35%	0%
Wood and paper	16%	0%
11 Chemicals n.e.s.	14%	22%
Public administration and defence	6%	53%

SOURCES: Nello et al. (2019); Nello et al. (2017); Raes et al. (2017); Togo, Ministère de l'Environnement, du Développement Durable et de la Protection de l'Environnement (2021).

Peatlands NbS expenditure allocation

Peatlands NbS expenditure was also only available at global level for CAPEX and OPEX. The allocation of the expenditure to E3ME regions was done using information on peatland area in global total (UNFCCC 2009), that is, countries with the largest peatland are also had the largest proportion of the expenditure.

The sectoral allocation follows the one presented in Table A.3 for Agriculture, forestry, fishing, and hunting, with non-EU developing countries having the same allocation as non-EU developed countries.

Mangroves NbS expenditure allocation

Mangroves NbS expenditure was also only available at global level for CAPEX and OPEX. The allocation of the expenditure to E3ME regions was done using information on mangrove area in 2020, as given by FAOSTAT. For sectoral allocation, the EU and non-EU developed countries follow the same allocation as presented in Table A.3 above for Agriculture, forestry, fishing and hunting, with non-EU developing countries following the allocation in Table A.7. Developing countries mangrove expenditure sectoral allocation below, as

given by ILO.

Table A.7 Developing countries mangrove expenditure

	CAPEX	OPEX
Public administration and defence	18%	17%
Forestry	82%	83%

sectoral allocation

SOURCE: Kusmana (2017).

Modelling employment

The direct employment in NbS presented in Chapter 6 is a result of:

- Direct employment exogenously added from PEPs.
- Government employees in NbS work or administering NbS work.
- E3ME estimation from government and private current and investment expenditure on NbS.

The indirect employment effects result from the private and public expenditure on NbS. Induced effects accrue through income effects from direct and indirect employment.

Voluntary employment

Voluntary employment in NbS is calculated using the ILO volunteer employment database and an average share of volunteers who worked on protecting/preserving nature. In most of the databases used for employment data in E3ME, voluntary employment is not captured. In the case of Eurostat data, the National Accounts employment data includes “unpaid voluntary

workers [...] if their volunteer activities result in goods; [...]. But if their volunteer activities result in services, for example caretaking or cleaning without payment, they are not included under employment, because those volunteer services are excluded from production” (EU 2013). Thus, in the case of European countries, voluntary employment in NbS is considered as part of the E3ME employment results. For all other countries, it is added additionally to the E3ME employment results.

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