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MAIA
Mapping and Assessment for
Integrated ecosystem Accounting

The MAIA country fact sheets summarize the state of affairs on natural capital accounting (NCA) in the countries connected to the MAIA project. They serve as an accessible overview and entry point for collaboration. The factsheets describe the needs from policy, society, science and business for the use of NCA, give an overview of the ongoing and published research -including knowledge gaps- in the country, include contact details and an overview of national partners and stakeholders involved in the accounts. Information in this document is based on MAIA Deliverables and exchanges, and the content is reviewed, co-authored and updated by MAIA-liaison persons in the participating country. This version was updated on 15 December 2020.

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and more generally, the German Nature Conservation
Agency (Bundesamt für Naturschutz BfN) and
Thünen Institute for Int. Forestry & Forest Economics.

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Summary

Some ecosystem accounts are already incorporated into the Statistical System related to the National Sustainable Development Strategy of Germany. Now, the priorities for Germany are to take the first steps in implementing the accounting framework, focussing on biodiversity conservation targets in urban and rural areas. Afterwards, the knowledge gathered in the process will lead to a reporting system to inform policy on the full range of ecological and economic effects of policy decisions.

The ecosystem extent account for Germany is available on a regional and national scale. An ecosystem condition account is under development. Ecosystem services accounts in biophysical and economic terms have been developed for Natural soil fertility of cropland and grassland, Amenity value of public urban green spaces, Appreciation of species and habitats services, Timber and carbon sequestration of woodlands. Biophysical ecosystem services accounts are done for Soil erosion mitigation, Pollination service potential and Recreation services. Accounts of Climate gas mitigation and economic accounts of Recreation services are on-going.

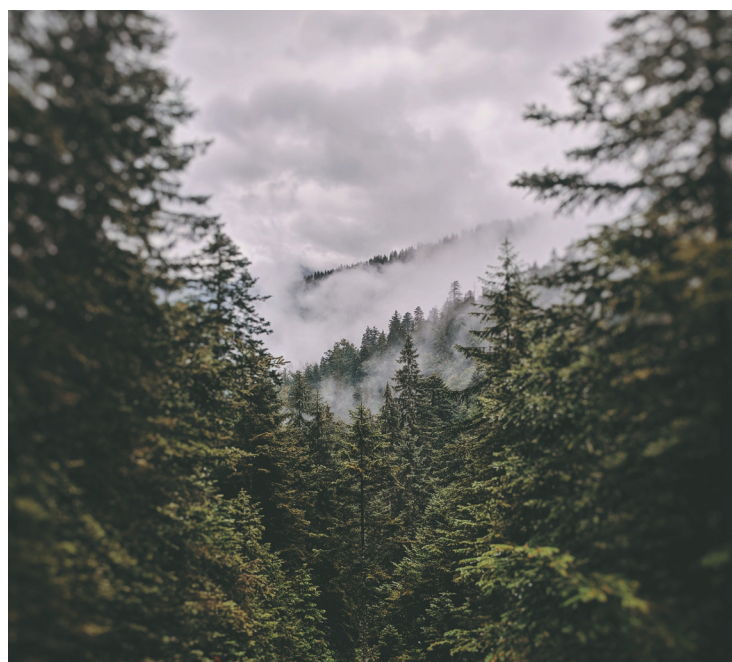
In general, the data sources for the extent account pose some issues due to differences in accuracy or quality. Moreover, up until now, there is only little awareness of the importance of integrating natural capital and Ecosystem Services into economic accounting and related government reports. However, there are no structural knowledge gaps or difficulties recorded in Germany and additional funding has already been found for a follow-up project.

In Germany, further capacity building for the National Statistical Agency would be beneficial. The time is right to inform policy makers of the potential and advantages of natural capital accounting. They stress the importance of sufficient funding and cooperation, both national and international and suggest enhancing knowledge sharing, not only within the MAIA project, but also involving experts from KIP INCA, UN SEEA and UNSD.

Country policy priorities for developing natural capital accounts

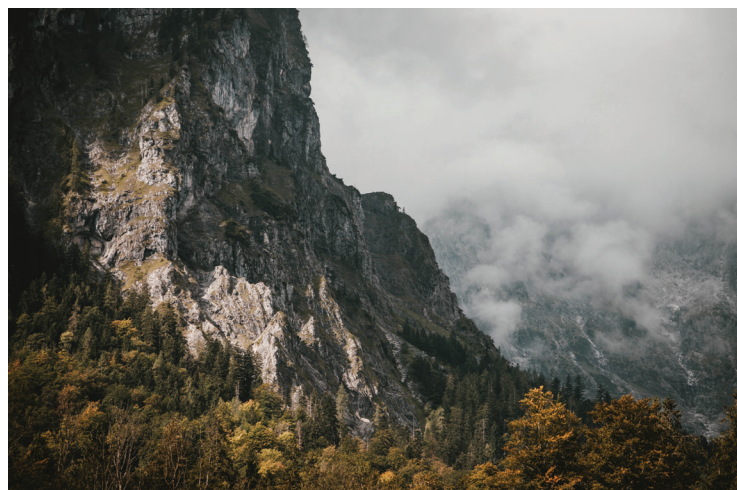
The priorities for Germany are to take the first steps in implementing the accounting framework, focussing on biodiversity conservation targets in urban and rural areas. The knowledge gathered in the process will support the development of a reporting system based on ecosystem accounts to inform policy on the full range of ecological and economic effects of policy decisions that tangle nature's biotic resources including nature conservation issues.

Ecosystem accounting data provides basic information on the state and economic relevance of ecosystems and their services. This needs to be on a regular basis, comparable and statistically valid. Such information is not yet available in Germany. Some information from the German SEEA has already been entered into the "Indicator Report" of the National Sustainable Development Strategy of Germany. However, ES were not yet included. The policy goals of developing ecosystem accounts numerous. They include the creation of a harmonized data base, elucidate the intersectoral physical and economic relations between nature, economy and



society and provide data for land use decisions and environmental policies. For the latter this also includes scenarios for alternative policy programs, for example on renewable energy, infrastructure and forest and agricultural policies.

The specific aim of the MAIA project in Germany is to analyze the theoretical framework and the methodological principles concerning ecosystem accounting and to take first steps to application. A key priority is to develop the pilot accounts related to issues that are of high political relevance and closely related to biodiversity conservation targets in urban areas and the countryside (land conversion, green urban areas, biodiversity accounting). Afterwards, based on the experiences made with the pilots, a roadmap will be developed for a comprehensive ecosystem and ecosystem services reporting system. This will be fully integrated into the SEEA and thus linked to the central accounting framework. It will be used to inform policy on the full range of ecological and economic effects of policy decisions.

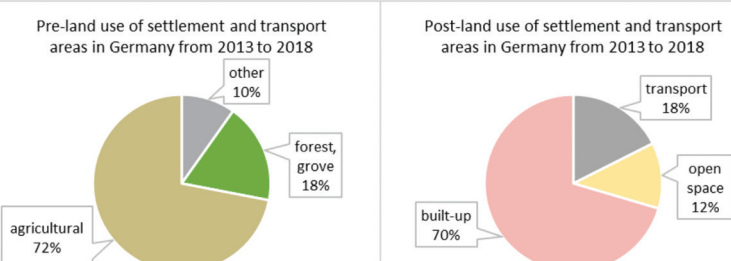
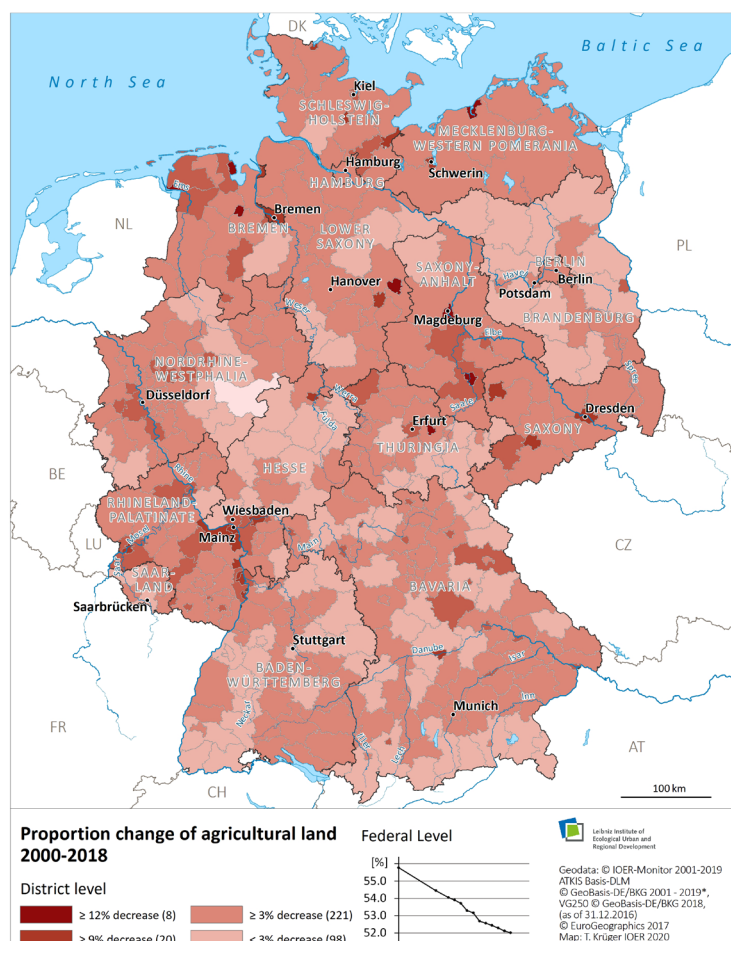


Pilot accounts under development

Summary table of accounts

Account		Ecosystem Types / Ecosystem Services	Link to research
Accounts for ecosystem assets	Ecosystem extent account	All ecosystems*	Grunewald et. al, 2020
		<i>All ecosystems</i>	Schröter et al., 2015
	Ecosystem condition account	All ecosystems	
	Ecosystem monetary asset account		
Accounts for ecosystem services	Ecosystem services supply and use table - physical terms	Natural soil fertility of cropland and grassland*	Grunewald et al., 2021
		Soil erosion mitigation*	Syrbe et al., 2018
		Pollination service potential*	
		Recreation services*	
		Amenity value of public urban green spaces*	Grunewald et al., 2021
		Appreciation of species and habitat services*	
		Timber of woodlands*	Elsasser et al., 2021
		Carbon sequestration of woodlands*	Elsasser et al., 2021
	Ecosystem services supply and use table - monetary terms	Climate gas mitigation*	
		Urban climate regulation*	
		Natural soil fertility of cropland and grassland*	Grunewald et al., 2021
		Amenity value of public urban green spaces*	Grunewald et al., 2021
		Appreciation of species and habitat services*	
		Timber of woodlands*	Elsasser et al., 2021
		Carbon sequestration of woodlands*	Elsasser et al., 2021
		Climate gas mitigation*	
		Recreation services*	
Thematic accounts			

Scale	State of development
National	Finished
Regional	Ongoing
Local	None ongoing or published
*Highlighted in the fact sheet	



Figures source: Grunewald et al. (2020)

Summary overview of highlight accounting projects

Extent accounts

Germany created a nationwide uniform system of ecosystem type classifications that can consistently deal with diverse data sources on the extent and condition of ecosystems. GIS land-use and ecosystem data that is compatible with EU-wide approaches or with other regularly collected data sources were combined and blended, for example, from sample-based surveys, to generate a complete, updatable picture of the state of Germany's ecosystems (Grunewald, et al. 2020). Allocation tables with different classes or levels (layers) enable an ecosystem extent accounting, which are used to help draw up balances (area balances, status balances, ecosystem service balances) and can be further detailed, depending on the respective task.

A total of 35 CLC-Classes (minimum 1 ha resolution), 13 ecosystem subclasses, 5 ecosystem main classes on the basis of the "LBM-DE" (Digitales Landbedeckungsmodell für Deutschland/digital land cover model for Germany) were considered in the ecosystem typology with additional polygons added representing linear landscape elements (roads/alleys, rivers, treelines, hedges, rocks/stone ridges) by buffering topographical (ATKIS/German Official Topographic-Cartographic Information System) data and with about 300 subtypes differentiated by type and condition on the basis of reporting for the Habitats Directive, WFD-reporting, High Nature Value farmland survey, National Forest Inventory, agricultural land use statistics, land use statistics for settlements, industry and transport. The data used are from 2012, 2015 and 2018 and it is planned to integrate the updated data of 2021.

Ecosystem Services accounts

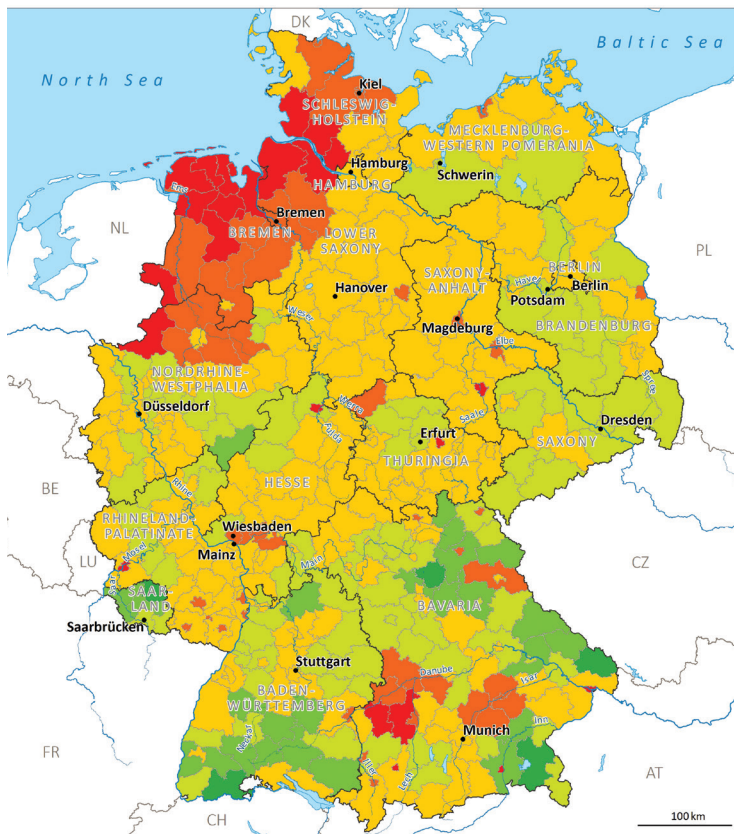
The accounts for Ecosystem Services in Germany cover many ES with finished and on-going accounts (table above). Ecosystem service accounts in biophysical and economic terms have been developed for Natural soil fertility of cropland and grassland, Amenity value of public urban green spaces, Appreciation of species and habitats services, Timber and carbon sequestration of woodlands. Biophysical ecosystem services accounts are done for Soil erosion mitigation, Pollination service potential and Recreation services. Accounts of Climate gas mitigation and economic accounts of Recreation services are on-going. A more elaborate explanation of these ES accounts can be found in the table below.

In addition, a conceptual proposal for an ecosystem condition account is needed and tangible proposals are to be developed on how the already processed data (from public available remote sensing and geo-data, official statistics, HNV mapping, forest inventory data, etc.) and aggregation and evaluation models (e.g. recreation evaluation, demand for urban green spaces) can be integrated into a common data and evaluation model.

Ecosystem Service	Coverage	Years	Physical measure / model	Economic valuation method
Natural soil fertility of cropland and grassland	National - For all grasslands and croplands that are under agricultural use or were converted to a different use	2012 2015 2018	Müncheberger Soil Quality Rating classifying a site according to its productivity when used as cropland or grassland, the scale was calibrated with the help of winter wheat and winter rye yields	Agricultural land rent for soils with a specific SQR, calculated via regression
Soil erosion mitigation	National	2012 2015	Calculation of soil erosion (tonnes) with the Universal Soil Loss Equation based on typical C-factors for the real land use / land cover and for bare soil as the reference situation; effect of linear elements is calculated with the length (L) factor for a situation with and without linear elements	No economic valuation
Pollination service potential	National	2015	Relative density of pollinators depending on flower supply, suitability as nesting habitat and distance (according to Zulian et al. 2013)	Economic evaluation not yet planned
Urban climate regulation	All settlements > 50,000 inhabitants	2018	Ongoing work - according to Zardo et al. 2017	No economic valuation planned
Climate gas mitigation	National (all terrestrial ecosystem types included) - Finalized: mapping of carbon stocks in soils and vegetation for 2015 Ongoing: mapping of carbon sequestration and GHG emissions	2015 2018	Green House Gas emissions and carbon sequestration according to LULUCF (Peatland services according to SEEA-EA) Stocks for 2015 finalized and mitigation services ongoing	Current price on carbon markets; long term mitigation cost to reach the 1.5 degree target
Recreation	National - Already mapped: potential supply and demand (matching approach) for 2015	2015 2018	Matching of potential supply (ecosystem specific weighted landscape heterogeneity) and potential demand (accessibility weighted population density) Additionally for National Parks, Nature Parks (IUCN category IV) and Biosphere Reserves: Visits Ongoing methodological refinement	Planned for National Parks: simulated prices derived from travel cost analysis; Method for residence near recreation in woodland see below; Method for other areas under discussion
Amenity value of public urban green spaces	Settlements > 50,000 inhabitants including also all smaller settlements when part of a metropolitan region of a "Functional Urban Area" according to the EU Urban Atlas	Spatial data for 2018; population in 100 x 100m cell according to 2011 census	Green space supply is measured in hectare public green space in 1km radius around place of residence; service is measured as increment of individual well-being that is related to an increase in actual supply of one hectare	Hectare public green space in 1km radius around place of residence a) related to house prices (hedonic pricing method); b) related to individual well-being; which is also correlated with income (experienced preference method) Both methods are complementary and not rivalry
Services for Nature Conservation (Other terms used for this service: existence value [CICES], appreciation of species and habitats services [latest SEEA EA proposal for the global consultation 11/2020])	National -Average Biotope Points of CLC-ecosystem categories will be mapped in "EEA Part II; Schweppe-Kraft et al. 2020	2015 2018	(Calculations finalized) Biotope Point Approach "Biotope Points" are widely employed in Germany to determine the no-net loss when, according to nature conservation law, impacts on biological diversity need to be offset by the upgrading or development of new habitats. They take into account characteristics of ecosystems such as naturalness, age, the occurrence of endangered species or the degree of threat to the ecosystem itself. Biotope Points were determined nationwide to all existing ecosystems synthesizing consistently all existing comprehensive data sources on the type and condition of ecosystems (LBM-DE and land use statistics, agricultural statistics, Habitats Directive and WFD reporting, National Forest Inventory, High Nature Value farmland survey)	(Calculations finalized) The average cost spent to produce a biotope point was taken as the price of an incremental increase in appreciation of species and habitat services and multiplied with the sum of all Biotope Points in Germany to end at the value of the stock of species and habitats that produce appreciation of species and habitat services. The yearly service can be calculated as the infinite annuity of the stock value using an appropriate discount rate (here: 3%)
Timber for woodlands ecosystems	national - All German municipalities, mapped at county level	2018 LBM. DE data; tree species composition according to 2012 Federal Forest Inventory	Timber increment (estimated from Federal Forest Inventory data)	Potential gross sales revenues at current prices
Carbon sequestration for woodlands ecosystems	national - municipalities, mapped at county level	See above	Increase of carbon storage in woodlands and in timber products; additionally calculated: Climate mitigation by substitution of alternative non-timber products by timber products (calculated by "DFWR-Klimarechner" model)	Current price on carbon markets; long term mitigation cost to reach the 1.5 degree target
Recreation for woodlands ecosystems	national - municipalities, mapped at county level	see above	Number of visits in forests near living place extrapolated with 2011 census data	Contingent Valuation (willingness to pay for an annual ticket to get access to a forest near the living place, results include consumer surplus)
"Appreciation of species and habitats services" for woodlands ecosystems	national - counties, mapped at county level	see above	Forest bird diversity index (based at number of breeding pairs, as estimated in the Atlas of German Breeding Birds (ADEBAR), 2015)	Willingness to pay for an increment of species diversity (choice experiment); method seems to be suitable for deriving a simulated price

Development of regular Ecosystem Accounts

The Federal Statistical Office of Germany is involved in the work on the Experimental Ecosystem Accounts of the BfN within the framework of an advisory group accompanying the project. The Federal Statistical Office itself is currently implementing regular Ecosystem Accounts. Building on the broad experience and knowledge base of ecosystem research in Germany and the SEEA EA framework, a standardized nationwide system of accounts is developed stepwise. The aim is to compile extent accounts by 2021, followed by comprehensive condition and service accounts, and to regularly update and connect them to the SNA.

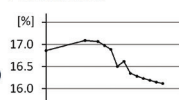


Proportion change of grazing areas 2000-2018

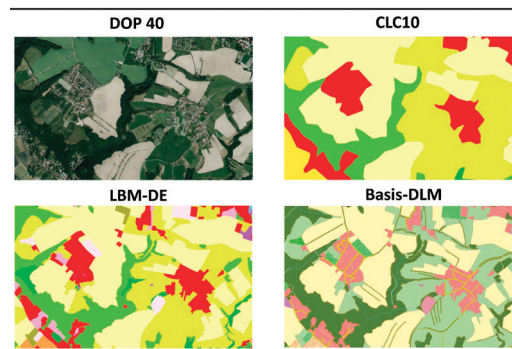
District level



Federal Level



Geodata: © IOER-Monitor 2001-201
ATKS Basis-DLM
© GeoBasis-DE/BKG 2001-2019*
VG250 © GeoBasis-DE/BKG 2018,
(as of 31.12.2016)
© EuroGeographics 2017
Map: T. Krüger IOER 2020



DOP 40 Digital orthophotos (40 cm ground resolution) – BKG (2019c)
CLC10 CORINE Land Cover 10 ha – BKG (2018c)
LBM-DE Digital Land Cover Model for Germany – BKG (2018a)

Knowledge gaps and difficulties for developing natural capital accounts

In general, the data sources for the extent account pose some issues due to differences in accuracy or quality. Moreover, up until now, there is only little awareness of the importance of integrating natural capital and Ecosystem Services into economic accounting and related government reports. However, there are no structural knowledge gaps or difficulties recorded in Germany and additional funding has already been found for a follow-up project.

For the extent account, the problems faced were related to the available data sources. It was for instance needed to merge LULC data on linear elements of different regions of Germany with a different degree of accuracy. For the long-term observation of ecosystem types, a consistent and stable data-gathering methodology for the production of the main German data base, the LBM-DE, should be implemented to help realize a representative system of ecosystem monitoring. The ecosystem extent account has been calculated on a national scale for the German state area (terrestrial, inland surface waters, marine) based on available data for the years 2012, 2015 and 2018. However, the results are still relatively uncertain with regard to trend developments or shifts, as these may be masked by methodological changes in the classification of land use and land cover.

Regarding the pilot account of natural soil fertility, regressions between soil fertility indicators and yields show that there is still need for additional research to better disentangle the contribution of soils from the contributions of anthropogenic factors to production. The calculation of amenity values of urban green space is based on data from different sources and years. There should be a recalculation based on more recent and harmonised data. The cost/price basis for the monetary valuation of services for nature conservation ("appreciation of ecosystems and species services") could be made more market-oriented by using the prices charged by the various conservation banking institutions in Germany for the compensation of detrimental effects on biodiversity caused by land use change. For the other ES accounts there are also still many questions regarding the methods and data for an economic evaluation.

The funding for a follow-up project to fill the gaps is already found. The project will focus on two things. On the one hand it will further develop the methods already developed for the pilot studies and calculate for a longer time period. On the other hand, it will record and analyse additional ES experimental accounts (carbon balances, avoidance of climate gases, pollination services and recreation in the landscape), and develop a conceptual proposal for an ecosystem condition account.

The next step is to determine how to implement the results in the SNA of Germany. However, until now, there has only been little awareness of the importance of integrating natural capital and Ecosystem Services into economic accounting and related government reports. It would be very relevant to include the accounts in, for example, the "Jahreswirtschaftsbericht der Bundesregierung", a yearly report about the German Economy from the Federal Ministry of Economy and Energy.

Support needs for developing natural capital accounts

Based on MAIA D3.2 (Annex 6 section 6 and 7); D5.1 (Annex 3 section 6e, 7 and 8)

In Germany, further capacity building for the National Statistical Agency would be beneficial. The time is right to inform policy makers of the potential and advantages of natural capital accounting. They stress the importance of sufficient funding and cooperation, both national and international and suggest enhancing knowledge sharing, not only within the MAIA project, but also involving experts from KIP INCA, UN SEEA and UNSD.

It is important to obtain and maintain sufficient resources and close cooperation between the different organizations/agencies involved in NCA. Specifically for and between those that deliver the basic data, design biophysical and monetary evaluation models and that are responsible for the coheren-

cy of the national accounting system. To this end, further capacity building at the National Statistical Agency would be beneficial, first steps have been successful. The time is right to inform policy makers and other decision makers in Germany about the potential and advantage of using ecosystem accounts, and the implications for economic thinking.

However, different kinds of "agenda setting" depend on new activities of the scientific community as well as the political and administrative willingness to use such integrated economic-ecological tools.

Next to national cooperation, also international cooperation between the MAIA MS is important for knowledge exchange about what works well and what does not in the accounting context. It would also be useful to call on previous expertise and to invite KIP INCA, UN SEEA and UNSD experts to attend expert workshops in Germany.

In general, the project and the approach used in Germany is good and there are no specific needs as there is international collaboration.



Main ecosystem types
in Germany, 2015

Semi-natural open areas
Forest and grass areas

Water
Urban, industrial

Geodata: LBM-DE 2015 (1 km² raster size) © GeoBasis-DE/BKG 2018*, VG250 © GeoBasis-DE/BKG 2018, (as of 31.12.2016), © EuroGeographics 2017
Map: K. Grunewald, S. Meier, C. Mich
11.11.2020



Sub ecosystem types
in Germany, 2015

Semi-natural open areas
Grassland and heathland
Wetlands
Open spaces with no or little veg.

Agricultural areas
Arable land
Grassland
Water

Urban, industrial
Buildings / transportation areas
Mining / dump sites

Geodata: LBM-DE 2015 (1 km² raster size) © GeoBasis-DE/BKG 2018*, VG250 © GeoBasis-DE/BKG 2018, (as of 31.12.2016), © EuroGeographics 2017
Map: K. Grunewald, S. Meier, C. Mich

Figure

Main ecosystem types in (left) and ecosystem subtypes (right) used in Germany to assess extent accounts.
Source: Grunewald, et al. (2020).

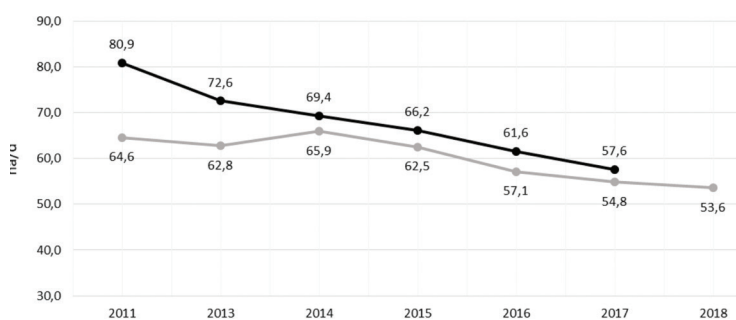
Involved partners and stakeholders

Based on D5.1 (Annex 6 section 2);

European NCA stakeholder day

Government	Research	Private sector or NGO
Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU)	Environmental Policy Research Centre, Freie Universität Berlin	
Federal Agency for Nature Conservation (BfN)	Technical University Berlin	
German Environment Agency	Leibniz Institute of Ecological Urban and Regional Development Dresden	
Federal Statistical Office	Thünen Institute	
	Leibniz University Hannover Institute of Physical Geography and Landscape Ecology	

Development of the indicator "land take". Comparison of figures from the Federal Environment Agency (black line) and the IOER monitor (grey line) (data source: UBA, IOER).



References and further reading

Ekinci, B., Interwies, E., Matauschek, M., 2019. Expert Meeting on Ecosystem Valuation in the Context of Natural Capital Accounting

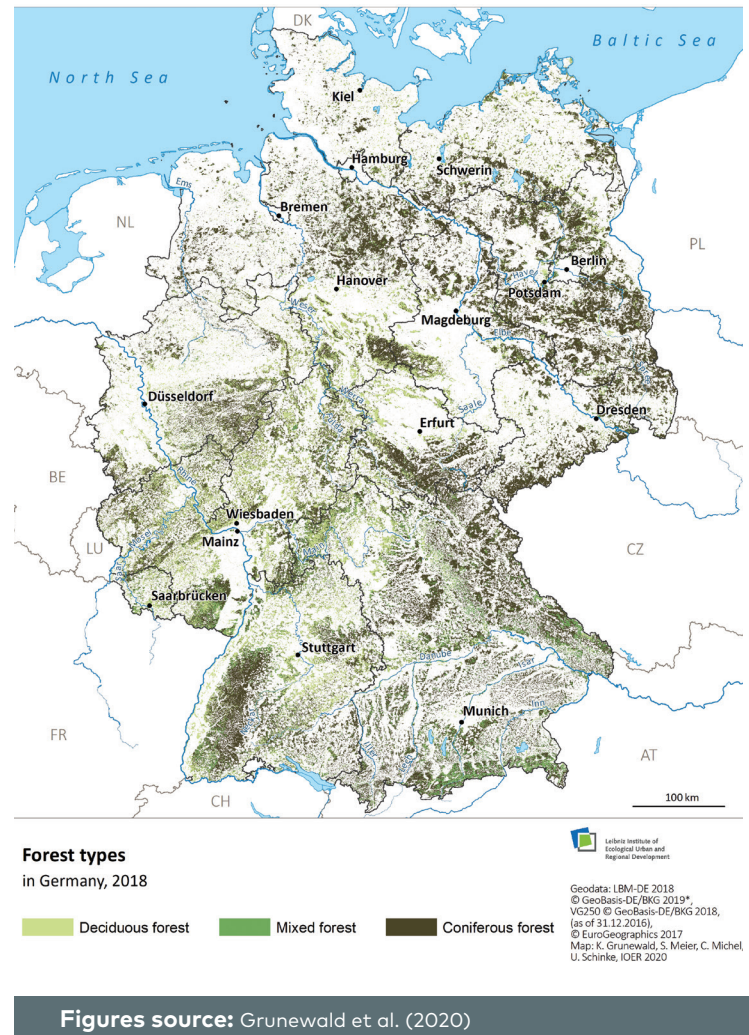
Elsasser, P., Altenbrunn, K., Köthke, M., Lorenz, M., Meyerhoff, J., 2021. Spatial Distribution of Forest Ecosystem Service Benefits in Germany: A Multiple Benefit-Transfer Model. *Forests* 12 (2), 169. <https://doi.org/10.3390/f12020169>

Grunewald, K., Hartje, V., Meier, S., Sauer, A., Schweppe-Kraft, B., Syrbe, R.-U., Zieschank, R., Ekinci, B., Hirschfeld, J., 2021. National accounting of ecosystem extents and services in Germany: a pilot project. In: La Notte, A., Grammatikopoulou, I., Grunewald, K., Barton, D. N., Ekinci, B.: Ecosystem and ecosystem services accounts: time for applications. pp.34 - 48, Publications Office of the European Union, Luxembourg. doi:10.2760/01033, JRC12366

Grunewald, K., Pekker, R., Zieschank, R., Hirschfeld, J., Schweppe-Kraft, B., Syrbe, R.-U., 2019. Grundlagen einer Integration von Ökosystemen und Ökosystemleistungen in die Umweltökonomische Gesamtrechnung in Deutschland. *Natur und Landschaft* 94, 330–338. <https://doi.org/10.17433/8.2019.50153719.330-338>

Grunewald, K., Schweppe-Kraft, B., Syrbe, R., Meier, S., Krüger, T., Schorcht, M., Walz, U., 2020. Hierarchical classification system of Germany's ecosystems as basis for an ecosystem accounting - methods and first results. *One Ecosystem* 5, e50648. <https://doi.org/10.3897/oneeco.5.e50648>

Grunewald, K., Syrbe, R.-U., Walz, U., Richter, B., Meinel, G., Herold, H., Marzelli, S., 2017. Germany's Ecosystem Services – State of the Indicator



Figures source: Grunewald et al. (2020)

Development for a Nationwide Assessment and Monitoring. *One Ecosystem* 2, e14021–e14021. <https://doi.org/10.3897/oneeco.2.e14021>

Schröter, M., Remme, R.P., Sumarga, E., Barton, D.N., Hein, L., 2015. Lessons learned for spatial modelling of ecosystem services in support of ecosystem accounting. *Ecosystem Services* 13, 64–69. <https://doi.org/10.1016/j.ecoser.2014.07.003>

Schweppe-Kraft, B., Syrbe, R.-U., Meier, S., Grunewald, K., 2020. Datengrundlagen für einen Biodiversitätsflächenindikator auf Bundesebene. In: *Flächennutzungsmonitoring XII mit Beiträgen zum Monitoring von Ökosystemleistungen und SDGs*, IÖR-Schriften 78. Rhombos-Verlag, Berlin, pp. 191–202

Syrbe, R.-U., Schorcht, M., Grunewald, K., Meinel, G., 2018. Indicators for a nationwide monitoring of ecosystem services in Germany exemplified by the mitigation of soil erosion by water. *Ecological Indicators* 94, 46–54

Zardo, L., Geneletti, D., Pérez-Soba, M., & van Eupen, M., 2017. Estimating the cooling capacity of green infrastructures to support urban planning. *Ecosystem Services* 26, 225–235. <https://doi.org/10.1016/j.ecoser.2017.06.016>

Zieschank, R., Hirschfeld, J., Pekker, R., Grunewald, K., Syrbe, R.-U., 2018. Policy Brief: Die übersehenen Werte der Natur. Ökosystemleistungen in der wirtschaftlichen Berichterstattung Deutschlands, Berlin, Dresden

Zulian, G., Maes, J., Paracchini, M.L., 2013. Linking Land Cover Data and Crop Yields for Mapping and Assessment of Pollination Services in Europe. *Land* 2, 472–492. <https://doi.org/10.3390/land2030472>