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The Future Forum on the Ocean

Mapping German Ocean Science

A Bibliometric Analysis of the Years 2012 to 2022

A.-S. Roy, H. Link, J. Karstensen, J. Heimer, J.-S. Fritz

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The German Marine Research Consortium (KDM)

Founded in 2004, KDM is the national association of marine research institutions in Germany. Since 2018, it has prioritized enhancing the marine research community's strategic capacity through a bottom-up approach and fostering international networking. KDM represents 20 members, encompassing the full spectrum of marine sciences in Germany. These members include major research institutes, universities, museums, non-university institutions, and federal authorities engaged in marine, polar, and coastal research. Towards the end of 2025, a merge is planned for the German Alliance of Marine Research and KDM.

The German Marine Research Alliance (DAM)

The German Marine Research Alliance (DAM) brings together 25 leading marine research institutions, making it one of the largest research alliances of its kind in the world. Founded by marine research institutions, the federal government and the northern German states, the DAM aims to promote the sustainable use of coasts, seas, and oceans through research and knowledge transfer, data management and digitalization, and coordination of infrastructures. Through its activities, the DAM provides guidance and practical knowledge for policy makers, businesses, and civil society – serving as a basis for the necessary changes towards greater sustainability.

The Future Forum on the Ocean (ZFO)

The ZFO serves as a collaborative platform for Germany's marine research community, aiming to develop forward-looking ocean and coastal strategies relevant to both science and society. It is supported by the breadth of German marine research and staffed by elected, independent experts with temporary mandates to develop creative ideas and contribute interdisciplinary expertise.

Content

Preface

This report is a pioneering effort aimed at establishing a foundational understanding of German Ocean Science, drawing on expertise from the organization behind UNESCO's Global Ocean Science Report. Designed as both a comprehensive reference and an exploratory analysis of output from Ocean Science in Germany, it seeks to inspire further discussion and research within the scientific community and beyond.

Serving as a resource for researchers, policymakers, and stakeholders, the report provides a broad scope of information on publication patterns and use with some limited analysis. It is envisioned as a starting point rather than a conclusive work, acknowledging its preliminary character. These limitations offer opportunities for refinement in subsequent iterations.

Future updates could be developed with more systematic methodologies, and the Future Forum on the Ocean (ZFO), supported by the German Marine Research Consortium (KDM), is prepared to facilitate such efforts. Readers are encouraged to critically engage with the material, leveraging it as a catalyst for innovation and deeper exploration of German Ocean Science.

A.-S. Roy, H. Link, J. Karstensen, J. Heimer, J.-S. Fritz

Introduction

The bibliometric analysis presented in this report is based on the publication record of German Ocean Science researchers for the period from 2012 to 2022 as accessible from Elsevier's Scopus database. The number of publications, collaboration patterns (both national, European, and international), gender dynamics, research areas, and research impacts were considered. Bibliometric analysis uses statistical methods to review bibliographic data, revealing patterns in collaboration and research networks. Inspired by UNESCO's Global Ocean Science Report (GOSR; Global Ocean Science Report, 2020) and the analysis on interdisciplinary collaboration (Peters & Ladewig, 2017), this analysis explores:

- Number of publications over time and considering topical sub-areas
- Interdisciplinary contributions
- Regional and sectoral collaborations
- Institutional diversity
- Gender dynamics
- Societal impacts of research

This exploratory analysis offers a first-of-its-kind bibliometric assessment of German Ocean Science from multiple perspectives. The research was contracted to Science-Metrix, a subsidiary of Elsevier, that also completed the Global Ocean Science Report (GOSR - Global Ocean Science Report, 2020) for IOC-UNESCO. Thus, the results presented here for Germany could also be put into relation to global trends. While the research results are very comprehensive, only an (albeit large) subset of the material is be presented here.

All bibliometric analyses are subject to inherent methodological limitations. As this study represents the first of its kind for the German Ocean Science community, the interpretation of its results must be approached with these constraints in mind. The selectivity of the underlying database toward specific Ocean Science journals may not fully capture the publication practices of all related disciplines. Likewise, the absence of standardized or harmonized metadata—particularly regarding institutional affiliations and author attributes such as gender and nationality—limits the interpretive depth of the findings.

Further complexity arises from the increasing prevalence of multiple institutional affiliations, a global trend also observed by Hottenrott et al. (2021). In this dataset, this is particularly evident among researchers affiliated with both the Alfred-Wegener-Institute, Helmholtz Center for Polar and Marine Research (AWI) and GEOMAR Helmholtz Center for Ocean Research Kiel, who simultaneously hold professorial appointments at, e.g., the University of Bremen and Kiel University (CAU), respectively. Additional variation at the University of Bremen stems from heterogeneous publication practices, with some authors publishing solely under MARUM and others under both MARUM and the University of Bremen. As these affiliation patterns cannot be retrospectively disentangled, the results are presented as provided by Science-Metrix.

Methods and Data Sources

The statistical analysis for this report was conducted by Science-Metrix using the Elsevier's Scopus database, a leading source of peer-reviewed literature. Scopus provided extensive coverage of more than 35,000 titles from over 11,000 publishers at the time of the analysis in 2022, including journal articles, reviews, and conference papers. Peer-reviewed publications from 2012 through mid-2023 were considered, with the Scopus dataset nearly 95% complete for 2022. The database's detailed metadata, such as author affiliations and institutional addresses, facilitated analyzes of international and sectoral collaborations.

The number of citations of the respective publications, as available within Scopus, was used as a proxy for scientific impact of the underlying research. However, to examine the broader socio-economic effects of ocean science, Scopus data was integrated with addi-tional resources: PATSTAT (for patent citations), PlumX (for tracking media and societal impact), and Overton (for policy-related citations).
As for any bibliometric analysis, our study is limited by the fact that no single database encompasses all research disciplines, resulting in a focus on a subset of the scientific landscape. However, since the same database was used by the GOSR (Global Ocean Science Report, 2020), a certain level of interoperability is ensured.

Executive Summary

The following is a summary of the main findings from the German Ocean Science Report

1. Publication statistics

- Germany has the second-highest number of publications (>79.000) in ocean sciences in Europe in the period 2012 to 2022.
- The number of publications in Ocean Science by Germany grew by 24% when comparing the period 2018 to 2022 with 2012 to 2016. This is comparable to other European countries but slower than the global growth rate of 44%.
- Major sub-areas of Ocean Science research include:
  - Blue Growth
  - Marine Ecosystem Functions & Processes
  - Ocean & Climate
- Germany specializes in "Ocean & Climate" and "Marine Ecosystem Functions," with a lower overall specialization index compared to other leading European nations.

2. Collaboration and Networking

- Publications in the sub-area of Blue Growth overlapped the most with several other sub-areas. Notably, Marine Ecosystem Functions & Processes and Biodiversity Use and Protection (7.8%), as well as Ocean & Climate and Ocean Crust & Marine Geohazards (7.1%), had the highest shares of co-publications.
- Publications from researchers in Germany are more interdisciplinary than on world average.
- 68% of German Ocean Science publications were written with international partners, indicating a strong global networking.
- Authors from Germany have diverse collaboration with European partners and are particularly collaborating on publications with authors based in the United Kingdom, Switzerland Austria and Belgium.
- In absolute numbers, the Alfred Wegener Institute for Polar and Marine Research (AWI) and GEOMAR Helmholtz Centre for Ocean Research Kiel had the most publications with international partners.
- Key global collaborators are based in the United States and Japan.

3. Research Impact

- Germany's research has a citation impact of 1.38 (ARC=), indicating high relevance and influence within the scientific community.
  - German Ocean Science publications are frequently cited in:
  - Patents (notably in Blue Growth and Ocean Health research)
  - Policy documents (related to global challenges like climate change)
  - News media, where Germany outperformed most European peers.

Executive Summary

4. Gender Aspects
   - At least one woman contributed to 64.5% of German Ocean Science publications, (i.e. 35.5% were written by men only), and only 28.4% of first authors and 16.5% of last authors were women, indicating the challenges of achieving gender parity in Ocean Science.
   - Germany ranks among the lowest in Europe for women's participation in first and last authorships.

5. Societal Contributions
   - German Ocean Science research contributes significantly to addressing UN Sustainable Development Goals, particularly in areas like biodiversity, pollution prevention, and carbon neutrality.
   - Germany's research plays a vital role in tackling complex societal challenges through interdisciplinary and policy-oriented approaches.

6. Limitations of and Future Directions for this bibliometric approach
   - The analysis reveals the selective nature of the Scopus database, which may underestimate contributions from fields like marine social sciences.
   - Future studies should aim to refine bibliometric methods, include more standardized metadata, and better address interdisciplinary overlaps.

Recommendations
- Enhance collaboration with underrepresented regions and disciplines.
- Expand focus on and collaboration with emerging areas like social sciences and humanities in ocean research.
- Increase efforts to promote women in Ocean Science, especially in leadership positions.
- Further development of metadata standardization and harmonization at national level e.g. by supporting a better connection between librarians across national marine research institutions or by improving bibliometric analysis in future studies.
- Consider implementing regular, automatized updates of marine science bibliometric analysis metrics.

Methods & Data Sources

1) Defining Ocean Science Research

For the purposes of this bibliometric study, Ocean Science was categorized into twelve "sub-areas of research". Of these, eight were characterized as "integrative, interdisciplinary and strategic themes for national and international ocean science strategies and policies" by the GOSR (Global Ocean Science Report, 2020). Additionally, four sub-areas of research were included as they were considered essential to comprehensively represent the German Ocean Science community in the bibliometric study. The sub-areas of research are:

1. Blue Growth (GOSR)
2. Marine ecosystems functions and processes (GOSR)
3. Ocean crust and marine geohazards (GOSR)
4. Ocean and climate (GOSR)
5. Biodiversity use and protection
6. Ocean observation and marine data (GOSR)
7. Ocean technology (GOSR)
8. Human health and well-being (GOSR)
9. Carbon neutrality
10. Ocean health (GOSR)
11. Social science and humanities related to ocean science
12. Prevent and eliminate pollution

The database was initially searched using "Ocean Science" as the overarching search term (input), followed by searches for specific sub-areas of research terms. The search terms do not represent disciplines, but were created by Science-Metrix who used its classification of science as a starting point to identify research subfields of relevance to Ocean Science and thus created the Ocean Science data set. Science-Metrix's journal-based classification of scientific research includes five broad domains, 20 fields and 174 subfields (see www.science-metrix.com/en/classification for more details). Of the 174 subfields some were fully (e.g., Fisheries, Marine Biology & Hydrobiology, Oceanography) or partly (e.g., Meteorology & Atmospheric Science) included in a 'seed' data set of Ocean Science. Then, specialized journals highly specific to Ocean Science and its sub-areas were identified and included to enrich the seed data set.

The gender of authors was inferred from the authors' names based on Science-Metrix method, which combines the use of existing and established name/gender lists and the use of NAMSOR, designed to determine the gender of names, taking into account different elements such as given name, surname, ethnicity and country.

2) Countries and Institutions considered in this report

The study calculated bibliometric indicators (Okubo, 1997) for Ocean Science and each of the 12 sub-area of research for publications with at least one author affiliated in Germany, as well as for the 13 most publishing European Union countries apart from Germany but including United Kingdom and Switzerland. Indicators for interdisciplinary collaboration are based on this dataset, whereas the indicators describing regional collaboration patterns are based on a selection of institutes. The institutions were defined as to include major German marine institutions as well as major institutions who published in topics related to ocean sciences.

The current bibliometric analysis includes 85 selected Ocean Science institutions in the calculations:

- 36 German institutions (Annex 3)
- 38 most publishing European institutions in Ocean Science (Annex 4a)
- 11 international institutions (Annex 4b)

All indicators used are referenced to the world level in Ocean Science (or sub-area) of the respective indicator.

3) Data coverage for publications and indicators

The citation impact indicators and cross-disciplinary indicators were calculated for the respective country/institution and are referenced to the world level in Ocean Science research. That is, the citation's score for each publication is normalized to the average indicator across all papers in Ocean Science (worldwide) published in the same year, in the same subfield and as the same type of document. These indicators are not computed for entities with less than 30 publications.

Methods & Data Sources

The indicators based on citations in journal publications are calculated for 2012–2020 only. Citations accrue over time in the years following publication, and citations must have accumulated for at least 3 years (i.e., publication year plus 2) for robust estimation of these indicators. Indicators based on citations by patents are calculated over a shorter period, since it takes more time for publications to accumulate this type of citation. In this study, they were computed up to 2019. A similar period was used for citations in policy-related literature.

4) Bibliometric indicators and specific data sources (detailed information in Annex 2)

The measure of Ocean Science through publication output and trends was calculated for each entity and publication set, by year and overall, where sufficient data exists for robust calculation of indicators. The bibliometric indicators calculated are listed below. The entity may be the country, world or an institute, depending on the indicator. That means, e.g., total number of publications by Germany refers to the number of publications, in which at least one author is affiliated with a German institute. Thus, a publication with eight authors from three countries may be counted three times (once for each country), but not eight times.

4.1) Indicators of growth

- Output volume (absolute number of publications)
- Share of publications (compared to the total number of publications in the category analyzed, e.g., a sub-area)
- Growth in output volume (growth ratio, GR)

4.2) Indicators of specialization

- Specialization index in Ocean Science and by sub-areas of research (SI)
- Publication volume within Ocean Science or corresponding sub-areas

4.3) Indicators of collaboration and cross-disciplinarity patterns

- Average number of authors per publication
- International co-publication rate (and average number of partnering countries on publications)
- Share of co-publications involving authors in Germany
- Collaboration matrix showing the number of co-publications between all selected institutions
- Cross-thematic integration (share of co-publications between categories)
- Disciplinary Diversity of Authors (DDA)
- Disciplinary Diversity of References (DDR)

4.4) Indicators of gender aspects

- Share of women authors (as at least one participating author)
- Share of women as first or last author

4.5) Indicators of citation impact

- Citation impact within the scientific community (in main report: Average Relative Citation ARC)
- Citation impact in news media (share of scientific publications cited by a news media)
- Citation impact in the patent literature (share of scientific publications cited by a patent)
- Citation impact in policy-relevant literature (share of scientific publications cited by a policy-relevant document)

4.6) Indicators of publications and collaboration

- Top 20 scientific journals (Germany and Worldwide)

4.7) Indicator of contributions to complex societal challenges

- Share of publications related to UN Sustainable Development Goals (for SDGs 1 to 16)

The following Figures 1-10, Tables 1-8 and Annexes were generated by Science-Metrix using data from Scopus. The R programming language (2021) was used for statistical computing and data visualization. Figure 11 and tables d in Annex 6-9 were generated by the authors based on the data provided by Science-Metrix using R.

ADDITIONAL INFO

For a discussion of this approach and its limitations, see: http://www.science-metrix.com/sites/default/files/science-metrix/publications/science-metrix_bibliometric_indicators_womens_contribution_to_science_report.pdf

1) Germany's publication activity in Ocean Science from 2012 to 2022

During the decade from 2012 to 2022, a total of 79,538 publications (full counting, where each entity received a count of 1 for each publication it is involved in) were published by scientists in Ocean Science affiliated with German institutions (*Figure 1*). The output increased from 5,843 publications in 2012 to 8,511 in 2021. The 2022 output was lower, but Scopus coverage was still not fully complete at the time of analysis. The number of publications increased by 24% in the period 2018–2022 compared to 2012–2016.

Germany's output accounted on average for a share of 5.6% on the global publications in Ocean Science research over the entire study period. However, the share on the global output decreased from 6.1% in 2012 to 4.8% in 2022. This trend is similar for most Western countries, and it parallels the increase in China's share of world output (pers. comm. Science-Metrix).

1.1) Germany's output and share by sub-areas of research

Most publications in Germany on Ocean Science research were in the sub-areas of Blue Growth (18,217), Marine Ecosystem Functions & Processes (17,795) and Ocean & Climate (17,950). The lowest output in Ocean Science research was achieved in the Social Sciences & Humanities related to ocean science (1,003) and in topics related to the Prevention and Elimination of Pollution (692; *Figure 2*). However, the Scopus database underestimated publications in Social Sciences & Humanities because such publications are often published in journals or media that are not included in the database. This could explain the comparatively low absolute number of publications in this sub-are of research (Pelke & Simonn, 2023). Still, the overall number of 23,204 publications in the Social Sciences & Humanities sub-area was well beyond the total number found for publications in marine social sciences on sustainability in Web of Science from 1991-2022 (1,215); demonstrating a strong increase in publications in the sub-area. At the global level, publications from Germany provided ca. 4% in this sub-area, which is comparable to most others sub-areas and indicting this share to be typical or suffering from the same shortcoming in the database Scopus.

1.2) Germany's Ocean Science publication activity in comparison with major European countries

Germany is the second largest European contributor to Ocean Science research output with more than 70,000 publications (*Figure 3*) after the United Kingdom, which produced over 100,000 peer-reviewed publications between 2012 and 2022. France, Italy, and Spain complete the top five of the highest number of publications and

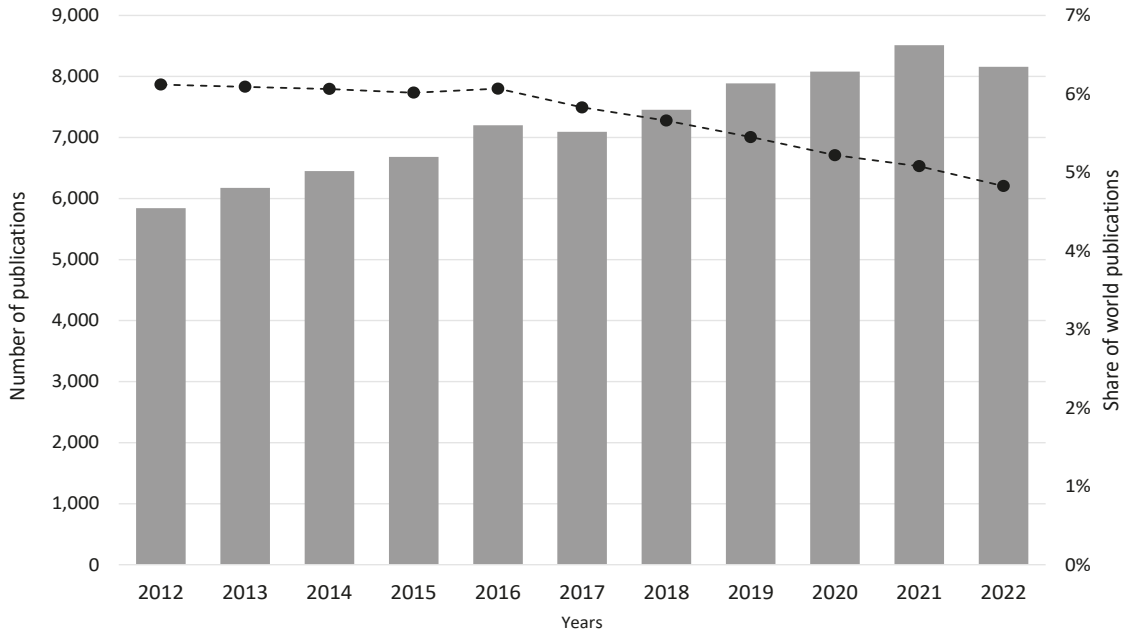


Figure 1. Germany's annual publication activity from 2012 to 2022 in Ocean Science Research, where the dashed line shows the share of World publications.

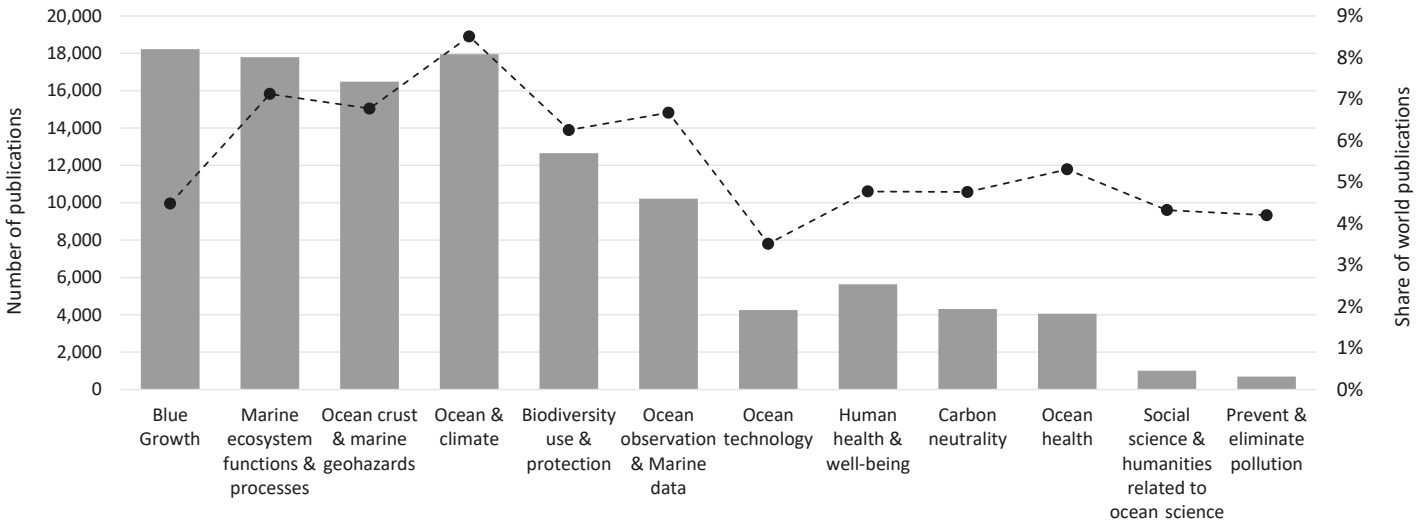
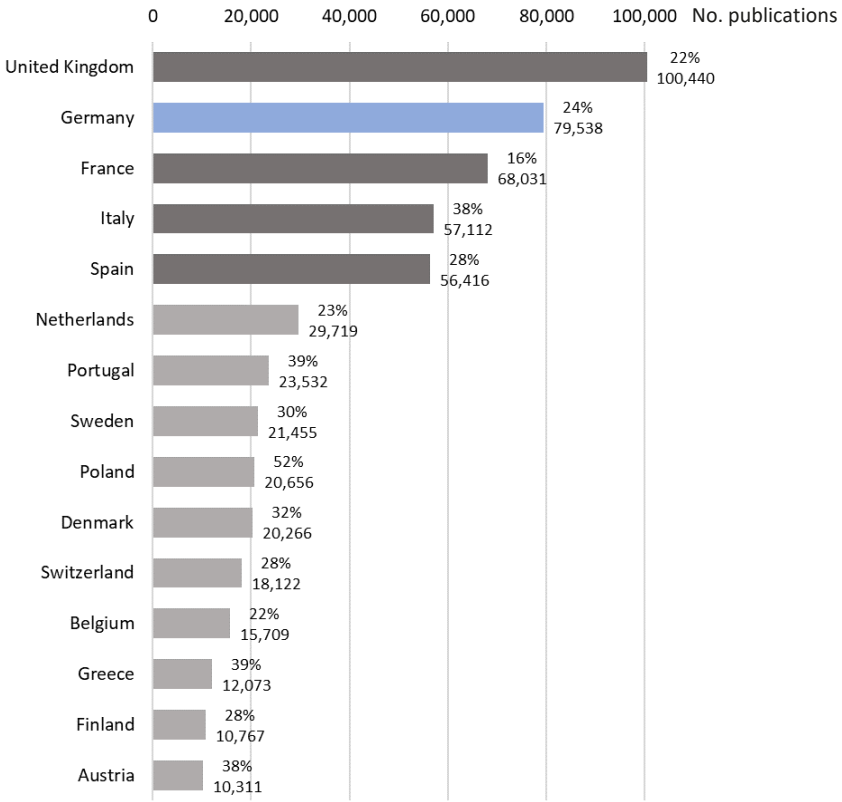


Figure 2.
Germany's publication activity from 2012 to 2022 in in the 12 sub-areas of Ocean Science research; where the dashed line shows the share of World publications (see also Table 2).

Figure 3.
Number of publications in Ocean Science for the 15 major European Countries in the period 2012 to 2022 and output growth rate comparing period 2012 to 2016 with 2018 to 2022 (in %).



growth in Ocean Science. These five countries each have substantially more publications than the next group of European countries, with a gap of over 25,000 publications in Ocean Science. They are among the countries with the most scientific personnel in Ocean Science across Europe. However, Portugal and France employed the most people in 2016 and 2017, respectively (GOSR, 2020, *Table 4.1*). All countries showed growth in output between the period of 2018–2022 and of 2012–2016; they have however experienced a slower pace than the global output in Ocean Science (world's growth: 44%).

The five European countries (United Kingdom, Germany, France, Spain and Italy) with the highest number of publications in Ocean Science showed similar patterns of output in the different sub-areas of research (*Figure 4*). Compared to France, Spain and Italy, authors in Germany published slightly more in the sub-areas Marine ecosystem, Ocean crust and Ocean & climate but published as much as the other three countries in the remaining sub-areas of research. Authors from the United Kingdom published most in the sub-area Blue Growth, while those from Italy and Spain were relatively more active in Blue Growth when compared to total activity. Authors from Germany published relatively more in Marine ecosystems functions & processes, Ocean & climate, and Biodiversity use and protection sub-areas. The two disciplines with the least publications from the top five European countries were Social science & humanities related to ocean science and Prevent & eliminate pollution.

Results

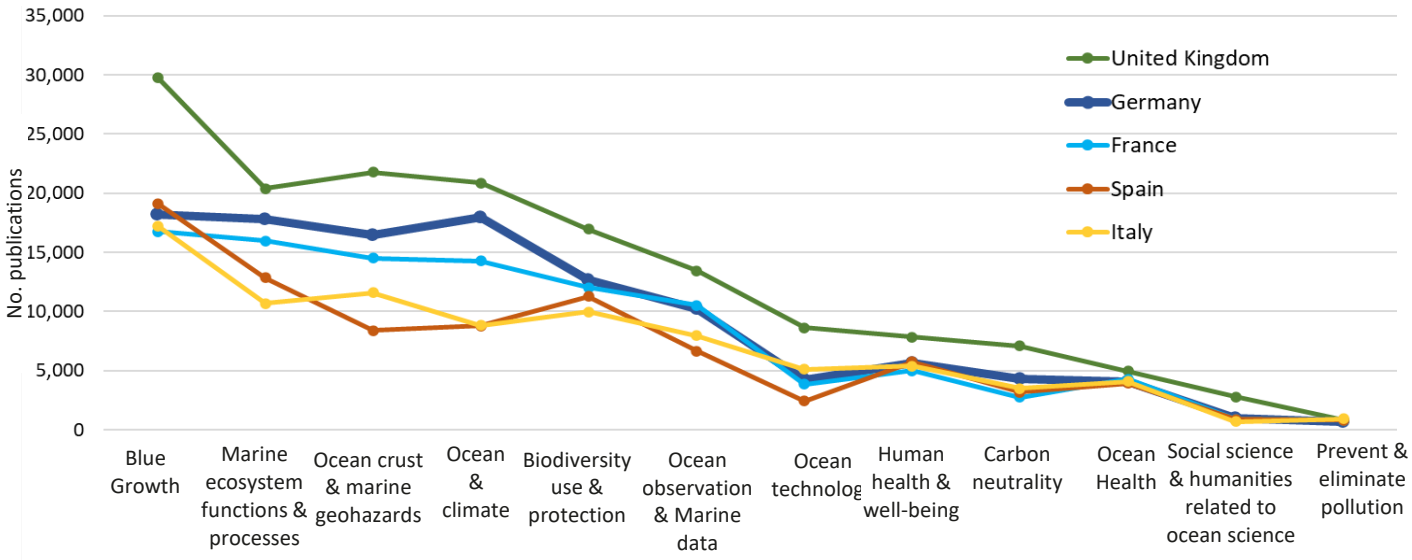


Figure 4.
Number of publications of the five most publishing European countries in each sub-area of research.

The scientific output and impact of the topmost publishing EU countries in the 12 established sub-area of research are presented in Annex 5. For example, the publication efforts in social sciences increased in all European countries considered here. These tables demonstrated that the German scientific output increased for all sub-areas during the study period. The tables further provide indicators about scientific impact or gender aspects.

1.3) Germany's Specialization in Ocean Science

Using the Specialization index (SI; see Annex 2), Germany is less specialized compared to the world average (SI <1) and to the four other most publishing European countries (United Kingdom, France, Spain, Italy; *Table 1*). However, at the level of sub-areas of research, Germany is more specialized than the world average, with a particular focus on Ocean & Climate (SI=1.40), in Marine Ecosystem Functions & Processing (SI=1.17). In contrast, Portugal was the European country most specialized in all areas of Ocean Science (SI=1.82) and also the most specialized in most sub-areas of research.

Table 1.
Specialization index (SI) in Ocean Science research and sub-areas of research for each selected country (2012-2022). The colors indicate the degree of specialization in a research area, where red is (< 1) less specialized, green (> 1) is more specialized, and white indicates the same specialization as the world average.

Countries	Global Ocean Science	Blue Growth	Marine ecosystem functions & processes	Ocean crust & marine geohazards	Ocean & climate	Biodiversity use & protection	Ocean observation & Marine data	Ocean technology	Human health & well-being	Carbon neutrality	Ocean health	Social science & humanities related to ocean science	Prevent & eliminate pollution
World	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Portugal	1.82	2.50	2.51	1.48	1.59	2.93	2.02	1.85	2.56	1.80	3.23	1.38	2.62
Denmark	1.47	1.79	2.14	1.30	1.71	1.94	1.88	1.19	1.39	2.41	1.40	1.22	1.49
Greece	1.24	1.61	1.24	1.36	1.28	1.63	1.77	1.62	1.35	1.55	1.66	1.11	1.60
Spain	1.19	1.41	1.54	1.04	1.25	1.67	1.31	0.61	1.47	1.05	1.54	1.14	1.47
France	1.17	1.00	1.56	1.45	1.65	1.45	1.68	0.77	1.03	0.74	1.38	0.97	1.21
United Kingdom	1.08	1.12	1.24	1.36	1.51	1.28	1.34	1.09	1.01	1.19	0.99	1.83	0.78
Sweden	1.06	1.07	1.55	0.89	1.46	1.58	1.21	0.76	1.11	1.10	1.43	1.12	0.91
Finland	1.04	1.11	1.58	0.59	1.53	1.62	1.37	0.96	1.06	0.92	1.52	1.08	1.01
Netherlands	1.00	0.99	1.19	1.15	1.48	1.27	1.26	1.03	1.03	1.02	0.96	1.41	0.95
Italy	1.00	1.05	1.06	1.18	1.04	1.23	1.29	1.05	1.13	0.96	1.34	0.76	1.43
Belgium	0.95	0.92	1.29	0.85	1.10	1.27	1.14	0.51	0.98	0.83	1.06	1.04	0.89
Germany	**0.92**	**0.74**	**1.17**	**1.11**	**1.40**	**1.03**	**1.10**	**0.58**	**0.78**	**0.78**	**0.87**	**0.71**	**0.69**
Poland	0.87	0.72	0.97	0.79	0.72	0.91	0.70	0.86	0.86	0.65	1.10	0.79	0.90
Austria	0.81	0.59	1.05	0.93	0.95	0.96	0.80	0.28	0.67	0.74	0.72	0.57	0.40
Switzerland	0.79	0.55	1.03	1.02	1.27	0.98	0.86	0.30	0.63	0.65	0.73	0.65	0.32

2) Collaboration structures in German Ocean Science

2.1) Interdisciplinary publication patterns

The interdisciplinary publications patterns for this report were defined as publications listed in more than one category. The largest thematic overlap was between Marine ecosystem functions & process and Biodiversity use & protection (7.8% of publications), Ocean crust & Marine geohazards and Ocean & climate (7.1%) as well as between Blue Growth and Marine ecosystem functions & processes (5.7%; Table 2). Overall, Blue Growth was the sub-area overlapping most with all other subareas. The sub-areas Ocean technology, Carbon neutrality, Social sciences and Prevent & eliminate pollution showed < 1% overlap with any other sub-area (except Blue Growth). The latter result is biased by the overall smaller number of publications reported in these sub-areas (see Figure 2).

Other indicators of interdisciplinary research were calculated based on disciplinary diversity of authors (DDA) and references (DDR). Here, Germany usually ranked together with the four other most publishing European countries (Annex 2) and always had a higher score than world average. Interestingly, for the sub-area Prevent & eliminate pollution, interdisciplinary collaboration was higher than in all other sub-areas (DDR 1.14, DDA 1.25).

Table 2.
Germany's interdisciplinary publications where the scores (%) represent the share of Ocean Science publications covering multiple research sub-areas for 2012-2022; decimals are here marked by a comma (",") in accordance with German formatting conventions.

	Blue Growth	Marine ecosystem functions & processes	Ocean crust & marine geohazards	Ocean & climate	Biodiversity use & protection	Ocean observation & Marine data
Blue Growth		5.7%	3.6%	3.8%	6.2%	2.9%
Marine ecosystem functions & processes	5.7%		4.9%	6.2%	7.8%	3.2%
Ocean crust & marine	3.6%	4.9%		7.1%	2.5%	3.0%
Ocean & climate	3.8%	6.2%	7.1%		3.8%	4.9%
Biodiversity use & protection	6.2%	7.8%	2.5%	3.8%		2.5%
Ocean observation & Marine	2.9%	3.2%	3.0%	4.9%	2.5%	
Ocean technology	2.1%	0.2%	0.6%	0.5%	0.2%	0.5%
Human health & well-being	4.0%	2.0%	0.9%	1.2%	2.2%	0.8%
Carbon neutrality	3.9%	0.5%	0.7%	0.6%	0.4%	0.5%
Ocean health	1.6%	2.0%	0.8%	1.2%	1.9%	0.7%
Social science & humanities related to ocean science	0.3%	0.1%	0.3%	0.3%	0.2%	0.1%
Prevent & eliminate pollution	0.3%	0.3%	0.1%	0.1%	0.2%	0.1%

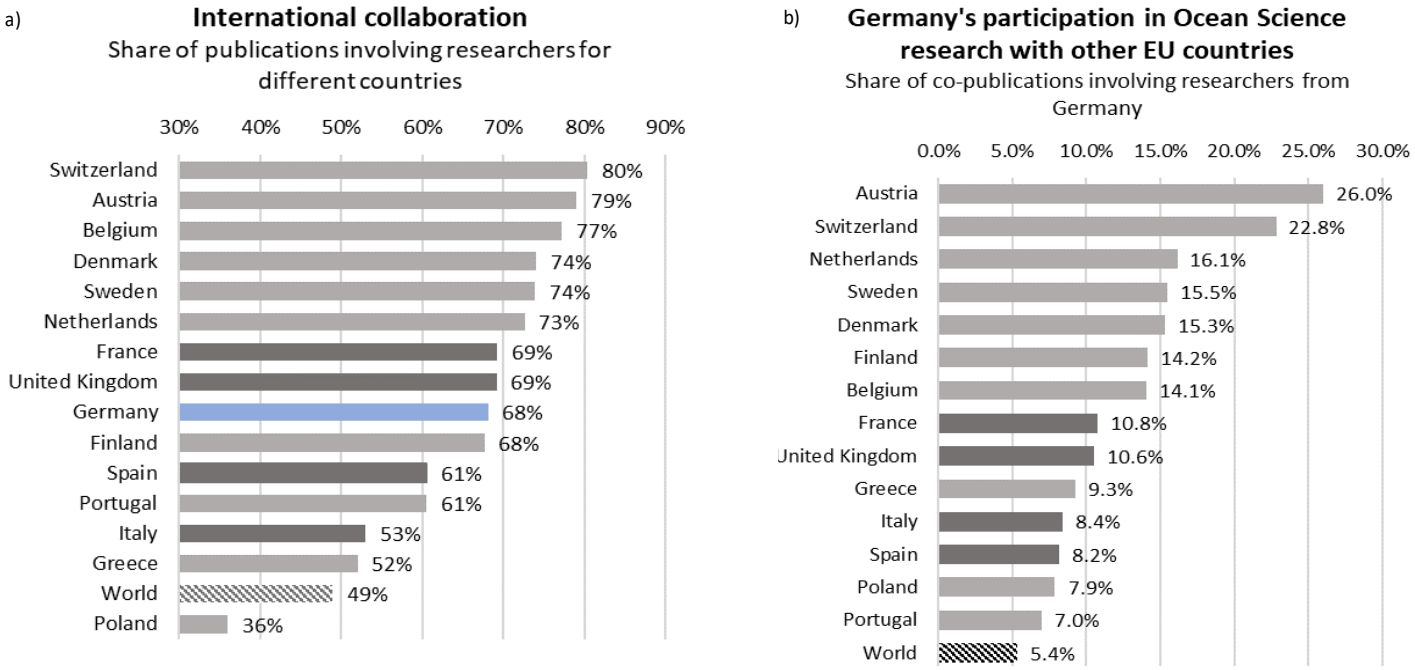
	Ocean technology	Human health & well-being	Carbon neutrality	Ocean health	Social science & humanities related to ocean science	Prevent & eliminate pollution
Blue Growth	2.1%	4.0%	3.9%	1.6%	0.3%	0.3%
Marine ecosystem functions & processes	0.2%	2.0%	0.5%	2.0%	0.1%	0.3%
Ocean crust & marine geohazards	0.6%	0.9%	0.7%	0.8%	0.3%	0.1%
Ocean & climate	0.5%	1.2%	0.6%	1.2%	0.3%	0.1%
Biodiversity use & protection	0.2%	2.2%	0.4%	1.9%	0.2%	0.2%
Ocean observation & Marine data	0.5%	0.8%	0.5%	0.7%	0.1%	0.1%
Ocean technology		0.1%	0.9%	0.1%	0.0%	0.0%
Human health & well-being	0.1%		0.2%	0.5%	0.1%	0.2%
Carbon neutrality	0.9%	0.2%		0.1%	0.1%	0.0%
Ocean health	0.1%	0.5%	0.1%		0.0%	0.3%
Social science & humanities related to ocean science	0.0%	0.1%	0.1%	0.0%		0.0%
Prevent & eliminate pollution	0.0%	0.2%	0.0%	0.3%	0.0%	

2.2) Regional geographic collaboration patterns

International collaborations are highlighted by the networking presence of German Ocean Science in the data. A total of 68% of German publications in Ocean Science were published with international partners (Figure 5a). This was similar to the other four top publishing countries United Kingdom (69%), France (69%), Spain (61%) and Italy (53%). However, the countries that collaborated most with other countries in the Ocean Science were Switzerland, Austria and Belgium (Figure 5a). Indeed, researchers in Germany participated in about 22,8 to 26% publications with researchers from Switzerland and from Austria, respectively (Figure 5b), making up the highest share of international collaboration in other countries. Figure 5 further showed that the share of co-publications involving authors from Germany was lower for the most publishing European countries (<11%). Still, given the lower absolute publication output by Austria (10,311) and Switzerland (18,122), authors from Germany co-authored more publications with the five most publishing countries (who each published > 50,000 publications). Overall, the results suggest that scientists in Germany tend to publish with many international partners and have diverse collaboration practices in Ocean Science.

Figure 5.

a) International collaboration showing the share of publications (%) involving at least one researcher from a different country, b) Germany's participation in Ocean Science research with other European countries showing the share of co-publications involving researchers from Germany (%). Note that absolute number of publications varies strongly among countries (Figure 3).



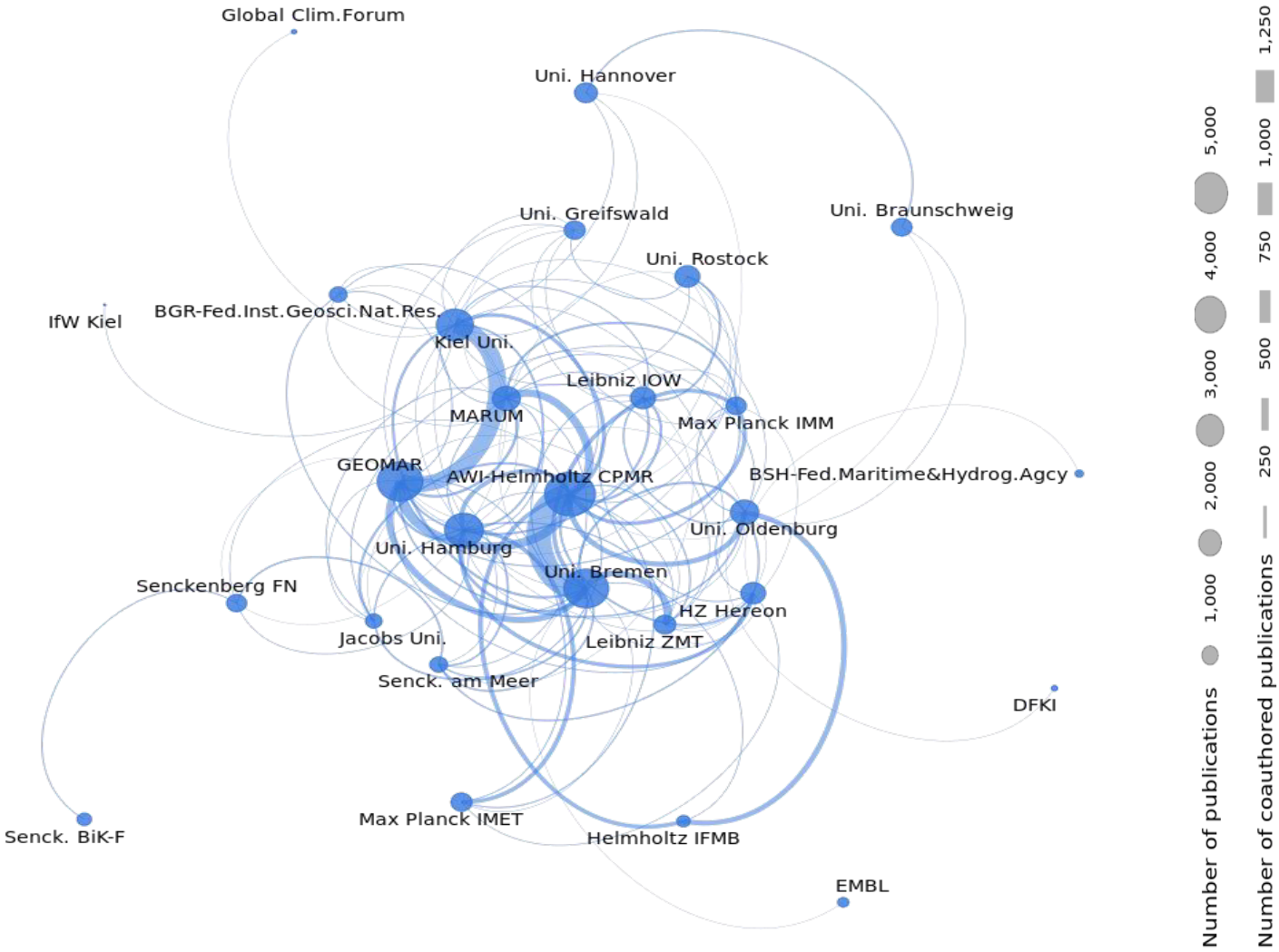


Figure 6.
Collaboration network of selected German institutions with German institutions in Ocean Science research (2012–2022), where the size of the bubbles is proportional to the number of publications. The width of the links is proportional to the number of co-publications. The collaboration links with fewer than 20 co-publications are not included.*

**Note: For this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen*

2.3) Inter-institutional collaboration in Germany

The collaboration structures and international networking underlying the German Ocean Science research was investigated on three different levels: 1) within the community of selected German institutions (Figure 6), 2) between the selected German institutions and selected European institutions (Figure 7) and 3) between the selected German institutions and selected international institutions (Figure 8).

German research institutions focusing on Ocean Science, such as the Alfred-Wegener-Institut, Helmholtz Zentrum für Polar- und Meeres-forschung and GEOMAR Helmholtz Zentrum für Ozeanforschung Kiel were central within the German Ocean Science collaboration network with many co-publications. This was followed by the University of Bremen, the University of Hamburg and Kiel University (note that for this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen). The above-mentioned institutions as well as most of the studied German institutions share numerous collaboration links between each other (Figure 6, Annex 6). It cannot be excluded that part of these collaborations stems from multiple affiliations of the same author, such as joint professorships between the University of Bremen and the AWI or Kiel University and

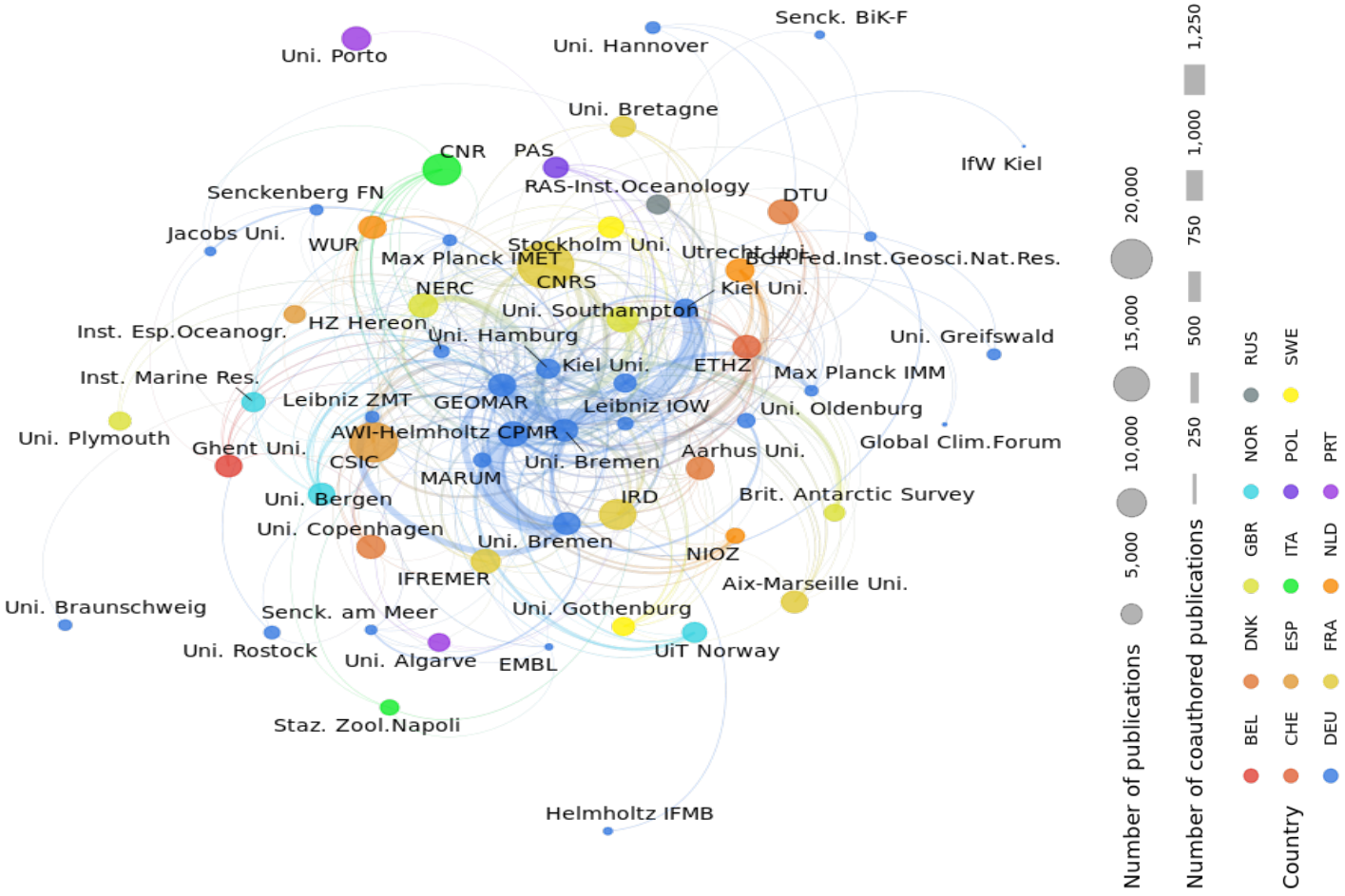


Figure 7.
Collaboration network of selected German and European institutions in Ocean Science research (2012–2022), where the size of the bubbles is proportional to the number of publications. The width of the links is proportional to the number of co-publications. Collaboration links with fewer than 20 co-publications are not included. Countries: Belgium (BEL), Denmark (DNK), United Kingdom (GBR), Norway (NOR), Russia (RUS), Switzerland (CHE), Spain (ESP), Italie (ITA), Poland (POL), Sweden (SWE), Germany (DEU), France (FRA), Netherland (NLD), Portugal (PRT).

GEOMAR. Nevertheless, even such joint professorships demonstrate the close collaboration between these institutions. The four most frequent institutional co-publishers were the AWI and the University of Bremen, with 1,258 co-publications; GEOMAR and Kiel University with 923; the AWI and GEOMAR, with 508; and finally, the AWI with MARUM, with 430. Details of bilateral collaborations with > 200 co-publications are presented in Annex 6a, while those with 15 and less are in Annex 6b. Some institutes have fewer co-publication partners of the tested German institutes, 16 co-published with at least 10 partners (Annex 6c). The AWI, Kiel University and University of Bremen were the institutes with the highest number of publishing partners from Germany. Institutes in more Eastern or Southern regions of Germany usually show less collaboration partners, with the exception of the Leibniz IOW (Figure 6, Annex 6c). Still, geographic proximity seems to enhance collaboration.

2.4) Collaboration between selected institutions in Germany and Europe, and the World

The collaboration network between German institutions and selected European institutions (Figure 7, Annex 7a-d) showed that the top three collaboration were between 1) GEOMAR and University Southampton with 384 co-pubs, 2) the AWI with the NERC with 374 and 3) the AWI with the CNRS with 325. Following GEOMAR

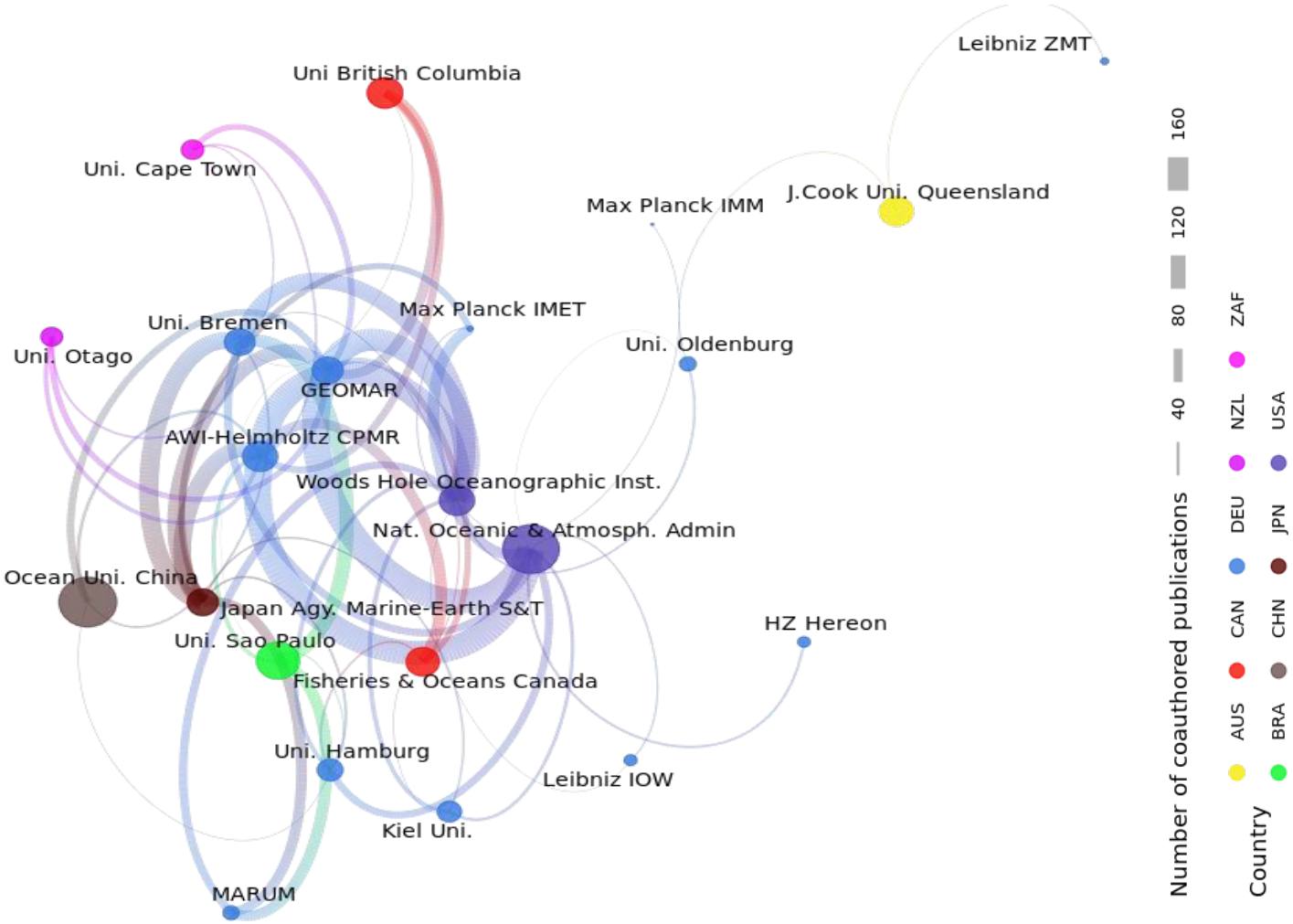


Figure 8.

Collaboration network of selected German institutions with international institutions in Ocean Science research (2012–2022), where the size of the bubbles is proportional to the number of publications. The width of the links is proportional to the number of co-publications. Collaboration links with fewer than 20 co-publications are not included. Countries: Australia (AUS), Canada (CAN), Germany (DEU), New Zealand (NZL), South Africa (ZAF), Brazil (BRA), China (CHN), Japan (JPN), United States (USA).*

**Note: For this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen*

and the AWI, the University of Bremen was of the third German institution who published the most with European institutes (Annex 7a). A large number of German institutes co-authored 10 or less publications with European institutes (Annex 7b). To provide an overview of how many European institutions German research institutes collaborate with, a comprehensive list was compiled (Annex 7c). The number of publishing collaborations held by European institutions was also examined, with the CNRS (23 partners) and the CSIC (22 partners) had the highest number of German co-publishing institutions. Notably, these collaborations included at least 10 co-authored papers (Annex 7d).

The collaboration of German institutions with the selected international institutions showed that the main collaborators are in the United States and Japan (Figure 8, Annex 8a-d). The AWI (170), GEOMAR (170) and University Bremen (162) are the German institutions with the highest number of co-publications with NOAA, Woods Hole Oceanographic Institute (WHOI) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Other selected German institutes which co-publish 10-15 publications with one of the non-European institutions is also presented (Annex 8b). Of the selected German institutes in Ocean Science, 17 co-published at least 10 publications with at least one of the selected international partners (Annex 8c).

3) Germany's impact through publications on the scientific community and on society

3.1) Impact on the scientific community

The impact of Germany's Ocean Science publications on the scientific community was measured with a citation impact i.e. the average of relative citations (ARC). These results showed that research with authors from Germany are cited more frequently than the global average.

Germany seemed to be one of the lesser specialized in Ocean Science among European countries with a specialization value of 0.92; meaning that Germany invests proportionately less effort than average in Global Ocean Science. It, however, appeared to be one of the countries which published a large number of impactful papers (Figure 9). Germany's published research had an ARC value of 1.38, which ranks in the top countries compared to the average number of citations received by all papers in Global Ocean Science (world-level) published in the same year and as the same type of document.

The specialization and scientific impact between 2012 and 2022 for the most publishing European countries was also calculated for each sub-area of research (Annex 5). This analysis showed that Germany put the most emphasis on sub-area Ocean & Climate research. This means Germany was the most specialized in this area compared to other sub-areas (Figure 10).

	Global Ocean Science	Blue Growth	Marine ecosystem functions & processes	Ocean crust & marine geohazards	Ocean & climate	Biodiversity use & protection	Ocean observation & Marine data	Ocean technology	Human health & well-being	Carbon neutrality	Ocean health	Social science & humanities related to ocean	Prevent & eliminate pollution
World	**1.00**	**1.07**	**1.07**	**1.00**	**1.10**	**1.17**	**1.08**	**0.93**	**1.12**	**1.24**	**1.23**	**1.00**	**1.46**
Switzerland	1.75	1.90	1.95	1.50	1.98	2.19	2.17	1.56	1.86	1.63	1.87	1.78	3.34
Netherlands	1.67	1.77	1.81	1.60	1.90	2.02	1.98	1.38	2.12	1.68	1.89	1.59	3.75
Denmark	1.59	1.64	1.77	1.53	1.84	1.96	1.74	1.60	2.04	1.72	1.79	1.62	1.89
Sweden	1.52	1.62	1.71	1.43	1.70	1.90	1.67	1.26	1.74	1.51	1.56	1.29	1.87
Austria	1.52	1.53	1.61	1.35	2.29	1.97	2.68	1.23	1.77	1.20	1.46	1.68	2.06
United Kingdom	1.51	1.60	1.63	1.46	1.69	1.85	1.80	1.38	1.81	1.67	1.85	1.42	2.70
Belgium	1.49	1.62	1.59	1.46	1.78	1.80	1.78	1.38	1.86	1.78	1.72	1.52	1.58
Germany	**1.38**	**1.44**	**1.51**	**1.32**	**1.51**	**1.70**	**1.52**	**1.22**	**1.57**	**1.37**	**1.57**	**1.15**	**1.89**
Finland	1.37	1.53	1.46	1.47	1.42	1.67	1.58	1.57	1.63	1.72	1.43	1.04	1.13
France	1.34	1.41	1.46	1.30	1.54	1.58	1.53	1.20	1.46	1.38	1.39	0.96	2.02
Italy	1.32	1.46	1.50	1.22	1.52	1.60	1.46	1.42	1.55	1.58	1.60	1.16	1.77
Portugal	1.24	1.36	1.30	1.11	1.33	1.40	1.27	1.63	1.42	1.72	1.25	0.69	1.72
Spain	1.24	1.31	1.36	1.15	1.38	1.48	1.44	1.22	1.48	1.45	1.38	0.89	1.77
Greece	1.21	1.31	1.28	1.11	1.39	1.53	1.44	1.03	1.48	1.31	1.45	1.14	1.36
Poland	0.85	1.00	0.98	0.80	0.98	1.06	1.04	0.73	1.03	0.89	0.94	0.75	0.78

Table 3.

ARC for each sub-area of research for each tested country is indexed to world level in Ocean Science, where a score above 1 indicates that a given entity is cited more frequently than the world average in Ocean Science, while a score below 1 shows the opposite. At the world level, apart from Ocean technology (ARC=0.93), the ARC in each sub-area equals with or is above the average papers in Ocean Science (>1.00).

Country	Pubs	SI	ARC
World	**1,422,722**	**1.00**	**1.00**
United Kingdom	100,440	1.08	1.51
Germany	**79,538**	**0.92**	**1.38**
France	68,031	1.17	1.34
Italy	57,112	1.00	1.32
Spain	56,416	1.19	1.24
Netherlands	29,719	1.00	1.67
Portugal	23,532	1.82	1.24
Sweden	21,455	1.06	1.52
Poland	20,656	0.87	0.85
Denmark	20,266	1.47	1.59
Switzerland	18,122	0.79	1.75

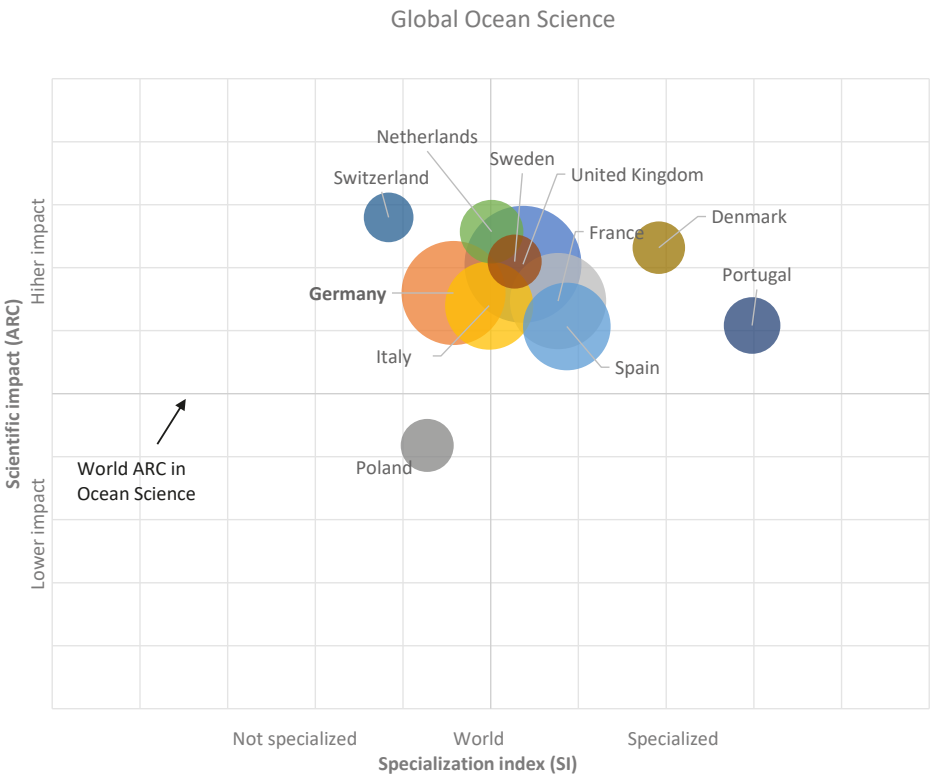


Figure 9.
Specialization and scientific impact between 2012 and 2022 for the most publishing European countries including United Kingdom and Switzerland: a) shows the relationship of each country to the World for their publication number (Pubs), their specialization index (SI) and their scientific impact as the average of relative citations (ARC); and b) the positional plot in Global Ocean Science research showing relations between countries.

Country	Pubs	SI	ARC
World	**211,008**	**1.00**	**1.10**
United Kingdom	20,883	1.51	1.69
Germany	**17,950**	**1.40**	**1.51**
France	14,282	1.65	1.54
Italy	8,838	1.04	1.52
Spain	8,799	1.25	1.38
Netherlands	6,490	1.48	1.90
Sweden	4,407	1.46	1.70
Switzerland	4,297	1.27	1.98
Denmark	3,508	1.71	1.84
Portugal	3,058	1.59	1.33
Poland	2,560	0.72	0.98

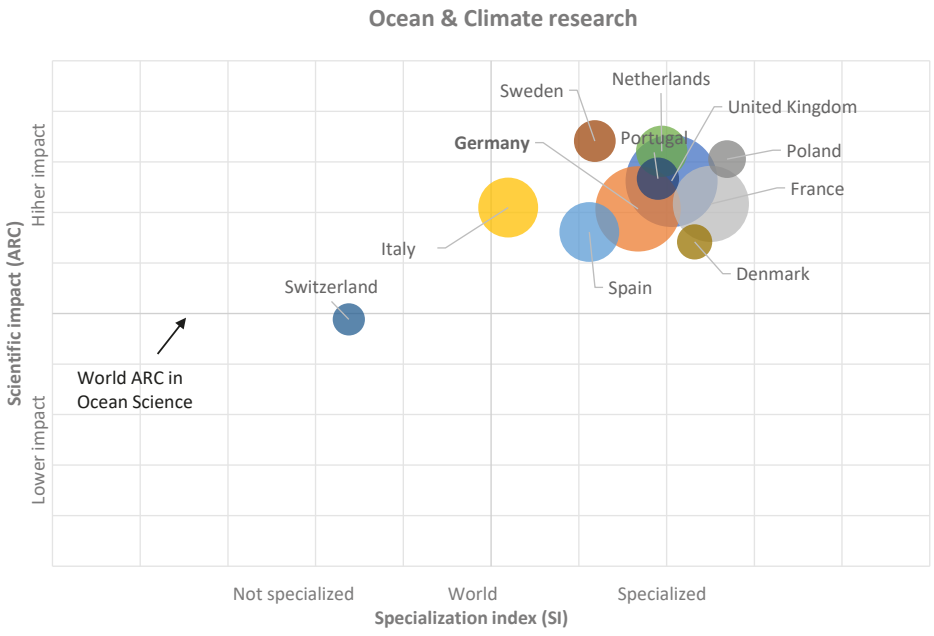


Figure 10.
Germany positional plot for Ocean & climate research. a) shows the relationship of each country to the World for their publication number (Pubs), their specialization index (SI) and their scientific impact as the average of relative citations (ARC); and b) the positional plot in Global Ocean Science research showing relations between countries for the sub-area Ocean & climate.

3.2) Impact beyond the scientific community

Patents

Germany's share of output in Ocean Science that was cited by patents (Table 4) was generally above average (score=1.22). Only the Netherlands (1.59), Switzerland (1.42) and the United Kingdom (1.25) had more output cited in patent related literature. Publications from Germany in the sub-areas of Blue Growth, Human health & well-being, Carbon neutrality, Ocean health, and Prevention & elimination of pollution were the most cited by patents.

Policy-relevant literature

The proportion of Germany's Ocean Science output referenced in policy-relevant literature (e.g., research cited in policy relevant documents to inform decisions on global challenges such as climate change) was on average above expectation (score=1.38, Table 5). Germany performed similarly to the other most publishing European countries (France=1.33, Italy=1.37, and Spain=1.45), except for the United Kingdom (1.78) which performed better. Notably, the Scandinavian countries (Denmark, Sweden, Finland) performed best.

Publications in the sub-areas of research like Blue Growth, Human health & well-being, Carbon neutrality, Ocean health, and Prevent & eliminate pollution were the most cited by policy relevant literature.

News media

Germany's share of output in Ocean Science that was mentioned in news items was also usually above expectation (score=1.66, Table 6). Germany performed better than the other large publishing European countries (France=1.32, Italy=1.12 and Spain=1.21). Overall, the United Kingdom performed best. Publications in the sub-areas of Blue Growth, Biodiversity use & protection, Human health & well-being, and Ocean health were the most mentioned in the news.

Indicator of contributions to complex societal challenges

Complex societal challenges are presented in Table 7, it demonstrates the share of publications related to UN Sustainable Development Goals (for SDGs 1 to 16) as to indicate the extent to which research efforts align with these global priorities.

Normalised share of publications cited by patents

	Global Ocean Science	Blue Growth	Marine ecosystem functions & processes	Ocean crust & marine geohazards	Ocean & climate	Biodiversity use & protection	Ocean observation & Marine data	Ocean technology	Human health & well-being	Carbon neutrality	Ocean health	Social science & humanities related to ocean science	Prevent & eliminate pollution
World	**1.00**	**1.12**	**0.72**	**0.79**	**0.66**	**0.64**	**1.16**	**1.02**	**1.20**	**1.27**	**0.92**	**1.00**	**0.85**
Netherlands	1.59	1.69	1.04	1.39	1.18	1.01	1.31	1.17	1.48	2.05	1.07	4.27	4.60
Switzerland	1.42	1.69	0.96	0.91	0.88	0.83	1.71	1.80	1.98	1.29	1.86	5.92	0.00
United Kingdom	1.25	1.31	0.72	1.02	1.00	0.58	1.29	1.22	1.34	1.65	1.06	0.79	2.00
Germany	**1.22**	**1.44**	**0.82**	**0.95**	**0.99**	**0.63**	**1.17**	**1.04**	**1.77**	**1.81**	**1.31**	**0.00**	**2.07**
Belgium	1.21	1.28	0.99	1.39	1.26	0.69	0.67	0.30	1.98	1.79	2.56	0.00	0.17
Austria	1.08	1.59	0.56	0.44	1.22	1.23	1.37	1.29	3.81	2.19	1.54	0.00	2.30
Denmark	1.06	1.26	0.83	0.44	0.54	0.87	1.07	1.20	1.53	1.60	1.04	0.00	3.64
France	1.05	1.18	0.75	0.94	0.50	0.62	1.10	1.41	1.38	1.33	0.83	0.00	3.62
Sweden	1.01	1.27	0.62	0.60	0.48	0.66	1.13	1.71	1.86	1.57	0.39	0.00	2.02
Finland	1.01	0.60	0.72	0.37	0.56	0.52	0.77	1.02	1.45	1.54	0.75	0.00	2.87
Spain	0.89	1.01	0.53	0.78	0.74	0.27	1.02	0.95	0.98	1.29	0.54	2.81	0.39
Italy	0.84	0.90	0.88	0.78	0.62	0.59	0.83	0.90	1.37	1.23	0.45	0.00	1.10
Portugal	0.77	1.04	0.84	0.51	0.33	0.15	0.75	0.90	1.37	0.78	0.39	3.58	0.00
Poland	0.57	0.53	0.37	0.30	0.05	0.33	0.60	0.65	0.71	0.73	0.52	0.00	0.04
Greece	0.48	0.46	0.16	0.17	0.27	0.10	0.29	0.62	0.80	0.41	0.49	0.00	0.00

Table 4.

Germany's share of output in Ocean Science cited by patents between 2012-2022. The world level in Ocean Science share is indexed to 1 and the colors show the relationship to the index. Red represents a share lower than the world's share, white shows a share equal to the world average and to green a share higher than the world's. Countries are listed descending from the highest to lowest share of cited papers in Ocean Science research as a whole.

Normalised share of publications cited by policy-related documents

	Global Ocean Science	Blue Growth	Marine ecosystem functions & processes	Ocean crust & marine geohazards	Ocean & climate	Biodiversity use & protection	Ocean observation & Marine data	Ocean technology	Human health & well-being	Carbon neutrality	Ocean health	Social science & humanities related to ocean science	Prevent & eliminate pollution
World	**1.00**	**1.38**	**1.15**	**1.12**	**1.44**	**1.47**	**1.32**	**0.91**	**1.59**	**1.45**	**1.36**	**1.00**	**1.58**
Denmark	2.01	2.60	1.93	1.96	2.51	2.39	2.57	1.67	2.76	2.99	3.62	1.95	5.00
Sweden	2.00	2.58	2.07	2.05	2.33	2.51	2.45	2.20	3.04	1.91	2.71	1.60	2.44
Finland	1.98	2.89	2.23	2.77	2.17	2.73	2.22	2.11	3.22	3.35	2.95	1.34	3.16
Netherlands	1.96	2.79	1.76	1.88	2.36	2.53	2.27	1.84	3.27	3.52	2.94	1.58	5.56
Belgium	1.84	2.26	1.69	2.13	2.44	2.16	2.34	2.05	3.00	2.34	2.60	1.65	1.87
United Kingdom	1.78	2.48	1.88	1.73	2.38	2.47	2.41	1.82	2.96	2.64	2.78	1.39	3.47
Greece	1.72	2.54	1.51	1.57	1.64	2.33	2.26	1.74	2.86	3.95	1.74	0.55	1.81
Switzerland	1.55	2.48	1.54	1.19	2.15	2.12	2.19	1.29	2.91	2.85	2.10	1.33	3.95
Spain	1.45	1.92	1.55	1.55	1.94	1.81	1.79	1.58	2.68	2.01	1.71	0.80	1.78
Germany	**1.38**	**2.14**	**1.41**	**1.42**	**1.86**	**1.88**	**1.85**	**1.61**	**2.21**	**2.57**	**2.13**	**1.21**	**3.50**
Italy	1.37	1.98	1.50	1.21	1.67	1.85	1.55	1.69	2.12	2.09	1.85	0.88	3.63
France	1.33	2.07	1.40	1.31	1.72	1.73	1.71	1.31	2.14	2.54	1.44	0.91	2.02
Portugal	1.18	1.60	1.22	1.43	1.38	1.55	1.39	1.24	1.90	2.17	1.16	0.59	1.40
Austria	1.10	1.66	1.08	1.26	1.89	1.50	1.50	2.08	1.88	1.62	1.40	1.50	1.88
Poland	0.74	1.16	0.93	0.72	1.00	1.04	0.91	1.08	1.44	0.76	1.05	0.71	0.43

Table 5.

Germany's share of output in Ocean Science cited by policy documents between 2012-2022. The world level in Ocean Science share is indexed to 1 and the colors show the relationship to the index. Red represents a share lower than the world's share, white shows a share equal to the world average and to green a share higher than the world's. Countries are listed descending from the highest to lowest share of cited papers in Ocean Science research as a whole.

Normalised share of publications mentioned in news media

	Global Ocean Science	Blue Growth	Marine ecosystem functions & processes	Ocean crust & marine geohazards	Ocean & climate	Biodiversity use & protection	Ocean observation & Marine data	Ocean technology	Human health & well-being	Carbon neutrality	Ocean health	Social science & humanities related to ocean science	Prevent & eliminate pollution
World	**1.00**	**1.15**	**1.17**	**1.10**	**1.49**	**1.37**	**1.13**	**0.92**	**1.34**	**1.11**	**1.05**	**1.00**	**1.39**
United Kingdom	2.17	2.58	2.48	2.21	2.65	2.81	2.35	1.67	3.16	2.31	2.56	1.44	3.95
Switzerland	2.05	2.73	2.16	1.60	2.35	2.50	2.01	2.40	2.62	3.21	1.93	0.84	2.59
Sweden	1.87	2.17	1.98	1.95	2.23	2.28	1.90	1.67	2.29	1.43	1.73	1.07	3.48
Netherlands	1.87	2.08	1.82	1.88	2.37	2.34	1.76	1.73	2.88	2.36	1.75	0.95	4.68
Denmark	1.82	1.97	2.05	1.94	2.45	2.24	1.93	1.71	2.29	2.39	2.28	1.16	2.86
Austria	1.70	2.43	1.57	1.53	2.12	2.16	1.68	3.03	2.42	3.01	1.38	1.43	1.63
Finland	1.69	2.29	1.48	1.65	1.62	1.75	1.47	3.44	2.62	3.50	1.32	0.51	1.10
Germany	**1.66**	**2.09**	**1.81**	**1.58**	**2.00**	**2.21**	**1.75**	**1.06**	**2.10**	**1.86**	**1.92**	**0.79**	**1.80**
Belgium	1.35	1.63	1.43	1.78	1.80	1.63	1.50	1.30	1.42	1.34	1.38	1.21	2.24
France	1.32	1.62	1.46	1.31	1.65	1.82	1.59	1.12	1.91	1.25	1.26	0.72	1.87
Spain	1.21	1.40	1.36	1.30	1.77	1.72	1.62	1.53	1.77	1.16	1.30	0.33	1.98
Italy	1.12	1.18	1.23	1.21	1.67	1.38	1.21	0.91	1.47	1.21	1.25	0.96	0.82
Portugal	0.86	0.99	1.02	0.99	1.39	1.14	1.14	0.36	1.14	0.91	0.76	0.53	1.28
Greece	0.80	0.91	0.96	1.09	1.22	1.04	1.13	0.67	1.43	0.72	0.74	0.56	1.85
Poland	0.56	0.61	0.58	0.59	0.92	0.72	0.85	0.23	0.73	0.62	0.56	0.65	0.67

Table 6.

Germany's share of output in Ocean Science mentioned in news items between 2012-2022. The world level in Ocean Science share is indexed to 1 and the colors show the relationship to the index. Red represents a share lower than the world's share, white shows a share equal to the world average and to green a share higher than the world's. Countries are listed descending from the highest to lowest share of cited papers in Ocean Science research as a whole.

Entity	pubs	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16
World	1,422,722	0.3%	1.5%	5.3%	0.3%	0.1%	9.8%	6.3%	1.8%	2.7%	0.5%	4.4%	2.3%	4.8%	17.2%	5.0%	0.5%
Germany	79,538	0.2%	1.6%	4.5%	0.2%	0.1%	6.7%	5.4%	1.4%	2.1%	0.4%	3.2%	1.6%	7.2%	16.6%	4.8%	0.5%

Table 7.

Contribution to the UN Sustainable Development Goals of Germany and selected German institutions in Ocean Science research (2012–2022).

4) Gender aspects in German Ocean Science publications

The share of publications in Ocean Science Research with women as a participating author, as first author or as last author in European countries for the study period is presented in Table 8. Portugal (77%), Italy (74.2%) and Spain (70.1%) were the countries with the highest percentage of women participating in publications (Table 8). Germany ranked within the four countries with the lowest percentage of women participating in publications of the 15 tested European countries with a 64.5 % of at least one woman participating. This correspondingly means that 35.5% off all publications with authors from Germany did not include women.

The five countries with the highest share of women as first author were Portugal (41%), Poland (35%), Italy (34.6%), Finland (32.6%) and Spain (31.5%) whereas Germany had a share of women as first author of 28.4%. The last author is often regarded as the leader of the research group responsible for the published study, though this varies across disciplines. Nonetheless, it frequently serves as a marker of seniority among authors (Chinchilla-Rodriguez et al., 2019; Tscharntke et al., 2007; Andersen, 2023). The five countries with the highest proportion of women as last authors were Portugal (26.9%), Italy (25.7%), Poland (25.6%), Finland (21.7%), and Sweden (20.4%). Conversely, Germany was again among the four countries with the lowest percentages, with women accounting for only 16.5% of last authorships.

The share of women co-authoring publications varied between sub-areas of research (Figure 11, created from the data presented in Annex 9). Following the previous results, Portugal had the highest percentage of women co-authors almost throughout all sub-areas or research. The next countries with the highest level of participating women were Italy, Spain and Finland. As for most countries, the highest share of women as contributing author was found in the sub-areas Marine ecosystem function & processes, Ocean health, Biodiversity use & protection, Human well-being and pollution.

Annex 10 presents the share of publications in Ocean Science research featuring women as participating authors, first authors, or last authors by selected institutions from 2012 to 2022, along with the total number of publications. This data provides an overview of women's contributions to Ocean Science and the studied sub-area of research.

Table 8.
Share of women participation in publications (2012-2022) for the top publishing European countries.

Country	Pubs	Share of women participication	Share of Women as 1st author	Share of Women as last author
United Kingdom	100,440	60.0%	26.1%	16.9%
Germany	**79,538**	**64.5%**	**28.4%**	**16.5%**
France	68,031	67.6%	27.6%	17.9%
Italy	57,112	74.2%	34.6%	25.7%
Spain	56,416	70.1%	31.5%	19.8%
Netherlands	29,719	60.7%	25.6%	15.6%
Portugal	23,532	77.0%	41.0%	26.9%
Sweden	21,455	67.4%	29.7%	20.4%
Poland	20,656	65.9%	35.0%	25.6%
Denmark	20,266	64.1%	28.0%	16.9%
Switzerland	18,122	66.5%	29.0%	16.4%
Belgium	15,709	67.0%	27.6%	16.7%
Greece	12,073	64.5%	29.9%	17.5%
Finland	10,767	69.4%	32.6%	21.7%
Austria	10,311	64.6%	27.0%	16.4%

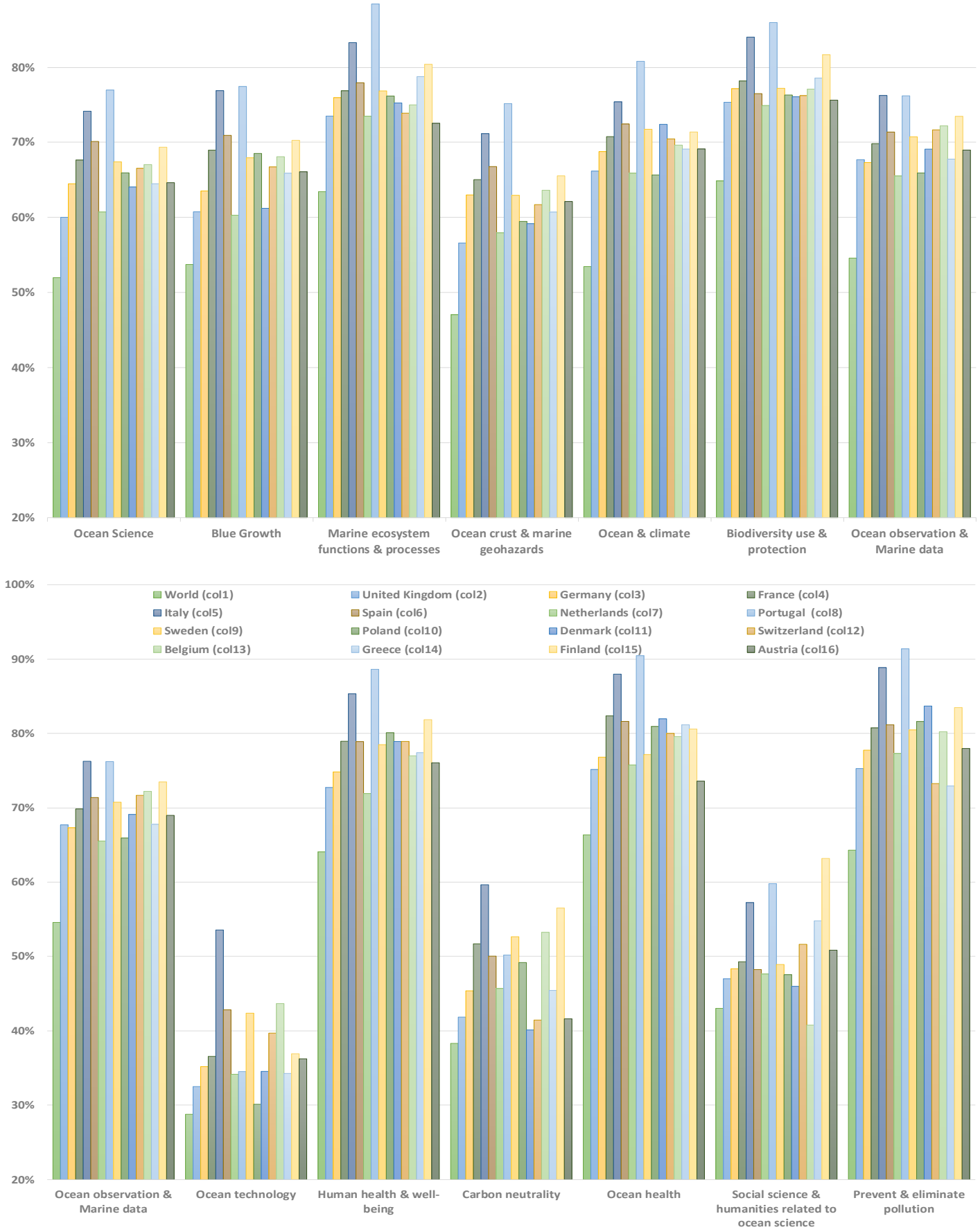


Figure 11.

Share of women as a participating author (%) in publications of the world and most publishing European countries in Ocean Science and sub-areas of research between 2012–2022. Each country's column number in each sub-area's histogram is indicated by "(col#)".

Conclusions

This report presents a first comprehensive bibliometric analysis of peer review publications on German Ocean Science research and scientists' participation. It aimed to map the number of German ocean scientific publications, the underlying networking and the publications' impact (via number of citations, patents and public reception) to better understand and support the German Ocean Science community and its potential. By categorizing the research output in 12 thematic areas the analysis offers insights into specific publication trends, thematic foci, and collaborative networks. The findings inform and can be used to reflect on future research priorities, interdisciplinary and international collaboration and transfer for sustainable ocean governance by the scientific community based in Germany.

Germany ranked second in number of publications in Ocean Science in European countries. Regarding the 12 research sub-areas selected for analysis (Annex 2) most publications were generated for Blue growth, Marine ecosystems functions & processes, Ocean crust & marine geo-hazards, and Ocean & climate followed by Biodiversity use & protection, and Ocean observation & Marine data. These sub-areas were also the ones with the highest bi-disciplinary collaboration, while particularly the sub-areas Ocean Technology and Carbon neutrality showed lower interdisciplinary publication patterns. Interestingly, this did not negatively affect the impact of the research output in these sub-areas.

When looking at e.g., Social science & humanities related to Ocean Science, the indicators showed that the country that published the most between 2021 and 2022 was the United Kingdom, followed by Germany, indicating a strong publishing effort difference between European countries probably explainable by the funding effort and interest of the countries funding agencies. Indeed, scientific output is generally closely related to the different funding structures and priorities of any country, emphasizing the impact of funding agency on research outcomes (Janger et al., 2019; Zacharewicz et al., 2019).
The publication efforts in social sciences increased in all tested European countries that could consider and in agreement with what has been reported by Pelke & Simonn (2023). This tendency reflects the increased scientific interest to combine disciplinary to interdisciplinary research as well as the realization of the importance of this discipline by natural scientists and for working towards sustainable solutions (Bogusz et al., 2024).

The Ocean Science community as a whole is a very diverse group that mainly comprises natural scientists, engineers, but also social and other disciplines' sciences. All these groups have different approaches towards publishing results (e.g., research journal publications, publication in conference proceeding, publication in policy brief). Identifying or composing a representative database for analysis from such various sources is a difficult task.

As with the other most-publishing European countries, Germany produced impactful publications in all thematic areas of Ocean Science. It generally is less specialized in Ocean Science than the world average (except in the sub-area of Ocean & climate), indicating that

its research focus is directed more to other disciplines. Considering the below-average specialization, the impact of German publications in the scientific community, news, media and patents is remarkable.

The current comparative assessment highlights that Germany strongly collaborates with international partners in 68% of its publications. Among the selected European countries included in the study, publications from Austria and Switzerland in Ocean Science proportionally involved the highest participation of German authors, although most collaborative publications were produced by Germany with the United Kingdom. Furthermore, German Ocean Science research is composed of a large network of collaborating institutions, with the AWI and GEOMAR attracting most of the collaboration activities. The University of Bremen, University of Hamburg and Kiel University are key collaborators within the German network in Ocean Science. These institutes are focusing on Ocean science as it is the key area of research in their scientific curriculum (Alfred Wegener Institute, 2024; GEOMAR Helmholtz Centre for Ocean Research Kiel, 2024). Furthermore, the selected Germans institutions share numerous collaboration ties with international institutions. Given the diversity and complexity of all collaboration links, a deeper analysis and collaboration establishment could be done in the future.

The share of women authors in German publications seems to have increased throughout the tested years but the number of first authors or last, typically supervising, authors is not as high as in other European countries. Many institutions have implemented support systems for female scientists in Ocean Science, but it is still challenging to measure concrete improvements. A further increase is expected to be seen in the near future as efforts are deployed in fostering institutional and policy-level changes to address equitable conditions for women in Ocean Science (Ahmadia et al., 2021; GOSR., 2020; Johri et al., 2021). Both, the different sub-areas of research as well as the publication's country of origin do seem to affect the percentage of women publishing, highlighting the cultural difference between fields of science as well as European countries.

All bibliometric analyses are partially restricted via the selection of the database. Indeed, as for any statistical methods a "major limitation" is in the representativeness of the underlying database. This must always be considered when interpreting the results of such analyses. At the time being, no literature database covers all disciplines, so that any analysis only represents a selection of disciplines.

This analysis can be used to identify the strengths and leverage potential in German Ocean Science including development potential in certain sub-areas of research. It can support the development of new research strategies, promote international cooperation, and strengthen public awareness for a strong, diverse and sustainable German Ocean Science of the future.

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Annexes

Mapping German Ocean Science

A Bibliometric Analysis of the Years 2012 to 2022

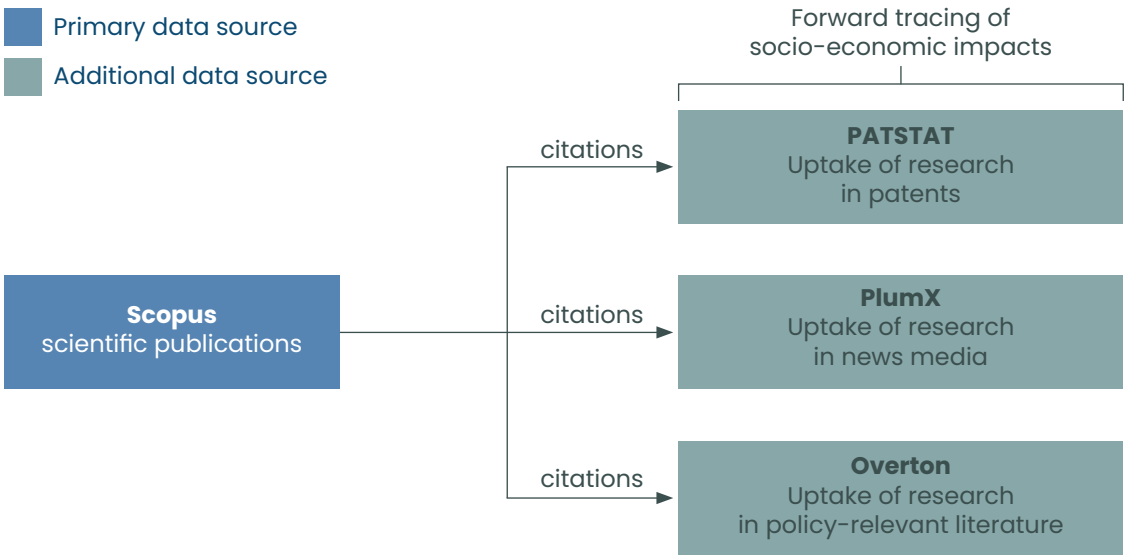

Figure S1.
Selected data sources as well as their planned integration in delivering the current study. The description of these data sources follows.

Annex 1. Data sources

PATSTAT, produced by the European Patent Office. PATSTAT includes information from several patenting offices around the world, which all have their own standards and practices. In matching the NPRs of IP5 patents to Scopus, most of the signal (i.e., citations to the scientific literature) are in fact attributable to the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO). This is due to various Issues, including use of languages other than English. As the EPO and USPTO cover two major markets where companies protect their IP, they together offer a suitable source for tracking the valorization of research in the form of knowledge transfer from the academic to the innovation literature.

PlumX maintains a database recording the uptake of scientific outputs beyond the scientific literature in, for example, social media, blogs, news, and educational resources. These data, because they track usage beyond academic circles as traditionally captured in bibliometric indicators, are often referred to as alternative data (or altmetrics). As an example, PlumX harvests mentions of scientific artefacts in Facebook, Twitter, journalistic and news websites, and Wikipedia. The PlumX database contains records for 52.6 million individual pieces of research output, which in total have been linked to over 9,4 billion altmetric captures. Of these research outputs, 83.2% have registered altmetric uptake for at least one of PlumX's metrics. In this study, PlumX data was used to track the media coverage of research (using Newsflo and other sources) , a proxy for the extent to which research informs the public dialog. These data, while they provide news coverage from 191 different countries, display a bias towards news in English . For tracking research uptake in policy, Science-Metrix used Overton. The database consists of more than 1,65 million policy-related documents. These documents include archived documents by national parliaments around the world, by inter-organizational agencies such as the United Nations, by city councils, and by a variety of think tanks. Around half of these documents make citations to academic or scholarly publications, and just over 2 million distinct journal-based publications are cited by at least one document in the database. A qualitative assessment of these citations by Science-Metrix revealed that while they 'should not be interpreted as indicative of advanced policy outcomes of research directly reaching the legislative or executive processes, they can be seen as achievements in contributing to the first stages of these processes, at the intersection between governance and academia' .

[2] https://plumanalytics.com/world-wide-news-coverage-plumx/
[3] https://www.elsevier.com/solutions/newsflo

[4] Pinheiro, H., Vignola-Gagné, E. and Campbell D. (2021). A large-scale validation of the relationship between cross-disciplinary research and its uptake in policy-related documents, using the novel Overton altmetrics database. Quantitative Science Studies, 2(2): 616-642.
[5] https://arxiv.org/pdf/2201.07643.pdfDecember 2022

The Overton database displays a bias towards English-language documents originating in Anglo-Saxon countries. Nevertheless, the database provides coverage of documents from other countries both in the native and English language, including for Germany which is the focal country of this study. According to Szomszor and Adie , Germany comes in fifth (excluding IGO) by the volume of documents indexed in Overton. The UK is the only other European country with a larger set of policy-related documents (233,166 vs. 151,988 for Germany), and the number of indexed documents for the EU and France is similar to that of Germany. Szomszor and Adie also reported the distribution.

Annex 2. Bibliometric indicators description

Indicators of growth

Number of publications (output volume): The number of publications produced by country or institution, based on full counting, for the past five years. Full counting (FULL) refers to the method of assigning a publication to a given entity each time this entity appears among the author addresses of a publication.

Growth ratio: This measures the percentage of increase of publications between two periods. A growth ratio (GR) of 1 thus indicates stability, a value above 1 indicates an increase, and a value below 1 indicates a decrease. For the purposes of this report, the GR of countries and regions will be calculated comparing the output of the 2012–2017 period to that of the 2018–2019 period and for the 10-year period as a whole, excluding 2022 which has incomplete data coverage in Scopus.

Indicators of specialization

Specialization index: The specialization index (SI) indicates how much emphasis a given entity puts on one field (or other thematic areas), relative to the global average of effort exerted in that field. For instance, if 20% of a given country's publications are in physics, but at the global level only 15% of papers are in physics, then the country is said to be specialized in physics, putting more emphasis on that field than is normally the case elsewhere around the world.

The SI reference value is 1 (i.e., the world level is always equal to 1); accordingly, an SI above 1 shows that an entity invests proportionately more effort than the average in a given area, an SI below 1 shows that an entity invests proportionately less effort than the average in that area, and an SI near 1 shows that an entity invests close to the average proportion of effort in that area. Two points are worth noting here. First, these proportions of publications are computed relative to a reference set that can be adjusted depending on the purpose. In this study, the whole of Scopus will be used to measure specialization in Ocean Science. However, the whole of Ocean Science in Scopus will be used to measure specialization within each of the 12 subsets or by field of science within Ocean Science. Second, the SI is a zero-sum game because it is measured as a proportion of total output. If the proportion of an entity's output in one area increases, there must be relative decreases elsewhere.

Indicators showing collaboration patterns and diversity in Ocean Science research

Share of publications with participation by women authors: The share of publications in a publication set where at least one author is identified as likely to be a woman. To infer a gender from a name, Science-Metrix employs an approach that combines the use of existing and established name/gender lists and the use of NAMSOR, designed to determine the gender

of names, taking into account different elements such as given name, surname, ethnicity and country.12

Share of publications with women as first or last authors: The share of publications in a publication set where the first or last author is identified as likely to be a woman.

International co-publication rate (ICR): Share of publications by a given entity that were authored by more than one author and with affiliations from at least two countries.

Share of co-publications involving authors in Germany: Share of publications by a given entity that were authored by more than one author and with affiliations from Germany and at least another country (note that for German institutions, this indicator doesn't apply).

Share of public–private co-publications: To detect publications that are the result of public–private partnerships (PPPs), institutional addresses on scientific publications are coded under the private (i.e., privately held, for-profit companies) and public sectors (i.e., all other organizations, which in turn are mostly in the academic sector). This process uses a semi-automated method of searching for key expressions in the address field of authors on scientific publications (e.g., 'Inc.', 'Ltd.', 'Corp.' for the private sector). Address fields not identified as 'private' are considered 'public'. This approach enables individually tagging publications under mutually exclusive categories: publications resulting from a PPP and publications not resulting from a PPP. The resulting indicator for this study is the proportion of an entity's papers that are co-authored by authors from the public and private sectors.

Interdisciplinarity: Interdisciplinary research is that which combines two or more academic disciplines into one activity (e.g., a research project). This is measured using DDR and DDA.

Disciplinary Diversity of References (DDR): The DDR of a publication is computed based on the material cited by the publication and reflects the diversity of knowledge that is being integrated in the publication. The indicator considers (a) the number of different subfields that are being cited, (b) the distribution of those citations across the cited subfields, and (c) the intellectual proximity of those subfields to one another. For example, a paper that draws on knowledge from four different subfields would have a higher DDR score than a paper that draws on only three. Similarly, a paper that cites one subfield 90% of the time and the other subfields only 10% of the time would have a lower score than a paper that cites its various subfields in roughly equal measure. Finally, a paper that integrates knowledge from biology and from chemistry would have a lower score than a paper that integrates knowledge from biology and the performing arts, because the former pair is more intellectually proximate than the latter pair. In addition to the average DDR score across an entity's publications, the share of an entity's papers among the top 10% with the highest DDR in the world will also be computed. As for the HCP, each paper's DDR score is adjusted to the average of all papers worldwide published in the same subfield and same year.

Disciplinary Diversity of Authors (DDA): The DDA reflects the diversity of the prior disciplinary backgrounds of a paper's co-authors. This indicator was developed so that it accounts for the number of distinct disciplines, the cognitive distance that separates them, and the balance between them. A paper co-authored by authors whose previous papers were distributed across subfields of science in a similar pattern (i.e., having similar relative frequency across subfields) would score lower than papers bringing together authors with different backgrounds (as measured by the subfields from their prior publications), even if those authors, individually, have published in a less diverse set of subfields. In other words, it is having differences between the backgrounds of each co-author that increases multi-disciplinary integration and not having individual authors with more diverse backgrounds. Nevertheless, authors having diverse backgrounds may be more likely to increase the multi-disciplinary integration of one paper, but only if this diversity is sufficiently different from the subfields of the remaining authors. As a result of this approach, a single-author publication, no matter the diversity of its author's background, will always receive the minimum score,

since the indicator is intended to capture diversity across different authors. Similar to the DDR, the average DDA score and the share of an entity's papers with a DDA score in the top 10% will be measured and normalized to the average of all papers worldwide published in the same subfield and same year.

Cross-thematic integration: This indicator highlights the integration on two or more research areas of Marine Sciences into a publication. It is a pair-wise calculation of the publication overlap between sub-areas. Cross-disciplinarity (knowledge integration): Cross-disciplinary research is that which combines two or more academic disciplines into one activity (e.g., a research project). This is measured using the Disciplinary Diversity of Authors (DDA) and the Disciplinary Diversity of References (DDR).

Citation impact within the scientific community

Relative citation rate: Counting citations can be used as a proxy for measuring contributions to subsequent knowledge generation; however, because citation practices vary between the disciplines and sub-disciplines of science, simple counting would create unwanted biases in the results. To correct these potential distortions, individual publications are evaluated relative to the average citation rate for publications in the same subfield and published in the same year. This measure is known as the relative citation (RC) rate. The RC will not be presented as a standalone indicator in this study but is instead integral to the calculation of indicators that will be presented.
For all indicators relying on the RC scores of papers, a certain amount of time must be allowed for the published work to have an impact on subsequent research and for articles to be cited. Accordingly, impact measures for the present study can be computed using articles published in 2019 or earlier. Papers published in 2020 or later have not had sufficient time for citations to accrue.

Average of relative citations: This is a field-normalized measure of observed scientific impact (it also takes account of the publication year and document type of scientific contributions in the normalization process). The average of relative citations (ARC) of a given entity is the average of the RCs of the papers belonging to it. An ARC value above 1 means that a given entity is cited more frequently than the world average, while a value below 1 means the reverse.

Highly cited publications: Highly cited publications (HCP) are publications that received the highest relative citation (RC) scores in their respective field; for this study, the top 10% most cited publications will be selected. This indicator is frequently used to examine research excellence, measuring how many high-impact articles are produced by a given research entity, relative to their expected contribution to world-leading research.
The HCP measure is normalized to 1, meaning that an entity with an HCP over 1 contributes more than its expected number of highly cited publications, an entity with an HCP below 1 contributes fewer than its expected number of highly cited publications, and an entity with an HCP near 1 contributes close to its expected number of highly cited publications.

Other citation-based indicators

Normalized share of publications cited by patents: This indicator informs on the relative level of uptake of scientific research into innovation. The share of publications cited by at least one patent is the number of scientific publications cited by a patent proportional to the total number of scientific publications. It is measured by linking records in Scopus to the patent literature. Patent applications filed at the USPTO, the European Patent Office (EPO), the Intellectual Property Office (IPO) of the and the Japan Patent Office (JPO), and through the World Intellectual Property Organization (WIPO) will be considered. This indicator is normalized by publication year and subfield of science, according to Science-Metrix's classification.

Normalized share of publications cited in news media: Same as above for 'cited in patents' but using news media.

Normalized share of publications cited in policy-relevant literature: Same as above for 'cited in patents' but using Overton.

Indicator of contributions to complex societal challenges

Share of publications related to Sustainable Development Goals: The United Nations Sustainable Development Goals (SDGs) are increasingly recognized as interesting objectives against which to measure the societal outcomes of research efforts. At Science-Metrix/Elsevier we have built thematic data sets covering each of the first 16 SDGs , and can measure the shares of given publication sets that fall within each SDG. This measurement will provide a sense of the probabilities to which a publication set could potentially be thematically related and useful to a SDG, particularly to those that reflect Ocean Science.

Visualization

Positional analysis: Performance analysis by subfields is presented using a visualization technique called *positional analysis*. These figures present three different types of information in a single graphic: production size, specialization and impact.

The size of production is proportional to the size of the bubble on the chart. The larger the bubble, the more papers are produced in the given subfield. The degree of specialization within a given subfield, relative to the world average, is presented along the horizontal axis (i.e., the x-axis); subfields in which an entity specializes more lie further to the right of the chart, subfields in which the entity specializes less lie to the left of the chart, and the global average is represented by the middle line. Impact is presented along the vertical axis (i.e., the y-axis); subfields in which the entity has high impact are towards the top of the chart, subfields in which the entity has lower impact are towards the bottom of the chart, and again the global average is the dividing line between the top and bottom half.

Numbering the quadrants 1 through 4 (anti-clockwise), we can conclude that the subfields in quadrant 1 are those in which the entity is specialized and has high impact, subfields in quadrant 2 are areas of high impact but low specialization, quadrant 3 contains subfields where the entity's specialization is high but impact is low, and quadrant 4 contains subfields in which the entity is neither specialized nor impactful.

Recall that size of production and specialization are *separate* but *linked* properties. A large bubble on the left side of the chart shows that the entity's production is large (demonstrated by the size of the bubble) but that the field is still not one of specialization for it (demonstrated by its position to the left of the center line). Such a situation would indicate that the entity is producing many papers in a field with great publication output on the world stage, a relatively smaller drip in a huge pool. Conversely, a small bubble on the right side of the chart would denote a subfield in which the entity is not producing many papers (demonstrated by the small bubble), but that this subfield is small at the world level, and therefore the entity's small output in this subfield is still above the global norm (demonstrated by the position of the bubble to the right of the center line).

Annex 3.

List of selected German institutions

(in alphabetical order)

CITY	INSTITUTION
Bremerhaven	AWI Alfred-Wegener-Institut, Helmholz Zentrum für Polar- und Meeresforschung
Bonn	BFN Bundesamt für Naturschutz
Hannover	BGR Bundesanstalt für Geowissenschaften und Rohstoffe
Hamburg	BSH Bundesamt für Seeschifffahrt & Hydrographie
Oldenburg	Carl von Ossietzky Universität Oldenburg
Kiel	Christian-Albrechts-Universität zu Kiel
Kaiserslautern	Deutsches Forschungszentrum für Künstliche Intelligenz
Stralsund	Deutsches Meeresmuseum
Berlin	Ecologic Institut GmbH
Heidelberg	EMBL | European Molecular Biology Laboratory
Greifswald	Ernst-Moritz-Arndt-Universität Greifswald
Hannover	Fraunhofer-Gesellschaft | Fraunhofer-Institut für Graphische Datenverarbeitung IGD
Braunschweig Hannover	Forschungszentrum Küste Universität Braunschweig Universität Hannover
Bremerhaven	Deutsches Schifffahrtsmuseum, Leibniz-Institut für deutsche Schifffahrtsgeschichte
Kiel	GEOMAR Helmholtz Zentrum für Ozeanforschung Kiel
Berlin	Global Climate Forum e.V.
Geesthacht	Helmholtz-Zentrum Hereon
Oldenburg	HIFMB Helmholtz-Institut für Funktionelle Marine Biodiversität
Postdam	IASS Institute For Advanced Sustainability Studies
Warnemünde	IOW Leibniz Institut für Ostseeforschung
Bremen	Jacobs University Bremen
Bremerhaven	Johann Heinrich von Thünen-Institut, Bundesforschungs-institut für Ländliche Räume, Wald und Fischerei
Kiel	Kiel Institut für Weltwirtschaft
Hannover	Leibniz Universität Hannover
Bremen	MARUM Zentrum für Marine Umweltwissenschaften
Bremen Hamburg	Max-Planck-Gesellschaft Max-Planck-Institut für Marine Mikrobiologie Max-Planck-Institut für Meteorologie
Frankfurt am Main Wilhelmshaven Frankfurt am Main Görlitz	Senckenberg Gesellschaft für Naturforschung Senckenberg Biodiversität und Klima Forschungszentrum Senckenberg am Meer Senckenberg Forschungsinstitut und Naturmuseum Senckenberg Museum für Naturkunde
Bremen	Universität Bremen
Hamburg	Universität Hamburg (incl. CEN-Center for Earth System Research and Sustainability)
Rostock	Universität Rostock
Bremen	ZMT Leibniz Zentrum Marine Tropenforschung

Annex 4.

a) List of European Institutions

COUNTRY	INSTITUTION
Denmark	Technical University of Denmark Aarhus University University of Copenhagen
France	Institut français de recherche pour l'exploitation de la mer Université de Bretagne Occidentale Muséum national d'histoire naturelle Institut de recherche pour le développement Aix-Marseille Université CNRS
Germany	Helmholtz Centre for Ocean Research Kiel Alfred Wegener Institute - Helmholtz Centre for Polar & Marine Research Senckenberg Gesellschaft fur Naturforschung University of Bremen Kiel University University of Hamburg Ludwig Maximilian University of Munich
United Kingdom	British Antarctic Survey University of Plymouth University of Southampton
Italy	Stazione Zoologica Anton Dohrn Napoli National Research Council of Italy
Netherlands	Royal Netherlands Institute for Sea Research - NIOZ Wageningen University & Research Delft University of Technology Utrecht University
Norway	Institute of Marine Research

b) List of Selected international institutions

(Countries in alphabetical order)

Australia	James Cook University Queensland
Brazil	Universidade de Sao Paulo
Canada	Fisheries and Oceans Canada University of British Columbia
China	Ocean University of China
Japan	Japan Agency for Marine-Earth Science and Technology
Korea	Korea Institute of Ocean Science & Technology
New Zealand	University of Otago
South Africa	University of Cape Town
USA	National Oceanic and Atmospheric Administration Woods Hole Oceanographic Institution

The international selection was based on SCOPUS list of top institutions outside Europe based on the output in Ocean Science or based on the institution's share of output in Ocean Science between 2012 and 2022; institutions with a minimum of 2000 publications were considered as well as worldwide coverage.

Annex 5. Scientific output and impact of the topmost publishing European countries in the sub-areas of research (2012–2022).

Number of publications; yearly output trend; growth ratio (GR) and growth index (GI); specialization index (SI); share of publications related to SDGs; average number of authors per publication; share of women as a participating author or as a first or last author; average number of countries partnering on publications; share of co-publications involving international (Intl) partners, at least one German author, or the public and private sectors; average disciplinary diversity of authors (DDA) or references (DDR), and share of publications among the top 10% with the highest DDA or DDR in the world as well as output by year. These were generated using data from Scopus, LexisNexis, Overton and PlumX.

a) Ocean Science (global)
b) Blue Growth
c) Marine Ecosystems Functions & Processes
d) Ocean Crust & Marine Geohazard research
e) Ocean & Climate Research
f) Biodiversity use & protection
g) Ocean observation & Marine data
h) Ocean technology
i) Human health & well-being
j) Carbon Neutrality Research
k) Ocean health
l) Ocean Engineering & Social Sciences
m) Prevent & eliminate pollution

a) Ocean Science Research

	Output					Diversity and Collaboration (share of co-publications)						
Enttiy	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**1,422,722**	**1.44**	**1.00**	**1.00**	**43.2%**	**4.8**	**52.0%**	**32.5%**	**1.4**	**48.9%**	**5.4%**	**6.4%**
United Kingdom	100,440	1.22	0.85	1.08	44.7%	6.2	60.0%	36.2%	2.5	69.1%	10.6%	10.1%
Germany	79,538	1.24	0.86	0.92	40.0%	6.8	64.5%	38.3%	2.5	68.1%	100.0%	8.8%
France	**68,031**	**1.16**	**0.81**	**1.17**	**41.1%**	**7.4**	**67.6%**	**39.0%**	**2.5**	**69.2%**	**10.8%**	**8.1%**
Italy	57,112	1.38	0.96	1.00	47.5%	7.0	74.2%	48.0%	2.2	53.0%	8.4%	8.2%
Spain	56,416	1.28	0.89	1.19	48.0%	6.7	70.1%	43.1%	2.3	60.5%	8.2%	7.2%
Netherlands	29,719	1.23	0.85	1.00	45.7%	7.5	60.7%	35.6%	2.8	72.6%	16.1%	11.5%
Portugal	23,532	1.39	0.96	1.82	51.3%	6.8	77.0%	53.7%	2.3	60.5%	7.0%	6.1%
Sweden	21,455	1.30	0.90	1.06	48.5%	7.1	67.4%	41.3%	2.9	73.9%	15.5%	8.9%
Poland	20,656	1.52	1.05	0.87	42.2%	5.7	65.9%	47.3%	1.9	36.0%	7.9%	4.5%
Denmark	20,266	1.32	0.92	1.47	48.7%	7.3	64.1%	38.3%	2.8	74.0%	15.3%	12.4%
Switzerland	18,122	1.28	0.89	0.79	39.2%	8.0	66.5%	38.8%	3.1	80.4%	22.8%	10.4%
Belgium	15,709	1.22	0.85	0.95	44.4%	7.8	67.0%	38.0%	2.9	77.2%	14.1%	8.4%
Greece	12,073	1.39	0.96	1.24	53.0%	7.6	64.5%	40.4%	2.4	52.0%	9.3%	7.8%
Finland	10,767	1.28	0.89	1.04	48.5%	7.5	69.4%	43.8%	2.8	67.6%	14.2%	9.8%
Austria	10,311	1.38	0.96	0.81	38.1%	7.5	64.6%	37.1%	3.0	79.0%	26.0%	11.6%

	Cross-disciplinarity				output by year										
Enttiy	Avg. DDA	$DDA_{10\%}$	Avg. DDR	DDR_{10} %	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**1.00**	**10.0%**	**1.00**	**10.0%**	**95,493**	**101,396**	**106,377**	**111,077**	**118,697**	**121,741**	**131,741**	**144,734**	**154,841**	**167,569**	**169,056**
United Kingdom	1.13	12.5%	1.02	10.8%	7,386	7,841	8,339	8,488	9,107	9,031	9,523	9,825	10,455	10,623	9,822
Germany	1.10	11.8%	1.02	10.3%	5,843	6,175	6,450	6,681	7,202	7,094	7,456	7,888	8,081	8,511	8,157
France	**1.20**	**13.6%**	**1.01**	**9.4%**	**5,230**	**5,580**	**5,803**	**5,852**	**6,238**	**5,984**	**6,430**	**6,570**	**6,839**	**7,114**	**6,391**
Italy	1.19	15.1%	1.03	11.0%	3,951	4,043	4,257	4,720	4,924	4,993	5,338	5,607	6,253	6,479	6,547
Spain	1.06	11.0%	1.00	9.4%	4,097	4,361	4,574	4,674	4,912	4,864	5,291	5,484	5,885	6,275	5,999
Netherlands	1.16	12.4%	1.04	10.0%	2,156	2,281	2,548	2,503	2,692	2,579	2,842	2,889	3,152	3,073	3,004
Portugal	1.18	14.0%	1.03	10.5%	1,551	1,674	1,785	1,968	2,092	1,882	2,078	2,288	2,547	2,943	2,724
Sweden	1.16	12.7%	1.04	11.1%	1,505	1,594	1,692	1,797	1,918	1,867	2,020	2,175	2,148	2,428	2,311
Poland	0.94	10.7%	1.03	11.1%	1,207	1,432	1,488	1,580	1,760	1,848	2,095	2,168	2,354	2,486	2,238
Denmark	1.15	12.0%	1.01	9.7%	1,427	1,484	1,620	1,658	1,790	1,755	1,992	1,995	2,066	2,338	2,141
Switzerland	1.16	12.9%	1.02	10.3%	1,273	1,388	1,434	1,496	1,633	1,636	1,742	1,786	1,859	1,972	1,903
Belgium	1.28	15.9%	1.03	10.1%	1,142	1,259	1,253	1,371	1,401	1,417	1,440	1,469	1,579	1,754	1,624
Greece	1.21	15.0%	1.02	10.6%	849	856	926	945	1,065	999	1,011	1,214	1,245	1,507	1,456
Finland	1.17	13.2%	1.02	9.3%	732	795	872	950	969	924	997	1,080	1,067	1,158	1,223
Austria	1.18	13.3%	1.04	11.0%	700	736	746	839	943	865	1,017	1,055	1,093	1,192	1,125

b) sub-area: Blue Growth

	Output					Diversity and Collaboration (share of co-publications)						
Entity	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**406,753**	**1.66**	**1.00**	**1.00**	**66.2%**	**4.8**	**53.7%**	**33.7%**	**1.4**	**49.2%**	**4.3%**	**7.2%**
United Kingdom	29,778	1.39	0.83	1.12	72.8%	6.2	60.8%	37.4%	2.5	67.5%	8.2%	12.3%
Spain	19,149	1.48	0.89	1.41	71.2%	6.4	70.9%	44.1%	2.3	58.9%	6.5%	9.1%
Germany	**18,217**	**1.41**	**0.85**	**0.74**	**67.2%**	**6.6**	**63.5%**	**37.9%**	**2.6**	**66.1%**	**100.0%**	**11.8%**
Italy	17,255	1.69	1.02	1.05	71.6%	6.9	76.9%	50.3%	2.2	51.4%	6.6%	9.6%
France	16,757	1.37	0.83	1.00	67.5%	7.4	69.0%	40.4%	2.7	69.5%	9.1%	9.9%
Portugal	9,281	1.75	1.06	2.50	70.9%	6.7	77.4%	54.7%	2.4	58.2%	5.9%	7.1%
Netherlands	8,428	1.41	0.85	0.99	71.5%	6.8	60.3%	36.4%	2.8	70.7%	14.0%	13.8%
Denmark	7,065	1.45	0.87	1.79	73.0%	6.9	61.2%	37.2%	2.8	69.2%	13.0%	16.4%
Sweden	6,240	1.60	0.96	1.07	73.0%	6.9	67.9%	42.2%	2.9	71.1%	12.7%	9.5%
Poland	4,931	2.08	1.25	0.72	64.6%	5.7	68.5%	48.6%	2.1	37.2%	8.2%	5.9%
Greece	4,494	1.58	0.95	1.61	72.3%	6.8	65.9%	41.3%	2.5	51.2%	7.4%	9.9%
Belgium	4,366	1.56	0.94	0.92	71.1%	7.9	68.1%	37.7%	3.1	76.0%	13.4%	10.6%
Switzerland	3,613	1.41	0.85	0.55	66.4%	8.4	66.7%	38.9%	3.3	79.7%	20.3%	13.5%
Finland	3,277	1.60	0.96	1.11	69.9%	7.3	70.3%	45.9%	2.9	66.4%	13.6%	9.9%
Austria	2,173	1.62	0.97	0.59	67.1%	7.9	66.1%	38.9%	3.3	79.0%	23.8%	13.5%

	Cross-disciplinarity				Output by year										
Entity	Avg. DDA	$DDA_{10\%}$	Avg. DDR	$DDR_{10\%}$	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**1.05**	**11.2%**	**1.03**	**11.6%**	**25,934**	**27,743**	**28,108**	**28,011**	**30,777**	**32,701**	**36,506**	**41,297**	**47,313**	**53,454**	**54,909**
United Kingdom	1.21	14.3%	1.05	12.1%	2,090	2,230	2,267	2,335	2,490	2,553	2,762	2,958	3,312	3,486	3,295
Spain	1.11	12.3%	1.03	11.0%	1,255	1,416	1,410	1,461	1,533	1,582	1,803	1,903	2,103	2,378	2,305
Germany	**1.17**	**13.7%**	**1.05**	**11.4%**	**1,252**	**1,375**	**1,384**	**1,374**	**1,535**	**1,529**	**1,704**	**1,858**	**1,932**	**2,177**	**2,097**
Italy	1.28	17.3%	1.06	13.1%	997	1,125	1,102	1,301	1,350	1,458	1,566	1,721	2,107	2,221	2,307
France	1.28	15.9%	1.03	10.4%	1,157	1,295	1,312	1,285	1,442	1,362	1,578	1,666	1,849	1,962	1,849
Portugal	1.21	15.2%	1.05	12.3%	518	582	586	697	740	685	839	911	1,106	1,329	1,288
Netherlands	1.26	15.2%	1.07	12.5%	529	592	697	654	744	687	820	779	958	963	1,005
Denmark	1.15	13.0%	1.00	9.9%	481	494	535	537	592	604	698	710	766	842	806
Sweden	1.25	14.7%	1.07	13.6%	428	412	436	448	485	494	575	673	694	820	775
Poland	1.05	12.9%	1.08	14.0%	217	293	296	292	376	397	484	541	628	725	682
Greece	1.23	15.7%	1.03	12.6%	283	316	336	312	367	337	379	444	503	633	584
Belgium	1.40	18.8%	1.05	12.3%	288	315	287	337	342	342	405	442	507	581	520
Switzerland	1.26	15.6%	1.05	11.3%	255	247	269	268	325	320	310	368	388	444	419
Finland	1.24	14.9%	1.05	11.4%	224	215	232	243	247	257	312	356	354	407	430
Austria	1.33	17.3%	1.09	13.9%	146	138	158	169	161	154	210	245	236	296	260

c) sub-area: Marine Ecosystems Functions & Processes

	Output					Diversity and Collaboration (share of co-publications)						
Entity	**Pubs**	**GR**	**GI**	**SI**	**Share in SDG**	**Avg. # of auth.**	**Share of Women Particip.**	**Share of 1st/last Women auth**	**Avg. # of countries**	**Intl co-pubs**	**co-pubs with German auth.**	**Public-private co-pubs**
World	**249,903**	**1.42**	**1.00**	**1.00**	**54.5%**	**5.2**	**63.4%**	**40.5%**	**1.6**	**57.4%**	**7.0%**	**5.2%**
United Kingdom	20,382	1.30	0.91	1.24	57.0%	7.1	73.5%	44.7%	2.8	77.5%	13.5%	8.6%
Germany	**17,795**	**1.30**	**0.92**	**1.17**	**49.8%**	**7.1**	**76.0%**	**46.6%**	**2.8**	**74.8%**	**100.0%**	**6.8%**
France	15,980	1.25	0.88	1.56	53.5%	7.8	76.9%	44.8%	2.8	74.8%	12.3%	6.8%
Spain	12,844	1.29	0.90	1.54	57.7%	7.1	77.9%	47.9%	2.6	68.9%	9.9%	7.6%
Italy	10,694	1.51	1.06	1.06	61.8%	7.6	83.3%	54.9%	2.5	59.7%	9.6%	6.9%
Netherlands	6,194	1.24	0.87	1.19	56.7%	7.7	73.5%	43.9%	3.1	80.6%	20.6%	9.7%
Portugal	5,715	1.51	1.06	2.51	61.1%	7.6	88.4%	62.0%	2.7	67.3%	9.7%	6.6%
Sweden	5,528	1.35	0.94	1.55	58.6%	7.7	76.9%	47.3%	3.1	78.7%	20.0%	6.9%
Denmark	5,197	1.37	0.97	2.14	55.5%	8.1	75.3%	45.4%	3.3	82.8%	19.3%	9.4%
Switzerland	4,118	1.42	1.00	1.03	46.8%	8.3	73.9%	43.2%	3.4	85.1%	24.7%	8.8%
Poland	4,068	1.48	1.04	0.97	53.3%	5.9	76.2%	53.7%	2.1	41.4%	9.5%	4.0%
Belgium	3,768	1.32	0.93	1.29	54.5%	8.4	75.0%	43.0%	3.3	83.1%	17.9%	7.1%
Finland	2,877	1.36	0.95	1.58	59.2%	7.9	80.4%	52.6%	3.1	71.6%	16.2%	6.6%
Austria	2,353	1.43	1.00	1.05	46.0%	7.7	72.5%	42.2%	3.3	84.8%	30.9%	8.8%
Greece	2,133	1.47	1.03	1.24	64.9%	8.7	78.8%	48.5%	3.1	63.0%	10.9%	7.5%

	Cross-disciplinarity				Output by year										
Entity	**Avg. DDA**	**$DDA_{10\%}$**	**Avg. DDR**	**$DDR_{10\%}$**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
World	**1.03**	**10.1%**	**1.01**	**8.8%**	**16,803**	**18,000**	**18,993**	**19,760**	**20,716**	**21,375**	**22,876**	**24,645**	**26,805**	**30,157**	**29,773**
United Kingdom	1.20	12.8%	1.06	10.1%	1,459	1,562	1,635	1,679	1,752	1,787	1,890	1,997	2,147	2,322	2,152
Germany	**1.19**	**12.6%**	**1.10**	**11.1%**	**1,213**	**1,393**	**1,404**	**1,451**	**1,593**	**1,543**	**1,613**	**1,784**	**1,826**	**2,005**	**1,970**
France	1.24	13.4%	1.04	8.5%	1,131	1,286	1,319	1,358	1,397	1,376	1,532	1,510	1,647	1,787	1,637
Spain	1.03	9.8%	0.98	7.4%	940	1,018	998	1,075	1,116	1,065	1,193	1,228	1,327	1,445	1,439
Italy	1.22	15.7%	1.02	10.0%	641	725	740	851	933	941	995	1,037	1,239	1,322	1,270
Netherlands	1.20	11.9%	1.07	9.3%	425	507	531	511	558	530	560	593	645	680	654
Portugal	1.17	13.5%	1.00	9.4%	378	365	406	456	481	479	509	545	622	766	708
Sweden	1.18	12.6%	1.06	9.5%	367	414	415	456	504	471	516	552	526	668	639
Denmark	1.16	11.9%	1.03	9.7%	350	348	400	416	487	446	499	499	573	607	572
Switzerland	1.27	14.6%	1.11	11.1%	248	316	302	335	344	381	387	418	397	466	524
Poland	0.99	11.2%	1.02	8.9%	227	274	315	337	352	340	395	394	463	512	459
Belgium	1.33	16.4%	1.07	10.0%	249	279	281	340	324	350	361	363	401	429	391
Finland	1.14	11.9%	1.00	6.7%	179	202	208	253	264	267	245	302	290	318	349
Austria	1.23	14.5%	1.11	11.6%	159	158	146	200	228	189	208	261	231	290	283
Greece	1.22	14.3%	0.97	7.6%	154	124	155	168	185	194	191	235	212	255	260

d) sub-area: Ocean Crust & Marine Geohazard research

Entity	Output					Diversity and Collaboration (share of co-publications)						
	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**243,524**	**1.39**	**1.00**	**1.00**	**42.4%**	**4.8**	**47.0%**	**28.5%**	**1.5**	**54.9%**	**6.6%**	**8.4%**
United Kingdom	21,781	1.23	0.89	1.36	42.6%	6.2	56.6%	32.6%	2.5	72.5%	12.1%	12.3%
Germany	**16,484**	**1.23**	**0.89**	**1.11**	**38.5%**	**7.0**	**63.0%**	**35.5%**	**2.7**	**76.3%**	**100.0%**	**8.6%**
France	14,499	1.17	0.85	1.45	36.6%	7.4	65.0%	35.3%	2.6	73.7%	12.3%	9.6%
Italy	11,611	1.33	0.96	1.18	44.9%	7.1	71.2%	41.8%	2.3	57.5%	10.1%	8.7%
Spain	8,410	1.22	0.88	1.04	45.4%	7.3	66.8%	38.1%	2.5	67.7%	11.4%	7.8%
Netherlands	5,850	1.27	0.92	1.15	46.5%	7.6	57.9%	31.7%	2.8	76.1%	17.0%	13.0%
Switzerland	3,980	1.36	0.98	1.02	34.7%	8.0	61.7%	34.1%	3.2	86.6%	25.4%	10.4%
Portugal	3,290	1.22	0.88	1.48	51.3%	7.4	75.2%	47.8%	2.7	69.1%	12.2%	7.2%
Poland	3,210	1.38	1.00	0.79	36.8%	6.2	59.5%	40.3%	2.1	44.2%	10.2%	6.2%
Sweden	3,082	1.32	0.95	0.89	44.1%	8.0	62.9%	35.8%	3.2	83.2%	18.7%	8.9%
Denmark	3,081	1.36	0.98	1.30	43.4%	8.0	59.2%	34.0%	3.0	77.0%	17.7%	13.6%
Belgium	2,411	1.32	0.95	0.85	45.0%	8.8	63.6%	33.6%	3.2	82.4%	18.7%	9.7%
Greece	2,273	1.31	0.94	1.36	52.2%	7.9	60.7%	36.5%	2.4	55.2%	11.0%	6.9%
Austria	2,033	1.34	0.96	0.93	39.1%	8.8	62.1%	32.4%	3.3	83.9%	30.1%	12.8%
Finland	1,036	1.39	1.00	0.59	54.1%	10.7	65.5%	37.2%	3.4	73.5%	18.9%	12.3%

Entity	Cross-disciplinarity				Output by year										
	Avg. DDA	$DDA_{10\%}$	Avg. DDR	$DDR_{10\%}$	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**0.99**	**9.9%**	**0.97**	**9.8%**	**16,606**	**18,209**	**18,646**	**19,234**	**20,695**	**20,740**	**23,031**	**24,846**	**26,532**	**28,084**	**26,901**
United Kingdom	1.11	11.6%	1.00	9.5%	1,587	1,758	1,796	1,734	2,024	1,936	2,151	2,111	2,374	2,291	2,019
Germany	**1.11**	**11.2%**	**1.03**	**9.2%**	**1,195**	**1,298**	**1,313**	**1,382**	**1,556**	**1,431**	**1,594**	**1,629**	**1,686**	**1,742**	**1,658**
France	1.18	12.9%	0.99	8.4%	1,121	1,205	1,255	1,198	1,303	1,278	1,392	1,369	1,532	1,563	1,283
Italy	1.13	12.7%	1.02	9.7%	840	892	874	930	1,014	1,009	1,120	1,143	1,319	1,267	1,203
Spain	1.10	10.9%	1.01	9.7%	651	672	728	668	750	707	764	763	886	915	906
Netherlands	1.18	11.9%	1.07	9.5%	418	436	455	507	527	529	581	573	643	614	567
Switzerland	1.11	11.0%	1.00	8.7%	272	305	303	327	338	338	442	352	431	471	401
Portugal	1.23	14.4%	1.05	9.9%	210	261	301	307	277	277	291	311	359	374	322
Poland	0.89	9.6%	1.02	11.2%	235	225	220	259	278	310	346	301	344	384	308
Sweden	1.17	11.7%	1.03	10.7%	209	249	228	249	270	289	308	307	327	349	297
Denmark	1.15	11.9%	1.03	9.2%	239	241	214	234	261	275	330	298	314	373	302
Belgium	1.38	16.7%	1.10	10.9%	163	180	168	189	238	236	242	225	269	265	236
Greece	1.38	18.0%	1.09	12.9%	165	161	187	194	206	167	212	251	215	251	264
Austria	1.18	12.7%	1.04	9.8%	143	159	143	172	178	176	194	186	222	248	212
Finland	1.23	13.9%	1.00	10.6%	76	71	75	83	88	96	99	98	108	125	117

e) sub-area: Ocean & Climate Research

Entity	Output					Diversity and Collaboration (share of co-publications)						
	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**211,008**	**1.39**	**1.00**	**1.00**	**48.8%**	**5.0**	**53.5%**	**33.1%**	**1.6**	**59.6%**	**8.3%**	**5.8%**
United Kingdom	20,883	1.18	0.85	1.51	49.7%	7.4	66.2%	37.8%	2.8	75.6%	16.7%	8.3%
Germany	**17,950**	**1.24**	**0.89**	**1.40**	**45.0%**	**7.8**	**68.8%**	**38.9%**	**2.9**	**76.9%**	**100.0%**	**6.9%**
France	14,282	1.21	0.87	1.65	45.2%	8.4	70.8%	37.9%	2.9	77.1%	16.0%	8.9%
Italy	8,838	1.39	1.00	1.04	53.0%	8.2	75.4%	45.6%	2.7	65.1%	14.3%	8.4%
Spain	8,799	1.28	0.92	1.25	52.4%	7.9	72.5%	42.1%	2.8	71.1%	13.6%	6.6%
Netherlands	6,490	1.25	0.90	1.48	53.8%	8.7	65.9%	36.0%	3.2	80.2%	23.5%	9.6%
Sweden	4,407	1.29	0.92	1.46	52.1%	9.0	71.7%	41.1%	3.5	84.3%	23.1%	6.5%
Switzerland	4,297	1.28	0.92	1.27	45.1%	9.8	70.5%	39.3%	3.6	86.6%	31.4%	9.1%
Denmark	3,508	1.34	0.96	1.71	50.7%	9.5	72.4%	41.5%	3.5	83.1%	21.6%	8.9%
Portugal	3,058	1.42	1.02	1.59	61.0%	8.0	80.8%	52.4%	2.7	69.4%	10.7%	5.7%
Belgium	2,714	1.31	0.94	1.10	49.2%	10.2	69.6%	36.0%	3.6	85.6%	22.4%	8.0%
Poland	2,560	1.61	1.15	0.72	47.6%	7.2	65.7%	44.3%	2.4	46.1%	13.1%	4.8%
Finland	2,338	1.15	0.82	1.53	47.1%	10.3	71.4%	39.9%	3.5	78.6%	22.9%	10.6%
Greece	1,855	1.31	0.94	1.28	55.3%	9.0	69.1%	38.4%	2.9	61.5%	14.9%	6.1%
Austria	1,807	1.40	1.00	0.95	47.4%	11.3	69.1%	36.9%	3.8	86.7%	31.8%	14.1%

Entity	Cross-disciplinarity				Output by year										
	Avg. DDA	$DDA_{10\%}$	Avg. DDR	$DDR_{10\%}$	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**1.03**	**10.3%**	**0.99**	**8.6%**	**14,362**	**15,176**	**16,126**	**16,725**	**18,210**	**18,077**	**19,634**	**20,962**	**22,701**	**24,535**	**24,500**
United Kingdom	1.14	11.8%	1.01	8.6%	1,577	1,636	1,769	1,791	1,971	1,827	2,011	1,989	2,152	2,103	2,057
Germany	**1.15**	**11.5%**	**1.04**	**8.4%**	**1,305**	**1,321**	**1,490**	**1,525**	**1,679**	**1,554**	**1,622**	**1,774**	**1,876**	**1,973**	**1,831**
France	1.22	13.0%	1.01	7.7%	1,048	1,153	1,144	1,196	1,355	1,243	1,361	1,424	1,502	1,530	1,326
Italy	1.26	14.9%	1.07	9.2%	612	573	656	710	801	836	838	840	969	994	1,009
Spain	1.14	11.2%	1.05	8.5%	641	642	755	704	791	730	821	863	925	999	928
Netherlands	1.25	12.6%	1.11	9.3%	463	491	547	540	586	578	650	646	698	669	622
Sweden	1.22	12.8%	1.05	8.8%	305	333	346	372	410	371	420	450	441	486	473
Switzerland	1.21	12.2%	1.05	7.6%	261	332	337	388	394	396	387	425	434	480	463
Denmark	1.25	12.1%	1.08	8.6%	257	250	290	289	296	281	340	324	347	425	409
Portugal	1.24	14.8%	1.08	9.9%	184	206	236	251	281	259	297	322	318	363	341
Belgium	1.31	15.6%	1.06	9.0%	191	200	208	226	236	260	263	251	292	292	295
Poland	1.04	11.4%	1.04	8.9%	119	149	187	205	232	235	256	291	275	330	281
Finland	1.16	11.3%	1.00	6.6%	180	168	198	233	224	184	207	212	205	271	256
Greece	1.32	16.8%	1.04	9.5%	137	103	161	144	189	163	161	176	183	232	206
Austria	1.22	13.1%	1.07	8.4%	116	114	126	163	168	159	173	182	184	231	191

f) sub-area: Ocean Observation & Marine Data

Entity	Output					Diversity and Collaboration (share of co-publications)						
	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**202,339**	**1.76**	**1.00**	**1.00**	**72.2%**	**5.3**	**64.9%**	**42.2%**	**1.6**	**57.9%**	**6.1%**	**4.9%**
United Kingdom	16,972	1.55	0.88	1.28	76.1%	7.7	75.3%	46.7%	3.0	77.1%	12.6%	9.2%
Germany	**12,650**	**1.66**	**0.95**	**1.03**	**66.5%**	**8.1**	**77.2%**	**46.5%**	**3.1**	**76.5%**	**100.0%**	**7.9%**
France	12,048	1.47	0.83	1.45	69.6%	8.7	78.2%	46.2%	3.0	73.5%	12.6%	7.0%
Spain	11,287	1.64	0.93	1.67	74.2%	7.5	76.5%	47.1%	2.7	66.7%	9.7%	7.7%
Italy	9,988	1.83	1.04	1.23	79.0%	8.1	84.0%	55.7%	2.6	57.0%	9.6%	8.1%
Portugal	5,395	1.71	0.97	2.93	76.1%	8.1	86.0%	60.1%	2.9	66.7%	9.2%	6.2%
Netherlands	5,366	1.57	0.89	1.27	74.2%	8.7	74.9%	44.8%	3.4	79.6%	19.6%	10.2%
Sweden	4,554	1.60	0.91	1.58	72.3%	8.7	77.2%	46.6%	3.5	80.7%	21.5%	7.7%
Denmark	3,804	1.72	0.98	1.94	70.2%	9.6	76.1%	44.4%	3.7	84.4%	20.3%	10.7%
Switzerland	3,185	1.62	0.92	0.98	62.7%	10.1	76.2%	44.1%	3.8	85.5%	25.1%	10.0%
Poland	3,078	1.89	1.07	0.91	67.3%	6.8	76.3%	54.7%	2.4	42.2%	11.0%	4.2%
Belgium	2,987	1.64	0.93	1.27	69.8%	9.6	77.1%	44.3%	3.6	83.1%	18.1%	8.3%
Finland	2,374	1.74	0.99	1.62	70.9%	9.7	81.7%	52.1%	3.6	75.1%	19.5%	7.9%
Greece	2,272	1.80	1.02	1.63	80.7%	9.0	78.6%	49.9%	3.2	60.2%	11.8%	8.5%
Austria	1,748	1.59	0.90	0.96	61.5%	9.4	75.6%	43.9%	3.8	87.0%	30.0%	12.0%

Entity	Cross-disciplinarity				output by year										
	Avg. DDA	$DDA_{10\%}$	Avg. DDR	$DDR_{10\%}$	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**1.09**	**11.8%**	**1.05**	**10.3%**	**11,391**	**12,366**	**13,472**	**14,222**	**15,828**	**16,750**	**18,793**	**20,776**	**23,605**	**27,245**	**27,891**
United Kingdom	1.26	14.8%	1.08	11.4%	1,055	1,091	1,265	1,253	1,425	1,454	1,594	1,736	1,956	2,153	1,990
Germany	**1.27**	**15.4%**	**1.11**	**12.3%**	**710**	**819**	**845**	**929**	**1,036**	**1,099**	**1,248**	**1,307**	**1,384**	**1,604**	**1,669**
France	1.31	15.9%	1.05	9.0%	715	843	879	935	1,095	1,028	1,191	1,232	1,271	1,500	1,359
Spain	1.10	11.7%	1.02	9.0%	653	766	775	821	905	952	1,103	1,135	1,288	1,472	1,417
Italy	1.30	17.6%	1.07	11.9%	529	620	596	721	748	895	923	1,030	1,197	1,350	1,379
Portugal	1.20	14.2%	1.02	9.6%	303	335	365	417	413	432	459	563	634	754	720
Netherlands	1.31	15.8%	1.10	11.4%	276	349	415	412	462	451	537	563	616	645	640
Sweden	1.25	14.0%	1.09	11.1%	264	282	310	364	389	373	448	505	465	583	571
Denmark	1.21	12.9%	1.04	9.8%	227	216	243	269	325	324	368	378	433	525	496
Switzerland	1.33	16.8%	1.11	12.1%	172	195	233	231	270	301	312	314	318	417	422
Poland	1.07	12.3%	1.03	10.6%	114	171	215	218	257	265	305	346	353	429	405
Belgium	1.36	17.3%	1.06	9.6%	171	191	197	226	248	259	288	295	342	404	366
Finland	1.23	13.7%	1.03	8.6%	122	136	159	179	203	188	226	270	266	302	323
Greece	1.34	18.0%	1.03	11.0%	128	131	153	140	191	192	209	240	246	328	314
Austria	1.32	15.7%	1.12	12.3%	107	108	118	141	149	134	165	184	180	229	233

g) sub-area: Ocean Biodiversity Use & Protection research

	Output					Diversity and Collaboration (share of co-publications)						
Entity	**Pubs**	**GR**	**GI**	**SI**	**Share in SDG**	**Avg. # of auth.**	**Share of Women Particip.**	**Share of 1st/last Women auth**	**Avg. # of countries**	**Intl co-pubs**	**co-pubs with German auth.**	**Public-private co-pubs**
World	**153,246**	**1.40**	**1.00**	**1.00**	**47.5%**	**5.1**	**54.6%**	**33.8%**	**1.5**	**54.9%**	**6.5%**	**6.9%**
United Kingdom	13,445	1.23	0.88	1.34	49.6%	7.8	67.7%	38.8%	2.8	72.8%	13.1%	11.7%
France	10,529	1.19	0.85	1.68	45.8%	8.6	69.8%	38.6%	2.9	72.2%	12.7%	10.6%
Germany	**10,221**	**1.26**	**0.90**	**1.10**	**43.3%**	**8.3**	**67.3%**	**37.6%**	**2.9**	**71.2%**	**100.0%**	**11.1%**
Italy	7,967	1.34	0.96	1.29	54.1%	8.5	76.3%	46.4%	2.6	56.1%	10.9%	11.2%
Spain	6,670	1.23	0.88	1.31	53.3%	8.5	71.4%	40.4%	2.8	65.0%	11.9%	10.1%
Netherlands	4,038	1.26	0.90	1.26	47.6%	9.6	65.5%	35.5%	3.3	77.3%	21.3%	13.1%
Portugal	2,816	1.39	0.99	2.02	57.9%	8.0	76.2%	49.3%	2.8	62.9%	9.4%	8.4%
Denmark	2,793	1.29	0.92	1.88	50.3%	9.8	69.1%	38.3%	3.5	77.6%	20.3%	13.4%
Sweden	2,653	1.32	0.94	1.21	51.3%	10.1	70.8%	40.8%	3.7	78.1%	21.4%	10.2%
Switzerland	2,125	1.39	0.99	0.86	47.1%	11.8	71.7%	40.0%	4.0	85.3%	28.7%	12.9%
Belgium	2,033	1.32	0.94	1.14	51.8%	11.5	72.2%	39.4%	3.9	81.1%	20.4%	12.1%
Greece	1,868	1.39	0.99	1.77	58.5%	9.6	67.8%	39.9%	3.1	58.0%	12.2%	9.4%
Poland	1,802	1.68	1.20	0.70	47.6%	8.8	65.9%	45.1%	2.8	45.9%	12.7%	7.5%
Finland	1,530	1.27	0.90	1.37	52.8%	11.5	73.5%	44.5%	3.8	71.8%	22.0%	10.7%
Austria	1,096	1.28	0.92	0.80	44.3%	12.8	69.0%	38.4%	4.3	85.6%	33.5%	17.6%

	Cross-disciplinarity				output by year										
Entity	**Avg. DDA**	**$DDA_{10\%}$**	**Avg. DDR**	**$DDR_{10\%}$**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
World	**1.09**	**11.9%**	**1.03**	**11.1%**	**10,488**	**11,003**	**11,366**	**12,396**	**13,128**	**13,012**	**13,585**	**15,376**	**16,511**	**18,101**	**18,280**
United Kingdom	1.21	13.5%	1.01	9.7%	974	1,056	1,080	1,195	1,188	1,200	1,227	1,375	1,386	1,418	1,346
France	1.25	14.0%	1.01	8.1%	776	830	882	945	963	916	921	1,068	1,087	1,151	990
Germany	**1.19**	**13.2%**	**1.02**	**9.0%**	**701**	**759**	**836**	**907**	**939**	**862**	**896**	**1,059**	**1,090**	**1,142**	**1,030**
Italy	1.35	18.6%	1.07	12.8%	512	595	573	735	702	670	691	815	857	885	932
Spain	1.18	13.2%	1.03	10.4%	516	523	545	586	568	563	629	647	664	740	689
Netherlands	1.25	14.0%	1.03	8.9%	278	312	321	345	374	349	365	410	411	448	425
Portugal	1.26	15.9%	1.04	9.6%	196	189	215	227	249	240	234	295	279	361	331
Denmark	1.19	10.9%	1.01	8.0%	202	205	223	231	255	237	264	263	290	347	276
Sweden	1.18	12.3%	1.01	9.4%	181	201	186	248	230	222	233	287	249	315	301
Switzerland	1.28	16.1%	1.03	9.7%	129	149	171	183	172	203	185	213	224	250	246
Belgium	1.35	17.2%	1.01	8.7%	135	149	147	182	185	178	172	212	208	235	230
Greece	1.36	18.3%	1.05	11.6%	126	139	136	151	167	149	158	209	181	216	236
Poland	1.08	13.9%	1.07	11.9%	109	97	123	130	153	163	173	216	189	248	201
Finland	1.25	13.9%	1.00	8.2%	104	103	122	154	131	137	126	149	161	164	179
Austria	1.33	15.9%	1.06	11.6%	79	66	93	96	106	91	108	96	105	139	117

h) sub-area: Ocean Technology Research

Entity	Output					Diversity and Collaboration (share of co-publications)						
	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**121,134**	**1.53**	**1.00**	**1.00**	**33.4%**	**3.9**	**28.8%**	**17.3%**	**1.3**	**35.3%**	**3.3%**	**9.7%**
United Kingdom	8,631	1.30	0.85	1.09	42.8%	4.8	32.5%	18.1%	1.9	56.3%	3.6%	14.6%
Italy	5,143	1.32	0.86	1.05	43.6%	5.6	53.6%	30.6%	1.7	39.3%	4.8%	11.5%
Germany	**4,254**	**1.11**	**0.72**	**0.58**	**36.6%**	**5.7**	**35.2%**	**19.2%**	**1.9**	**47.6%**	**100.0%**	**14.2%**
France	3,845	1.21	0.79	0.77	37.6%	6.1	36.6%	19.5%	2.0	56.5%	5.6%	15.0%
Netherlands	2,596	1.22	0.80	1.03	34.4%	6.0	34.2%	19.9%	2.1	54.7%	8.0%	13.4%
Spain	2,461	1.42	0.93	0.61	53.1%	5.5	42.8%	25.2%	1.9	49.7%	4.9%	10.8%
Portugal	2,045	1.46	0.95	1.85	41.9%	5.7	34.5%	21.5%	1.9	47.4%	4.3%	7.2%
Poland	1,739	1.78	1.16	0.86	33.7%	3.5	30.1%	22.3%	1.5	21.6%	2.7%	5.8%
Denmark	1,395	1.59	1.04	1.19	52.0%	7.5	34.6%	20.3%	2.3	62.8%	7.2%	20.4%
Greece	1,345	1.07	0.70	1.62	47.9%	4.3	34.3%	21.3%	1.8	40.7%	6.5%	11.2%
Sweden	1,319	1.75	1.14	0.76	49.9%	7.6	42.4%	25.2%	2.2	58.3%	6.7%	18.0%
Finland	845	1.52	0.99	0.96	37.4%	5.4	36.9%	20.9%	2.1	53.6%	7.8%	15.5%
Belgium	726	1.31	0.85	0.51	40.9%	6.6	43.7%	20.5%	2.4	64.2%	8.4%	13.5%
Switzerland	592	1.52	0.99	0.30	38.7%	12.3	39.7%	22.3%	2.7	72.7%	13.0%	15.0%
Austria	309	1.30	0.85	0.28	42.1%	7.2	36.2%	19.7%	2.6	67.6%	20.7%	25.9%

Entity	Cross-disciplinarity				Output by year										
	Avg. DDA	$DDA_{10\%}$	Avg. DDR	$DDR_{10\%}$	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**0.95**	**8.7%**	**0.99**	**10.1%**	**7,658**	**8,361**	**8,401**	**9,714**	**9,727**	**10,134**	**11,540**	**13,098**	**12,972**	**14,170**	**15,359**
United Kingdom	1.10	12.2%	1.03	11.7%	585	613	650	775	771	813	833	919	871	952	849
Italy	1.04	11.3%	1.02	10.6%	385	320	329	546	440	463	510	522	507	520	601
Germany	**0.94**	**9.8%**	**0.93**	**9.3%**	**339**	**372**	**357**	**392**	**392**	**350**	**388**	**432**	**395**	**414**	**423**
France	1.11	11.9%	0.99	9.8%	289	323	314	314	346	343	368	415	394	373	366
Netherlands	1.01	9.8%	0.97	7.6%	184	201	226	234	224	220	243	281	263	238	282
Spain	1.21	14.9%	1.05	13.0%	150	167	191	212	224	178	262	261	260	272	284
Portugal	0.91	9.4%	0.93	7.2%	145	117	99	209	214	118	233	203	206	275	226
Poland	0.73	6.8%	1.07	17.1%	83	129	96	127	131	167	184	175	199	238	210
Denmark	1.07	11.2%	0.97	8.2%	81	95	97	121	100	114	136	143	177	170	161
Greece	1.00	11.0%	1.05	14.7%	106	93	135	134	136	96	91	102	135	163	154
Sweden	1.16	14.5%	1.05	14.7%	68	86	66	105	118	101	127	165	137	185	161
Finland	1.09	13.3%	1.04	13.1%	49	46	63	76	76	65	84	79	100	85	122
Belgium	1.22	16.6%	0.97	11.5%	56	81	40	60	55	52	51	85	98	75	73
Switzerland	1.02	12.1%	0.93	10.7%	41	42	39	40	50	58	54	72	62	79	55
Austria	1.21	16.1%	1.02	14.3%	27	16	26	27	30	19	35	32	34	36	27

i) sub-area: Human Health & Wellbeing Research

	Output					Diversity and Collaboration (share of co-publications)						
Entity	**Pubs**	**GR**	**GI**	**SI**	**Share in SDG**	**Avg. # of auth.**	**Share of Women Particip.**	**Share of 1st/last Women auth**	**Avg. # of countries**	**Intl co-pubs**	**co-pubs with German auth.**	**Public-private co-pubs**
World	**118,101**	**1.82**	**1.00**	**1.00**	**65.1%**	**5.3**	**64.1%**	**40.9%**	**1.5**	**51.2%**	**4.5%**	**5.3%**
United Kingdom	7,844	1.60	0.88	1.01	71.7%	7.2	72.7%	45.7%	2.8	72.0%	10.1%	10.0%
Spain	5,771	1.74	0.95	1.47	67.4%	7.2	78.9%	51.9%	2.4	61.0%	7.5%	8.2%
Germany	**5,636**	**1.57**	**0.86**	**0.78**	**65.5%**	**7.5**	**74.8%**	**47.4%**	**2.8**	**70.6%**	**100.0%**	**10.2%**
Italy	5,388	1.87	1.03	1.13	70.2%	7.8	85.3%	60.4%	2.3	50.6%	7.3%	8.3%
France	5,001	1.39	0.76	1.03	68.1%	8.0	78.9%	48.0%	2.7	67.2%	9.4%	7.7%
Portugal	2,759	2.23	1.22	2.56	67.9%	7.4	88.6%	67.8%	2.4	55.6%	6.3%	7.0%
Netherlands	2,538	1.42	0.78	1.03	73.8%	7.9	71.9%	43.7%	3.1	73.8%	16.6%	12.2%
Sweden	1,864	1.65	0.90	1.11	73.0%	8.2	78.5%	50.6%	3.2	75.5%	15.3%	7.8%
Poland	1,702	2.06	1.13	0.86	62.5%	6.0	80.1%	59.5%	2.1	34.1%	7.5%	5.6%
Denmark	1,593	1.74	0.95	1.39	69.1%	9.1	78.9%	50.1%	3.4	77.1%	18.0%	12.3%
Belgium	1,356	1.86	1.02	0.98	68.4%	9.4	77.0%	45.1%	3.4	79.5%	14.5%	9.8%
Switzerland	1,205	1.40	0.77	0.63	67.8%	9.6	78.9%	48.2%	3.7	83.1%	22.1%	12.8%
Greece	1,093	1.75	0.96	1.35	73.4%	8.2	77.4%	51.9%	2.9	52.6%	10.5%	9.1%
Finland	909	1.75	0.96	1.06	72.8%	8.5	81.8%	56.4%	3.2	70.8%	19.4%	10.5%
Austria	714	2.00	1.10	0.67	64.4%	8.7	76.1%	48.3%	3.4	78.4%	25.9%	13.2%

	Cross-disciplinarity				Output by year										
Entity	**Avg. DDA**	**$DDA_{10\%}$**	**Avg. DDR**	**$DDR_{10\%}$**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
World	**1.15**	**13.8%**	**1.10**	**14.3%**	**6,508**	**6,944**	**7,607**	**8,242**	**9,155**	**9,475**	**10,755**	**11,954**	**14,259**	**16,096**	**17,106**
United Kingdom	1.35	18.6%	1.13	14.9%	466	517	552	594	646	616	783	812	912	980	966
Spain	1.22	14.7%	1.08	14.1%	312	376	358	433	446	492	565	592	683	740	774
Germany	**1.29**	**16.7%**	**1.12**	**13.6%**	**355**	**363**	**400**	**407**	**478**	**493**	**505**	**612**	**667**	**704**	**652**
Italy	1.42	21.5%	1.13	16.7%	281	279	314	392	444	479	491	524	716	732	736
France	1.37	19.0%	1.09	13.4%	308	361	395	400	462	401	470	485	574	593	552
Portugal	1.36	19.7%	1.13	17.1%	122	141	143	181	210	184	244	281	350	446	457
Netherlands	1.33	16.9%	1.10	12.2%	147	179	210	213	212	209	249	229	285	297	308
Sweden	1.33	16.6%	1.12	15.9%	101	114	135	144	149	162	165	196	219	235	244
Poland	1.11	15.1%	1.13	17.6%	64	85	103	117	145	131	175	180	226	234	242
Denmark	1.30	17.1%	1.08	12.6%	94	88	111	113	131	121	169	155	194	230	187
Belgium	1.48	22.3%	1.10	12.6%	61	69	100	95	109	113	126	124	172	213	174
Switzerland	1.34	17.8%	1.10	14.9%	81	78	97	97	107	100	106	123	138	128	150
Greece	1.39	20.2%	1.08	14.0%	62	67	65	83	89	87	97	108	124	149	162
Finland	1.38	18.0%	1.11	14.5%	54	37	74	75	66	68	86	107	107	122	113
Austria	1.41	19.4%	1.14	17.2%	32	40	43	53	55	45	76	86	93	100	91

j) sub-area: Carbon Neutrality Research

	Output					Diversity and Collaboration (share of co-publications)						
Entity	**Pubs**	**GR**	**GI**	**SI**	**Share in SDG**	**Avg. # of auth.**	**Share of Women Particip.**	**Share of 1st/last Women auth**	**Avg. # of countries**	**Intl co-pubs**	**co-pubs with German auth.**	**Public-private co-pubs**
World	**90,653**	**1.75**	**1.00**	**1.00**	**100.0%**	**4.3**	**38.3%**	**23.0%**	**1.3**	**41.8%**	**4.5%**	**10.1%**
United Kingdom	7,087	1.48	0.85	1.19	100.0%	4.8	41.9%	24.9%	1.9	55.5%	5.4%	14.0%
Germany	**4,314**	**1.29**	**0.73**	**0.78**	**100.0%**	**5.1**	**45.4%**	**25.5%**	**1.9**	**47.0%**	**100.0%**	**16.1%**
Italy	3,507	1.77	1.01	0.96	100.0%	5.3	59.7%	35.9%	1.8	43.9%	5.1%	13.3%
Spain	3,181	1.52	0.87	1.05	100.0%	5.3	50.0%	29.0%	1.9	51.4%	4.9%	12.6%
France	2,754	1.54	0.88	0.74	100.0%	5.9	51.7%	29.5%	2.1	58.9%	5.4%	14.3%
Denmark	2,121	1.40	0.80	2.41	100.0%	5.3	40.1%	23.8%	2.1	57.4%	8.5%	20.2%
Netherlands	1,919	1.72	0.98	1.02	100.0%	5.3	45.7%	27.6%	2.2	63.0%	11.4%	17.8%
Portugal	1,486	1.69	0.96	1.80	100.0%	4.8	50.2%	33.6%	1.9	48.1%	3.5%	7.9%
Sweden	1,428	1.58	0.90	1.10	100.0%	5.1	52.7%	31.4%	2.1	58.5%	6.1%	15.0%
Poland	988	2.48	1.42	0.65	100.0%	4.1	49.2%	33.3%	1.6	28.3%	4.1%	7.1%
Greece	964	1.46	0.83	1.55	100.0%	5.3	45.4%	26.3%	1.9	41.1%	5.4%	12.0%
Switzerland	948	1.38	0.79	0.65	100.0%	5.2	41.5%	23.3%	2.2	59.4%	10.2%	17.0%
Belgium	877	1.40	0.80	0.83	100.0%	6.3	53.2%	26.7%	2.4	64.3%	10.8%	13.8%
Finland	607	1.59	0.91	0.92	100.0%	5.5	56.5%	31.3%	2.3	59.7%	9.6%	16.5%
Austria	603	1.28	0.73	0.74	100.0%	5.2	41.6%	23.5%	2.2	56.6%	15.9%	18.6%

	Cross-disciplinarity				Output by year										
Entity	**Avg. DDA**	**$DDA_{10\%}$**	**Avg. DDR**	**$DDR_{10\%}$**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
World	**1.04**	**10.4%**	**1.02**	**9.1%**	**4,728**	**5,480**	**6,093**	**6,806**	**7,076**	**7,582**	**8,357**	**9,814**	**10,211**	**11,765**	**12,741**
United Kingdom	1.24	15.0%	1.08	12.7%	387	434	539	633	611	618	686	737	761	868	813
Germany	**1.08**	**12.0%**	**1.05**	**11.5%**	**254**	**340**	**340**	**393**	**395**	**379**	**412**	**427**	**422**	**464**	**488**
Italy	1.15	13.9%	1.05	10.1%	140	178	231	317	289	302	329	362	397	465	497
Spain	1.13	12.8%	1.02	10.1%	148	193	216	296	304	267	320	350	339	371	377
France	1.31	17.7%	1.05	10.4%	163	165	217	210	239	230	263	287	328	335	317
Denmark	1.11	11.5%	1.04	10.0%	144	149	145	174	193	191	192	236	226	221	250
Netherlands	1.23	14.1%	1.09	11.6%	83	99	155	159	157	145	208	193	238	234	248
Portugal	1.15	13.6%	1.06	8.6%	61	81	98	140	135	103	118	173	182	209	186
Sweden	1.16	13.7%	1.08	13.1%	79	80	94	114	139	120	131	151	136	186	198
Poland	0.89	9.9%	1.04	11.6%	40	51	40	56	68	100	93	110	121	147	162
Greece	1.19	15.9%	1.03	11.0%	56	55	76	77	97	76	69	103	88	134	133
Switzerland	1.16	12.8%	1.07	12.1%	50	75	72	71	95	84	111	105	87	110	88
Belgium	1.31	15.7%	1.04	10.3%	56	59	64	85	73	68	80	85	96	92	119
Finland	1.19	15.5%	1.04	10.4%	47	36	41	53	43	38	59	75	66	70	79
Austria	1.16	13.8%	1.09	14.1%	38	45	35	61	63	51	50	58	51	71	80

k) sub-area: Ocean Health Research

Entity	Output					Diversity and Collaboration (share of co-publications)						
	Pubs	GR	GI	SI	Share in SDG	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of countries	Intl co-pubs	co-pubs with German auth.	Public-private co-pubs
World	**76,469**	**1.77**	**1.00**	**1.00**	**71.4%**	**5.4**	**66.4%**	**42.7%**	**1.5**	**54.1%**	**5.2%**	**4.6%**
United Kingdom	4,960	1.43	0.80	0.99	74.0%	6.9	75.1%	45.9%	2.7	75.1%	10.7%	9.7%
France	4,315	1.48	0.84	1.38	72.0%	7.8	82.4%	50.1%	2.5	68.6%	8.3%	5.9%
Italy	4,115	1.68	0.95	1.34	78.3%	7.5	88.0%	62.0%	2.2	52.6%	6.1%	7.8%
Germany	**4,056**	**1.48**	**0.84**	**0.87**	**72.0%**	**7.3**	**76.8%**	**46.9%**	**2.7**	**73.0%**	**100.0%**	**8.0%**
Spain	3,927	1.52	0.86	1.54	76.1%	6.9	81.6%	51.9%	2.4	63.7%	6.9%	7.0%
Portugal	2,251	1.41	0.79	3.23	75.3%	7.0	90.4%	67.4%	2.2	60.5%	5.8%	4.4%
Sweden	1,563	1.50	0.85	1.43	75.8%	7.2	77.2%	49.0%	2.9	75.7%	18.9%	7.9%
Netherlands	1,535	1.30	0.73	0.96	70.2%	7.8	75.8%	43.7%	2.9	76.6%	19.9%	11.6%
Poland	1,416	1.76	0.99	1.10	72.5%	5.6	80.9%	60.6%	1.9	35.5%	6.9%	2.4%
Denmark	1,042	1.62	0.91	1.40	71.2%	7.9	82.0%	49.5%	3.2	84.5%	19.8%	11.9%
Belgium	945	1.33	0.75	1.06	74.6%	8.5	79.6%	45.6%	3.1	81.0%	14.4%	8.4%
Switzerland	900	1.42	0.80	0.73	63.4%	8.0	80.0%	49.7%	3.2	80.3%	19.9%	10.3%
Greece	871	1.76	1.00	1.66	76.5%	8.1	81.2%	51.9%	2.7	57.4%	8.8%	6.7%
Finland	845	1.43	0.81	1.52	76.2%	7.2	80.6%	52.4%	2.9	68.8%	17.8%	8.3%
Austria	492	1.92	1.09	0.72	67.3%	7.8	73.6%	42.5%	3.3	86.8%	24.0%	11.8%

Entity	Cross-disciplinarity				Output by year										
	Avg. DDA	$DDA_{10\%}$	Avg. DDR	$DDR_{10\%}$	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
World	**1.17**	**14.0%**	**1.07**	**11.1%**	**3,946**	**4,429**	**5,076**	**5,438**	**6,330**	**6,579**	**7,331**	**7,458**	**8,984**	**10,281**	**10,617**
United Kingdom	1.30	16.3%	1.08	11.8%	285	332	374	418	460	426	499	512	539	560	555
France	1.42	19.8%	1.08	11.0%	242	297	298	355	384	399	466	393	500	489	492
Italy	1.45	23.2%	1.10	12.8%	188	247	253	328	378	379	391	372	467	541	571
Germany	**1.27**	**16.3%**	**1.08**	**11.2%**	**227**	**297**	**290**	**323**	**361**	**338**	**413**	**397**	**428**	**481**	**501**
Spain	1.18	14.1%	1.05	10.4%	223	276	284	280	363	327	407	385	438	492	452
Portugal	1.21	14.9%	1.06	11.4%	125	162	186	184	201	187	192	205	261	294	254
Sweden	1.24	14.5%	1.08	10.8%	95	96	139	114	127	137	139	159	149	206	202
Netherlands	1.27	15.7%	1.07	10.7%	81	102	137	133	155	137	151	142	152	180	165
Poland	1.08	13.9%	1.08	12.5%	49	76	115	111	123	107	168	154	170	179	164
Denmark	1.30	15.8%	1.05	11.3%	50	63	76	81	92	94	93	97	123	141	132
Belgium	1.41	19.4%	1.07	10.5%	58	73	79	84	78	78	78	78	100	132	107
Switzerland	1.32	16.9%	1.08	11.5%	47	61	66	83	83	77	74	78	103	121	107
Greece	1.30	18.0%	1.04	11.1%	45	53	55	64	72	72	93	76	114	112	115
Finland	1.21	13.7%	1.04	9.7%	52	66	53	67	76	81	85	75	85	105	100
Austria	1.44	21.0%	1.14	16.1%	20	26	27	43	39	39	53	58	56	71	60

I) sub-area: Ocean Engineering & Social Sciences

	Output					Diversity and Collaboration (share of co-publications)						
Entity	**Pubs**	**GR**	**GI**	**SI**	**Share in SDG**	**Avg. # of auth.**	**Share of Women Particip.**	**Share of 1st/last Women auth**	**Avg. # of countries**	**Intl co-pubs**	**co-pubs with German auth.**	**Public-private co-pubs**
World	**23,204**	**1.41**	**1.00**	**1.00**	**50.2%**	**2.4**	**43.0%**	**36.0%**	**1.2**	**31.9%**	**2.7%**	**1.8%**
United Kingdom	2,779	1.20	0.84	1.83	49.8%	2.6	47.0%	39.7%	1.6	32.5%	2.8%	3.1%
Germany	**1,003**	**1.45**	**1.02**	**0.71**	**49.3%**	**3.2**	**48.4%**	**35.7%**	**1.7**	**38.6%**	**100.0%**	**1.3%**
France	923	1.01	0.71	0.97	46.7%	3.7	49.3%	37.2%	1.7	36.1%	3.3%	2.5%
Spain	885	1.55	1.10	1.14	51.8%	3.2	48.2%	36.4%	1.5	28.0%	1.9%	2.0%
Italy	711	1.87	1.32	0.76	46.4%	3.4	57.2%	42.8%	1.6	35.1%	3.7%	4.2%
Netherlands	680	1.45	1.02	1.41	58.5%	3.2	47.6%	35.0%	1.8	47.3%	5.4%	3.8%
Sweden	372	1.55	1.09	1.12	56.2%	2.6	48.9%	42.7%	1.7	38.0%	4.3%	1.6%
Poland	307	1.55	1.10	0.79	42.0%	2.5	47.6%	39.1%	1.4	19.2%	3.6%	0.3%
Portugal	291	1.73	1.22	1.38	40.5%	3.6	59.8%	45.4%	1.7	39.2%	3.1%	1.4%
Belgium	282	1.24	0.88	1.04	49.6%	3.2	40.8%	28.4%	1.8	41.3%	5.3%	1.8%
Denmark	274	1.45	1.02	1.22	51.5%	2.7	46.0%	34.3%	1.6	40.7%	5.1%	1.5%
Switzerland	244	1.41	0.99	0.65	50.8%	4.2	51.6%	38.5%	2.2	54.9%	10.2%	4.5%
Finland	182	1.34	0.95	1.08	57.7%	2.7	63.2%	53.3%	1.7	35.4%	3.8%	0.0%
Greece	177	1.63	1.15	1.11	41.8%	3.7	54.8%	37.9%	1.8	35.2%	11.3%	1.1%
Austria	118	1.54	1.09	0.57	47.5%	4.0	50.8%	39.8%	2.2	56.4%	19.5%	2.5%

	Cross-disciplinarity				Output by year										
Entity	**Avg. DDA**	**$DDA_{10\%}$**	**Avg. DDR**	**$DDR_{10\%}$**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
World	**1.00**	**10.0%**	**1.00**	**10.0%**	**1,606**	**1,682**	**1,631**	**1,827**	**1,919**	**2,280**	**2,231**	**2,327**	**2,324**	**2,725**	**2,652**
United Kingdom	1.08	11.2%	1.01	8.7%	214	234	227	231	245	252	278	260	252	270	316
Germany	**1.08**	**11.9%**	**1.00**	**9.0%**	**62**	**63**	**86**	**83**	**80**	**87**	**100**	**115**	**103**	**103**	**121**
France	1.14	12.9%	0.98	9.2%	71	85	75	90	97	83	87	85	81	84	85
Spain	1.11	11.5%	0.97	5.6%	56	68	71	57	66	74	102	84	101	102	104
Italy	1.11	10.0%	0.94	2.2%	44	38	52	36	56	62	71	73	84	100	95
Netherlands	1.48	14.0%	1.02	9.0%	41	49	48	55	63	54	83	63	74	71	79
Sweden	1.32	12.7%	1.01	13.4%	17	16	26	36	38	33	42	28	37	40	59
Poland	0.81	7.1%	0.89	4.8%	21	17	22	20	25	39	24	29	31	45	34
Portugal	1.19	13.6%	0.97	10.8%	14	17	21	20	25	26	28	27	32	43	38
Belgium	1.31	14.2%	0.94	5.6%	22	23	16	28	26	24	23	20	29	33	38
Denmark	1.13	11.5%	0.97	10.8%	17	16	21	20	24	34	20	27	23	36	36
Switzerland	1.28	15.9%	1.02	9.2%	17	13	19	23	19	25	19	25	23	30	31
Finland	1.28	14.1%	1.01	10.1%	6	14	12	24	14	18	19	18	12	21	24
Greece	1.25	12.2%	1.01	7.2%	17	15	9	14	7	14	7	16	21	25	32
Austria	1.36	14.7%	1.03	9.0%	8	6	9	7	11	14	9	11	13	17	13

m) sub-area: Prevent & Eliminate Pollution Research

	Output					Diversity and Collaboration (share of co-publications)						
Entity	**Pubs**	**GR**	**GI**	**SI**	**Share in SDG**	**Avg. # of auth.**	**Share of Women Particip.**	**Share of 1st/last Women auth**	**Avg. # of countries**	**Intl co-pubs**	**co-pubs with German auth.**	**Public-private co-pubs**
World	**16,480**	**1.83**	**1.00**	**1.00**	**99.0%**	**5.2**	**64.3%**	**41.7%**	**1.4**	**48.6%**	**4.1%**	**4.5%**
Italy	950	1.75	0.96	1.43	98.5%	6.9	88.8%	62.2%	1.8	43.7%	3.9%	5.7%
United Kingdom	841	2.09	1.14	0.78	99.0%	6.5	75.3%	49.8%	2.5	72.5%	7.4%	9.0%
France	815	1.33	0.73	1.21	99.3%	7.5	80.7%	48.6%	2.2	68.1%	5.4%	7.5%
Spain	807	1.52	0.83	1.47	98.3%	6.5	81.2%	53.3%	2.0	57.1%	3.8%	5.8%
Germany	**692**	**1.73**	**0.95**	**0.69**	**98.7%**	**6.5**	**77.7%**	**49.4%**	**2.5**	**75.4%**	**100.0%**	**7.9%**
Portugal	394	1.31	0.72	2.62	98.5%	6.6	91.4%	69.8%	2.0	57.4%	5.1%	4.3%
Netherlands	326	2.08	1.14	0.95	99.4%	6.8	77.3%	49.1%	2.7	76.9%	17.8%	11.0%
Poland	250	1.50	0.82	0.90	98.8%	4.8	81.6%	62.0%	1.7	34.9%	5.6%	2.8%
Denmark	239	1.55	0.85	1.49	100.0%	8.3	83.7%	56.9%	3.1	84.1%	22.6%	8.8%
Sweden	215	1.94	1.06	0.91	98.6%	6.7	80.5%	56.7%	2.6	74.0%	20.5%	6.5%
Greece	181	1.68	0.92	1.60	99.4%	6.1	72.9%	47.5%	2.0	46.4%	4.4%	6.6%
Belgium	172	1.34	0.73	0.89	98.8%	7.1	80.2%	46.5%	2.8	86.6%	16.9%	7.0%
Finland	121	1.37	0.75	1.01	100.0%	6.8	83.5%	62.8%	2.5	76.9%	22.3%	5.0%
Switzerland	86	1.76	0.96	0.32	98.8%	7.4	73.3%	46.5%	3.1	88.4%	14.0%	4.7%
Austria	59	1.48	0.81	0.40	98.3%	6.9	78.0%	44.1%	2.8	83.1%	22.0%	5.1%

	Cross-disciplinarity				Output by year										
Entity	**Avg. DDA**	**$DDA_{10\%}$**	**Avg. DDR**	**$DDR_{10\%}$**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
World	**1.25**	**16.1%**	**1.14**	**13.2%**	**914**	**1,055**	**1,079**	**1,100**	**1,218**	**1,301**	**1,449**	**1,707**	**1,965**	**2,274**	**2,418**
Italy	1.53	26.1%	1.18	14.8%	65	62	59	65	73	58	98	85	135	122	128
United Kingdom	1.45	22.7%	1.14	13.9%	33	55	43	50	71	63	81	98	98	127	122
France	1.54	25.0%	1.14	13.1%	52	64	66	68	70	70	70	79	84	95	97
Spain	1.29	18.5%	1.13	12.8%	46	59	66	55	72	55	58	80	97	102	117
Germany	**1.35**	**16.3%**	**1.16**	**14.4%**	**37**	**48**	**43**	**39**	**66**	**55**	**65**	**68**	**90**	**97**	**84**
Portugal	1.35	18.7%	1.13	13.9%	21	40	32	27	40	24	34	33	42	48	53
Netherlands	1.50	21.1%	1.15	11.0%	14	18	16	24	23	33	22	37	41	39	59
Poland	1.12	17.0%	1.13	10.1%	15	22	23	14	16	25	25	24	20	34	32
Denmark	1.30	15.7%	1.07	8.5%	15	20	14	16	20	22	20	29	22	33	28
Sweden	1.39	17.3%	1.11	16.5%	16	7	11	22	12	15	15	19	31	40	27
Greece	1.37	22.8%	1.16	12.0%	9	12	16	13	13	12	12	18	21	31	24
Belgium	1.56	22.1%	1.12	10.0%	14	10	15	10	18	15	11	14	13	30	22
Finland	1.36	19.0%	1.21	17.1%	8	8	12	9	9	12	9	11	14	16	13
Switzerland	1.58	27.4%	1.13	12.2%	6	3	5	9	6	6	6	8	8	7	22
Austria	1.50	25.9%	1.20	17.5%	4	2	6	3	8	2	6	5	9	8	6

Annex 6. Collaboration between German institutions in Ocean Science research (2012–2022).*

**Note: For this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen*

The collaboration category indicates collaboration links among German institutions with a) more than 200 shared publications (Pubs) and b) less than 15 shared publications. The collaboration links with fewer than 10 co-publications are not shown. c) List of German institutions with the greatest number of partners (>10) with whom they published at least 10 papers.

a)

Selected German Institution		Partner institution		Number and share of co-publications			Co-publications by year										
Institution	Total pubs	Partner institution	Total pubs	Co-Pubs	Share of co-publication	trend	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AWI - Helmholtz CPMR	5,953	Uni. Bremen	4,620	1258	21.1%		45	48	59	81	117	138	131	147	169	180	143
GEOMAR	4,777	Kiel Uni.	3,103	923	19.3%		48	50	46	61	102	74	105	112	115	108	102
AWI - Helmholtz CPMR	5,953	GEOMAR	4,777	508	8.5%		35	44	39	48	61	56	40	46	43	45	51
AWI - Helmholtz CPMR	5,953	MARUM	1,732	430	7.2%		20	20	35	27	26	43	42	39	63	67	48
Uni. Bremen	4,620	Leibniz ZMT	1,003	361	7.8%		10	14	22	36	35	35	44	36	36	48	45
GEOMAR	4,777	Uni. Bremen	4,620	355	7.4%		25	26	22	23	39	36	33	32	37	33	49
AWI - Helmholtz CPMR	5,953	Uni. Oldenburg	1,770	291	4.9%		7	14	7	9	14	25	27	29	52	59	48
Uni. Oldenburg	1,770	Helmholtz IFMB	356	287	16.2%		0	0	0	0	0	14	31	43	53	74	72
AWI - Helmholtz CPMR	5,953	Uni. Hamburg	3,425	243	4.1%		12	14	18	13	26	34	21	31	26	25	23
AWI - Helmholtz CPMR	5,953	Helmholtz IFMB	356	235	3.9%		0	0	0	0	0	13	28	34	52	57	51
Uni. Hamburg	3,425	Max Planck IMET	942	232	6.8%		14	15	15	24	17	19	21	28	26	27	26
Uni. Bremen	4,620	Max Planck IMM	881	228	4.9%		14	20	17	19	19	20	20	19	23	34	23
Uni. Hamburg	3,425	HZ Hereon	1,323	226	6.6%		14	6	11	19	10	18	27	24	27	31	39
AWI - Helmholtz CPMR	5,953	Max Planck IMM	881	215	3.6%		15	16	17	17	18	12	22	15	25	35	23
AWI - Helmholtz CPMR	5,953	Kiel Uni.	3,103	206	3.5%		20	15	9	8	23	17	13	15	24	27	35
Leibniz Ass.	9,541	Uni. Rostock	1,346	205	2.1%		11	6	12	6	15	11	19	30	26	38	31
Uni. Rostock	1,346	Leibniz Ass.	9,541	205	15.2%		11	6	12	6	15	11	19	30	26	38	31

b)

Selected German Institution		Partner institution		Number and share of co-publications			Co-publications by year										
Institution	Total pubs	Partner institution	Total pubs	Co-Pubs	Share of co-publication	trend	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Helmholtz IFMB	356	Senckenberg am Meer	649	15	4.2%		0	0	0	0	0	0	4	4	2	3	2
Jacobs Uni.	562	Kiel Uni.	3,103	15	2.7%		0	0	0	0	0	1	0	2	1	1	10
Leibniz Uni. Hannover	1,109	Uni. Hamburg	3,425	15	1.4%		0	0	1	0	4	3	1	0	1	3	2
Uni. Braunschweig	879	Uni. Hamburg	3,425	15	1.7%		0	0	1	0	3	2	2	0	1	3	3
Uni. Greifswald	940	Uni. Oldenburg	1,770	15	1.6%		0	0	0	0	0	0	0	2	2	5	6
DFKI	92	Uni. Bremen	4,620	14	15.2%		1	1	0	3	3	1	2	1	1	0	1
IfW Kiel	54	GEOMAR	4,777	14	25.9%		1	0	3	0	2	1	1	3	1	2	0
Max Planck IMET	942	MARUM	1,732	14	1.5%		0	2	2	0	0	0	0	3	4	3	0
BGR - Fed. Inst.Geosci. & Nat.Res.	644	Leibniz ZMT	1,003	13	2.0%		0	0	2	0	1	1	1	3	1	2	2
BSH - Fed. Maritime & Hydrogra. Agency	142	Uni. Bremen	4,620	13	9.2%		1	0	0	1	0	3	1	3	1	2	1
IASS	116	GEOMAR	4,777	13	11.2%		2	0	2	0	2	0	2	0	2	1	2
Leibniz Uni. Hannover	1,109	Uni. Oldenburg	1,770	13	1.2%		0	1	1	1	3	2	1	1	2	0	1
Senckenberg BiK-F	410	Uni. Bremen	4,620	13	3.2%		2	2	2	0	1	2	0	0	1	1	2
Senckenberg FN	839	Uni. Oldenburg	1,770	13	1.5%		0	1	1	0	1	1	1	4	1	1	2
Helmholtz IFMB	356	Kiel Uni.	3,103	12	3.4%		0	0	0	0	0	0	0	2	2	2	6
Helmholtz IFMB	356	MARUM	1,732	12	3.4%		0	0	0	0	0	0	1	2	2	2	5
Leibniz Uni. Hannover	1,109	Leibniz IOW	1,361	12	1.1%		2	1	0	1	2	4	1	0	1	0	0
Senckenberg am Meer	649	Kiel Uni.	3,103	12	1.8%		2	1	1	0	1	1	0	0	3	1	2
Senckenberg am Meer	649	Uni. Rostock	1,346	12	1.8%		2	0	2	0	1	1	2	0	1	1	2
Senckenberg am Meer	649	HZ Hereon	1,323	12	1.8%		1	0	1	2	1	3	0	1	1	2	0
Fraunhofer IGD	23	Uni. Rostock	1,346	11	47.8%		0	0	2	4	1	1	1	0	1	0	1
German Oceano. Museum	76	Uni. Rostock	1,346	11	14.5%		1	0	0	0	0	0	0	1	1	2	6
Max Planck IMET	942	Leibniz IOW	1,361	11	1.2%		0	0	0	1	2	1	2	2	2	1	0
Max Planck IMM	881	Uni. Hamburg	3,425	11	1.2%		0	0	1	1	0	3	2	3	0	1	0
BGR - Fed. Inst.Geosci. & Nat.Res.	644	Uni. Oldenburg	1,770	10	1.6%		0	1	0	0	0	0	0	2	1	4	2
IASS	116	AWI - Helmholtz CPMI	5,953	10	8.6%		1	0	1	0	2	0	0	0	3	0	3
Kiel Uni.	3,103	Uni. Braunschweig	879	10	0.3%		0	0	1	1	0	0	1	0	0	2	5
Leibniz ZMT	1,003	Uni. Rostock	1,346	10	1.0%		3	0	1	1	2	0	1	0	0	2	0

c)

Institutions	Number of Partners
AWI - Helmholtz CPMR	23
Kiel Uni.	22
Uni. Bremen	22
GEOMAR	20
Uni. Oldenburg	20
Uni. Hamburg	18
Leibniz IOW	16
MARUM	15
HZ Hereon	13
Leibniz ZMT	13
Senckenberg am Meer	13
Max Planck IMM	12
Uni. Rostock	12
BGR - Fed. Inst.Geosci. & Nat.Res.	11
Jacobs Uni.	10

Annex 7. Collaboration between selected German and European institutions in Ocean Science research (2012–2022).*

**Note: For this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen*

The collaboration category indicates collaboration links between a German and European institution with a) more than 150 shared publications (Pubs) and b) 10 shared publications. The collaboration links with fewer than 10 co-publications are not shown. c) List of German institutions with the greatest number of partners (>10) with whom they published at least 10 papers. d) List of European institutions showing the number of collaborating German institutes from the selected list

a)

Selected German Institution		Partner institution						Number and share of co-publications										
Institution	Total pubs	Partner institution		Total pubs	Co-Pubs	Share of co-publication	trend	Co-publications by year										
								2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
GEOMAR	4,777	Uni. Southampton	GBR	6,364	384	8.0%		19	21	30	37	53	41	43	44	31	36	29
AWI - Helmholtz CPMR	5,953	NERC	GBR	5,532	374	6.3%		22	32	38	21	34	30	31	34	41	49	42
AWI - Helmholtz CPMR	5,953	CNRS	FRA	22,575	325	5.5%		17	25	33	44	34	26	32	39	26	22	27
GEOMAR	4,777	CNRS	FRA	22,575	303	6.3%		17	44	25	17	28	21	35	43	32	25	16
AWI - Helmholtz CPMR	5,953	Brit. Antarctic Survey	GBR	2,497	258	4.3%		15	24	25	13	25	23	19	23	28	32	31
GEOMAR	4,777	NERC	GBR	5,532	258	5.4%		12	11	17	22	29	19	29	37	21	32	29
AWI - Helmholtz CPMR	5,953	Utrecht Uni.	NLD	5,019	239	4.0%		8	11	12	18	20	25	33	23	33	28	28
GEOMAR	4,777	CSIC	ESP	16,263	222	4.6%		11	29	15	12	15	9	27	31	22	24	27
Uni. Bremen	4,620	CNRS	FRA	22,575	216	4.7%		16	11	20	27	18	25	24	22	18	15	20
AWI - Helmholtz CPMR	5,953	Uni. Southampton	GBR	6,364	189	3.2%		8	13	17	12	25	12	15	25	20	23	19
Uni. Bremen	4,620	Utrecht Uni.	NLD	5,019	180	3.9%		6	13	9	6	13	24	26	23	31	14	15
GEOMAR	4,777	IRD	FRA	9,131	179	3.7%		11	21	19	11	18	10	22	26	17	13	11
Uni. Bremen	4,620	Uni. Southampton	GBR	6,364	177	3.8%		15	14	15	10	14	13	25	22	16	16	17
AWI - Helmholtz CPMR	5,953	UiT Arctic Uni. Norway	NOR	3,706	173	2.9%		4	8	4	10	16	17	21	12	28	28	25
AWI - Helmholtz CPMR	5,953	IRD	FRA	9,131	167	2.8%		10	12	17	18	17	13	17	24	12	13	14
Uni. Bremen	4,620	NERC	GBR	5,532	167	3.6%		9	9	14	8	13	8	20	19	21	28	18
AWI - Helmholtz CPMR	5,953	CSIC	ESP	16,263	166	2.8%		9	12	11	8	13	24	10	21	14	20	24
GEOMAR	4,777	Uni. Bergen	NOR	4,559	162	3.4%		12	24	18	12	17	13	13	21	10	10	12
Uni. Bremen	4,620	CSIC	ESP	16,263	161	3.5%		12	12	11	16	18	23	12	22	8	15	12
AWI - Helmholtz CPMR	5,953	Uni. Bergen	NOR	4,559	150	2.5%		9	10	13	13	18	7	11	17	18	14	20

b)

Selected German Institution		Partner institution						Number and share of co-publications										
Institution	Total pubs	Partner institution		Total pubs	Co-Pubs	Share of co-publication	trend	Co-publications by year										
								2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Senckenberg BiK-F	410	ETHZ	CHE	5,068	10	2.4%		1	0	1	0	0	0	1	2	2	1	2
Max Planck IMET	942	Uni. Copenhagen	DEN	5,248	10	1.1%		1	2	1	1	1	0	1	1	1	1	0
Thunen Inst.	126	DTU	DEN	5,774	10	7.9%		2	0	2	1	0	0	2	1	0	0	2
Uni. Oldenburg	1,770	Aarhus Uni.	DEN	4,915	10	0.6%		1	0	0	1	0	3	2	2	1	0	0
Leibniz ZMT	1,003	Inst. Esp. Oceanografia	ESP	2,788	10	1.0%		0	1	0	0	0	0	0	1	1	6	1
BSH - Fed. Maritime & Hydrogra. Agency	142	IFREMER	FRA	5,602	10	7.0%		1	0	0	0	4	3	0	1	1	0	0
Max Planck IMM	881	Aix-Marseille Uni.	FRA	4,477	10	1.1%		1	2	0	0	2	0	0	0	2	1	2
Max Planck IMM	881	Uni. Bretagne Occidentale	FRA	3,841	10	1.1%		2	0	2	0	0	0	0	0	1	5	0
Senckenberg am Meer	649	IRD	FRA	9,131	10	1.5%		3	2	2	1	0	0	1	0	1	0	0
Senckenberg BiK-F	410	IRD	FRA	9,131	10	2.4%		0	1	2	0	0	1	0	3	1	1	1
Helmholtz IFMB	356	Brit. Antarctic Survey	GBR	2,497	10	2.8%		0	0	0	0	0	1	0	2	1	4	2
Jacobs Uni.	562	Uni. Southampton	GBR	6,364	10	1.8%		0	1	1	3	0	1	0	1	2	0	1
Leibniz Uni. Hannover	1,109	Uni. Southampton	GBR	6,364	10	0.9%		2	0	1	1	1	0	2	0	0	1	2
Max Planck IMM	881	CNR	ITA	9,919	10	1.1%		2	2	1	0	2	0	1	1	0	1	0
Uni. Oldenburg	1,770	CNR	ITA	9,919	10	0.6%		0	0	0	0	0	1	0	2	2	3	2
HZ Hereon	1,323	TUDelft	NLD	4,725	10	0.8%		0	1	1	2	0	0	2	0	0	3	1
Leibniz ZMT	1,003	WUR	NLD	4,804	10	1.0%		1	0	0	2	1	0	0	0	1	2	3
Max Planck IMET	942	TUDelft	NLD	4,725	10	1.1%		0	2	0	1	0	2	0	0	2	2	1
Senckenberg FN	839	Utrecht Uni.	NLD	5,019	10	1.2%		1	0	0	0	1	0	1	1	3	2	1
Uni. Braunschweig	879	TUDelft	NLD	4,725	10	1.1%		0	0	0	0	1	2	0	3	0	1	3
AWI - Helmholtz CPMR	5,953	SINTEF	NOR	2,747	10	0.2%		0	0	0	1	1	2	3	0	1	1	1
Uni. Oldenburg	1,770	Inst. Marine Res.	NOR	3,395	10	0.6%		0	0	1	0	0	0	2	0	2	2	3
Uni. Oldenburg	1,770	UiT Arctic Uni. Norway	NOR	3,706	10	0.6%		0	0	0	0	0	1	4	1	1	1	2
Uni. Braunschweig	879	PAS	POL	3,973	10	1.1%		0	0	0	0	1	1	4	1	0	0	3
Uni. Bremen	4,620	Uni. Porto	PRT	5,301	10	0.2%		0	0	2	2	0	1	0	0	1	3	1
MARUM	1,732	Uni. Gothenburg	SWE	2,994	10	0.6%		0	0	1	1	1	1	1	0	0	4	1
Uni. Greifswald	940	Stockholm Uni.	SWE	4,094	10	1.1%		0	1	0	2	1	0	1	0	1	2	2

c)

Institutions	Number of Partners
AWI - Helmholtz CPMR	34
Uni. Bremen	33
GEOMAR	31
Uni. Hamburg	31
Kiel Uni.	30
MARUM	25
Uni. Oldenburg	25
Max Planck IMM	18
Max Planck IMET	16
Leibniz ZMT	13
Senckenberg am Meer	12
Senckenberg FN	11
BGR - Fed. Inst.Geosci. & Nat.Res.	10

d)

European institutions	Country	Total pubs	Number of German Partners
CNRS	FRA	22,575	25
CSIC	ESP	16,263	24
Uni. Southampton	GBR	6,364	20
Utrecht Uni.	NLD	5,019	20
IRD	FRA	9,131	18
ETHZ	CHE	5,068	17
NERC	GBR	5,532	17
NIOZ	NLD	2,002	17
Uni. Copenhagen	DEN	5,248	16
IFREMER	FRA	5,602	16
CNR	ITA	9,919	16
Uni. Bergen	NOR	4,559	16
WUR	NLD	4,804	15
Stockholm Uni.	SWE	4,094	15
DTU	DEN	5,774	14
Aix-Marseille Uni.	FRA	4,477	14

European institutions	Country	Total pubs	Number of German Partners
Aarhus Uni.	DEN	4,915	13
Uni. Bretagne Occidentale	FRA	3,841	13
Ghent Uni.	BEL	4,518	12
Brit. Antarctic Survey	GBR	2,497	11
Uni. Gothenburg	SWE	2,994	11
Inst. Esp. Oceanografia	ESP	2,788	10
Inst. Marine Res.	NOR	3,395	10
PAS	POL	3,973	10
TUDelft	NLD	4,725	9
UiT Arctic Uni. Norway	NOR	3,706	9
Uni. Algarve	PRT	2,845	8
Uni. Plymouth	GBR	2,925	7
Sta. Zoologica AD Napoli	ITA	2,014	7
Uni. Porto	PRT	5,301	7
INRAE	FRA	4,398	6
Muséum national d'histoire naturelle	FRA	2,087	4

Annex 8. Collaboration between selected German and non-European institutions in Ocean Science research (2012–2022).*

**Note: For this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen*

The collaboration category indicates collaboration links with a) more than 100 shared publications (Pubs) and b) 10 to 15 shared publications. The collaboration links with fewer than 10 co-publications are not shown. c) List of German institutions with their number of non-European partners with whom they published at least 10 papers. d) List of international institutions collaborating with German institutions.

a)

Selected German Institution		Partner institution		Number and share of co-publications														
Institution	Total pubs	Partner institution	Country	Total pubs	Co-Pubs	Share of co-publication	trend	Co-publications by year										
								2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AWI - Helmholtz CPMR	5,953	NOAA	USA	14,705	170	2.9%		8	12	9	17	19	14	10	22	18	21	20
GEOMAR	4,777	NOAA	USA	14,705	170	3.6%		11	13	14	15	13	16	16	28	16	13	15
AWI - Helmholtz CPMR	5,953	Woods Hole Oceanographic Institution	USA	5,941	162	2.7%		8	8	14	12	15	18	12	22	21	13	19
GEOMAR	4,777	Woods Hole Oceanographic Institution	USA	5,941	159	3.3%		4	11	8	14	12	13	16	22	20	15	24
Uni. Bremen	4,620	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	124	2.7%		9	16	6	10	11	8	16	17	15	10	6
Uni. Bremen	4,620	Woods Hole Oceanographic Institution	USA	5,941	120	2.6%		4	10	11	7	11	12	15	14	15	12	9
AWI - Helmholtz CPMR	5,953	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	116	1.9%		2	15	7	8	12	7	15	14	13	14	9
GEOMAR	4,777	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	109	2.3%		4	12	6	8	11	9	16	12	17	8	6

b)

Selected German Institution		Partner institution		Number and share of co-publications														
Institution	Total pubs	Partner institution	Country	Total pubs	Co-Pubs	Share of co-publication	trend	Co-publications by year										
								2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AWI - Helmholtz CPMR	5,953	James Cook University Queensland	AUS	5,483	15	0.3%		0	1	0	2	3	0	2	0	5	2	0
MARUM	1,732	Ocean University of China	CHN	15,291	15	0.9%		0	1	1	1	0	0	2	1	5	2	2
Max Planck IMM	881	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	15	1.7%		1	3	2	1	3	0	0	0	0	2	3
Uni. Oldenburg	1,770	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	15	0.8%		0	0	0	2	0	0	2	0	4	5	2
GEOMAR	4,777	Korea Institute of Ocean Science & Tech	KOR	3,257	15	0.3%		2	1	2	0	0	3	1	2	0	1	3
Uni. Hamburg	3,425	University of Cape Town	ZAF	2,734	15	0.4%		0	1	0	0	1	0	3	3	0	3	4
Uni. Bremen	4,620	James Cook University Queensland	AUS	5,483	14	0.3%		1	1	0	0	2	0	0	2	4	2	2
Leibniz IOW	1,361	Fisheries and Oceans Canada	CAN	5,367	14	1.0%		0	4	0	1	1	0	2	2	1	3	0
Leibniz IOW	1,361	University of British Columbia	CAN	6,120	14	1.0%		2	0	1	5	0	0	1	2	1	1	1
Senckenberg am Meer	649	Woods Hole Oceanographic Institution	USA	5,941	14	2.2%		4	1	1	3	1	0	1	0	2	1	0
Kiel Uni.	3,103	University of Cape Town	ZAF	2,734	14	0.5%		3	0	0	0	0	0	2	5	3	1	0
Leibniz Uni. Hannover	1,109	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	13	1.2%		0	0	2	1	2	1	0	2	1	3	1
Kiel Uni.	3,103	University of Otago	NZL	2,615	13	0.4%		1	2	0	1	1	0	2	2	2	0	2
Uni. Oldenburg	1,770	Universidade de Sao Paulo	BRA	8,783	12	0.7%		0	1	0	2	1	1	0	2	0	1	4
Kiel Uni.	3,103	Ocean University of China	CHN	15,291	12	0.4%		0	1	1	1	0	0	0	1	3	3	2
Uni. Hamburg	3,425	University of Otago	NZL	2,615	12	0.4%		2	1	1	1	2	0	0	3	0	1	1
BGR - Fed. Inst.Geosci. & Nat.Res.	644	Woods Hole Oceanographic Institution	USA	5,941	12	1.9%		1	1	3	1	0	1	1	0	2	1	1
MARUM	1,732	University of Cape Town	ZAF	2,734	12	0.7%		1	1	0	0	4	0	1	2	1	1	1
GEOMAR	4,777	James Cook University Queensland	AUS	5,483	11	0.2%		1	1	1	0	0	0	1	2	1	3	1
AWI - Helmholtz CPMR	5,953	Korea Institute of Ocean Science & Tech	KOR	3,257	11	0.2%		1	1	3	0	0	0	0	1	2	1	2
Jacobs Uni.	562	University of Otago	NZL	2,615	11	2.0%		1	0	0	1	1	0	1	2	2	1	2
Uni. Oldenburg	1,770	University of Otago	NZL	2,615	11	0.6%		0	1	0	0	0	0	1	1	4	1	3
Leibniz IOW	1,361	University of Cape Town	ZAF	2,734	11	0.8%		1	4	2	0	0	0	1	1	0	2	0
Helmholtz IFMB	356	James Cook University Queensland	AUS	5,483	10	2.8%		0	0	0	0	0	0	2	1	2	5	0
Uni. Hamburg	3,425	James Cook University Queensland	AUS	5,483	10	0.3%		1	0	3	2	0	1	1	0	2	0	0
Leibniz ZMT	1,003	University of British Columbia	CAN	6,120	10	1.0%		0	1	1	1	1	1	1	1	1	1	1
Max Planck IMM	881	University of British Columbia	CAN	6,120	10	1.1%		1	0	1	0	2	0	0	0	1	2	3
Leibniz ZMT	1,003	Japan Agency for Marine-Earth Science and Tech	JPN	4,781	10	1.0%		1	1	3	0	3	0	0	1	0	0	1
Helmholtz IFMB	356	NOAA	USA	14,705	10	2.8%		0	0	0	0	0	0	0	1	3	5	1
Senckenberg FN	839	Woods Hole Oceanographic Institution	USA	5,941	10	1.2%		2	1	0	0	0	0	0	0	1	3	3
HZ Hereon	1,323	University of Cape Town	ZAF	2,734	10	0.8%		1	1	0	0	0	1	2	1	1	2	1

c)

Institutions	Number of Partners
AWI - Helmholtz CPMR	11
GEOMAR	11
Uni. Bremen	10
Uni. Hamburg	10
Kiel Uni.	8
Uni. Oldenburg	7
HZ Hereon	6
Leibniz IOW	6
MARUM	6
Leibniz ZMT	4
Max Planck IMET	3
Helmholtz IFMB	2
BGR - Fed. Inst.Geosci. & Nat.Res.	1
Jacobs Uni.	1
Leibniz Uni. Hannover	1
Senckenberg am Meer	1
Senckenberg FN	1

d)

Institutions	Country	Number of German Partners
Woods Hole Oceanographic Institution	USA	14
Japan Agency for Marine-Earth Science and Tech	JPN	12
NOAA	USA	11
University of British Columbia	CAN	9
University of Otago	NZL	8
University of Cape Town	ZAF	8
Fisheries and Oceans Canada	CAN	7
James Cook University Queensland	AUS	7
Universidade de Sao Paulo	BRA	7
Ocean University of China	CHN	7
Korea Institute of Ocean Science & Technology	KOR	2

Annex 9. Scientific output and impact of the topmost publishing European countries in Ocean Science and sub-areas of research (2012–2022) where the average number of authors per publication; the share of women as a participating author and as a first or last author is presented.

	Ocean Science			Blue Growth			Marine ecosystem functions & processes			Ocean crust & marine geohazards			Ocean & climate		
Entity	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth
World	**4.8**	**52.0%**	**32.5%**	**4.8**	**53.7%**	**33.7%**	**5.2**	**63.4%**	**40.5%**	**4.8**	**47.0%**	**28.5%**	**5.0**	**53.5%**	**33.1%**
United Kingdom	6.2	60.0%	36.2%	6.2	60.8%	37.4%	7.1	73.5%	44.7%	6.2	56.6%	32.6%	7.4	66.2%	37.8%
Germany	**6.8**	**64.5%**	**38.3%**	**6.6**	**63.5%**	**37.9%**	**7.1**	**76.0%**	**46.6%**	**7.0**	**63.0%**	**35.5%**	**7.8**	**68.8%**	**38.9%**
France	7.4	67.6%	39.0%	7.4	69.0%	40.4%	7.8	76.9%	44.8%	7.4	65.0%	35.3%	8.4	70.8%	37.9%
Italy	7.0	74.2%	48.0%	6.9	76.9%	50.3%	7.6	83.3%	54.9%	7.1	71.2%	41.8%	8.2	75.4%	45.6%
Spain	6.7	70.1%	43.1%	6.4	70.9%	44.1%	7.1	77.9%	47.9%	7.3	66.8%	38.1%	7.9	72.5%	42.1%
Netherlands	7.5	60.7%	35.6%	6.8	60.3%	36.4%	7.7	73.5%	43.9%	7.6	57.9%	31.7%	8.7	65.9%	36.0%
Portugal	6.8	77.0%	53.7%	6.7	77.4%	54.7%	7.6	88.4%	62.0%	7.4	75.2%	47.8%	8.0	80.8%	52.4%
Sweden	7.1	67.4%	41.3%	6.9	67.9%	42.2%	7.7	76.9%	47.3%	8.0	62.9%	35.8%	9.0	71.7%	41.1%
Poland	5.7	65.9%	47.3%	5.7	68.5%	48.6%	5.9	76.2%	53.7%	6.2	59.5%	40.3%	7.2	65.7%	44.3%
Denmark	7.3	64.1%	38.3%	6.9	61.2%	37.2%	8.1	75.3%	45.4%	8.0	59.2%	34.0%	9.5	72.4%	41.5%
Switzerland	8.0	66.5%	38.8%	8.4	66.7%	38.9%	8.3	73.9%	43.2%	8.0	61.7%	34.1%	9.8	70.5%	39.3%
Belgium	7.8	67.0%	38.0%	7.9	68.1%	37.7%	8.4	75.0%	43.0%	8.8	63.6%	33.6%	10.2	69.6%	36.0%
Greece	7.6	64.5%	40.4%	6.8	65.9%	41.3%	8.7	78.8%	48.5%	7.9	60.7%	36.5%	9.0	69.1%	38.4%
Finland	7.5	69.4%	43.8%	7.3	70.3%	45.9%	7.9	80.4%	52.6%	10.7	65.5%	37.2%	10.3	71.4%	39.9%
Austria	7.5	64.6%	37.1%	7.9	66.1%	38.9%	7.7	72.5%	42.2%	8.8	62.1%	32.4%	11.3	69.1%	36.9%

	Biodiversity use & protection			Ocean observation & Marine data			Ocean technology			Human health & well-being			Carbon neutrality		
Entity	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth
World	**5.3**	**64.9%**	**42.2%**	**5.1**	**54.6%**	**33.8%**	**3.9**	**28.8%**	**17.3%**	**5.3**	**64.1%**	**40.9%**	**4.3**	**38.3%**	**23.0%**
United Kingdom	7.7	75.3%	46.7%	7.8	67.7%	38.8%	4.8	32.5%	18.1%	7.2	72.7%	45.7%	4.8	41.9%	24.9%
Germany	**8.1**	**77.2%**	**46.5%**	**8.3**	**67.3%**	**37.6%**	**5.7**	**35.2%**	**19.2%**	**7.5**	**74.8%**	**47.4%**	**5.1**	**45.4%**	**25.5%**
France	8.7	78.2%	46.2%	8.6	69.8%	38.6%	6.1	36.6%	19.5%	8.0	78.9%	48.0%	5.9	51.7%	29.5%
Italy	8.1	84.0%	55.7%	8.5	76.3%	46.4%	5.6	53.6%	30.6%	7.8	85.3%	60.4%	5.3	59.7%	35.9%
Spain	7.5	76.5%	47.1%	8.5	71.4%	40.4%	5.5	42.8%	25.2%	7.2	78.9%	51.9%	5.3	50.0%	29.0%
Netherlands	8.7	74.9%	44.8%	9.6	65.5%	35.5%	6.0	34.2%	19.9%	7.9	71.9%	43.7%	5.3	45.7%	27.6%
Portugal	8.1	86.0%	60.1%	8.0	76.2%	49.3%	5.7	34.5%	21.5%	7.4	88.6%	67.8%	4.8	50.2%	33.6%
Sweden	8.7	77.2%	46.6%	10.1	70.8%	40.8%	7.6	42.4%	25.2%	8.2	78.5%	50.6%	5.1	52.7%	31.4%
Poland	6.8	76.3%	54.7%	8.8	65.9%	45.1%	3.5	30.1%	22.3%	6.0	80.1%	59.5%	4.1	49.2%	33.3%
Denmark	9.6	76.1%	44.4%	9.8	69.1%	38.3%	7.5	34.6%	20.3%	9.1	78.9%	50.1%	5.3	40.1%	23.8%
Switzerland	10.1	76.2%	44.1%	11.8	71.7%	40.0%	12.3	39.7%	22.3%	9.6	78.9%	48.2%	5.2	41.5%	23.3%
Belgium	9.6	77.1%	44.3%	11.5	72.2%	39.4%	6.6	43.7%	20.5%	9.4	77.0%	45.1%	6.3	53.2%	26.7%
Greece	9.0	78.6%	49.9%	9.6	67.8%	39.9%	4.3	34.3%	21.3%	8.2	77.4%	51.9%	5.3	45.4%	26.3%
Finland	9.7	81.7%	52.1%	11.5	73.5%	44.5%	5.4	36.9%	20.9%	8.5	81.8%	56.4%	5.5	56.5%	31.3%
Austria	9.4	75.6%	43.9%	12.8	69.0%	38.4%	7.2	36.2%	19.7%	8.7	76.1%	48.3%	5.2	41.6%	23.5%

	Ocean health			Social science & humanities related to ocean science			Prevent & eliminate pollution		
Entity	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth	Avg. # of auth.	Share of Women Particip.	Share of 1st/last Women auth
World	**5.4**	**66.4%**	**42.7%**	**2.4**	**43.0%**	**36.0%**	**5.2**	64.3%	41.7%
United Kingdom	6.9	75.1%	45.9%	2.6	47.0%	39.7%	6.5	75.3%	49.8%
Germany	**7.3**	**76.8%**	**46.9%**	**3.2**	**48.4%**	**35.7%**	**6.5**	**77.7%**	**49.4%**
France	7.8	82.4%	50.1%	3.7	49.3%	37.2%	7.5	80.7%	48.6%
Italy	7.5	88.0%	62.0%	3.4	57.2%	42.8%	6.9	88.8%	62.2%
Spain	6.9	81.6%	51.9%	3.2	48.2%	36.4%	6.5	81.2%	53.3%
Netherlands	7.8	75.8%	43.7%	3.2	47.6%	35.0%	6.8	77.3%	49.1%
Portugal	7.0	90.4%	67.4%	3.6	59.8%	45.4%	6.6	91.4%	69.8%
Sweden	7.2	77.2%	49.0%	2.6	48.9%	42.7%	6.7	80.5%	56.7%
Poland	5.6	80.9%	60.6%	2.5	47.6%	39.1%	4.8	81.6%	62.0%
Denmark	7.9	82.0%	49.5%	2.7	46.0%	34.3%	8.3	83.7%	56.9%
Switzerland	8.0	80.0%	49.7%	4.2	51.6%	38.5%	7.4	73.3%	46.5%
Belgium	8.5	79.6%	45.6%	3.2	40.8%	28.4%	7.1	80.2%	46.5%
Greece	8.1	81.2%	51.9%	3.7	54.8%	37.9%	6.1	72.9%	47.5%
Finland	7.2	80.6%	52.4%	2.7	63.2%	53.3%	6.8	83.5%	62.8%
Austria	7.8	73.6%	42.5%	4.0	50.8%	39.8%	6.9	78.0%	44.1%

Annex 10. Share of publications in Ocean Science Research with women as a participating author, as first author or as last author, by selected institutions (2012–2022).*

*Note: For this analysis and technical reasons, MARUM at the University of Bremen was considered separate from University of Bremen

Region	Country	Institution	Pubs	Share of women participication	Share of Women as 1st author	Share of Women as last author
Europe	**Germany**	Helmholtz Ass.	19,819	72.8%	31.1%	18.3%
Europe	**Germany**	Leibniz Ass.	9,541	74.5%	33.2%	20.1%
Europe	**Germany**	AWI - Helmholtz CPMR	5,953	79.1%	36.5%	22.6%
Europe	**Germany**	Max Planck	5,626	74.8%	30.5%	17.8%
Europe	**Germany**	GEOMAR	4,777	75.4%	33.2%	18.5%
Europe	**Germany**	Uni. Bremen	4,620	75.2%	32.7%	19.3%
Europe	**Germany**	Uni. Hamburg	3,425	68.8%	31.2%	19.9%
Europe	**Germany**	Kiel Uni.	3,103	71.4%	32.5%	16.4%
Europe	**Germany**	Uni. Oldenburg	1,770	77.7%	39.4%	22.8%
Europe	**Germany**	MARUM	1,732	78.9%	30.6%	19.1%
Europe	**Germany**	Leibniz IOW	1,361	79.5%	35.9%	25.1%
Europe	**Germany**	Uni. Rostock	1,346	63.5%	31.1%	16.5%
Europe	**Germany**	HZ Hereon	1,323	70.0%	26.1%	18.4%
Europe	**Germany**	Leibniz Uni. Hannover	1,109	51.8%	19.5%	13.5%
Europe	**Germany**	Leibniz ZMT	1,003	78.9%	37.7%	22.6%
Europe	**Germany**	Max Planck IMET	942	71.2%	25.9%	19.6%
Europe	**Germany**	Uni. Greifswald	940	80.7%	34.8%	22.2%
Europe	**Germany**	Max Planck IMM	881	86.9%	41.7%	24.9%
Europe	**Germany**	Uni. Braunschweig	879	62.8%	26.6%	12.7%
Europe	**Germany**	Senckenberg FN	839	72.0%	35.9%	24.1%
Europe	**Germany**	CEN - Uni. Hamburg	697	69.6%	29.3%	18.2%
Europe	**Germany**	Senckenberg am Meer	649	84.6%	48.7%	31.1%
Europe	**Germany**	BGR - Fed. Inst.Geosci. & Nat.Res.	644	64.8%	23.9%	13.0%
Europe	**Germany**	Jacobs Uni.	562	66.0%	27.8%	20.1%
Europe	**Germany**	Senckenberg BiK-F	410	79.8%	36.6%	17.3%
Europe	**Germany**	Helmholtz IFMB	356	91.6%	47.5%	36.2%
Europe	**Germany**	EMBL	249	84.3%	29.3%	20.1%
Europe	**Germany**	BSH - Fed. Maritime & Hydrogra. Agency	142	81.0%	30.3%	18.3%
Europe	**Germany**	Thunen Inst.	126	72.2%	34.1%	15.9%
Europe	**Germany**	IASS	116	78.4%	43.1%	24.1%
Europe	**Germany**	DFKI	92	32.6%	15.2%	2.2%
Europe	**Germany**	German Oceano. Museum	76	72.4%	40.8%	19.7%
Europe	**Germany**	Global Climate Forum	73	69.9%	28.8%	13.7%
Europe	**Germany**	IfW Kiel	54	70.4%	35.2%	29.6%
Europe	**Germany**	NFN - Fed. Agency Nat. Conservation	45	91.1%	35.6%	24.4%
Europe	**Germany**	Ecologic Inst.	35	85.7%	48.6%	31.4%
Europe	**Germany**	Senckenberg MN Görlitz	30	86.7%	43.3%	26.7%
Europe	**Germany**	Fraunhofer IGD	23	39.1%	21.7%	4.3%
Europe	Belgium	Ghent Uni.	4,518	68.7%	29.5%	16.8%
Europe	Swisszerland	ETHZ	5,068	67.8%	29.3%	15.5%
Europe	Denmark	DTU	5,774	61.6%	26.9%	16.7%
Europe	Denmark	Uni. Copenhagen	5,248	70.5%	30.5%	17.9%
Europe	Denmark	Aarhus Uni.	4,915	73.1%	32.0%	18.1%
Europe	Spain	CSIC	16,263	79.4%	35.3%	20.8%
Europe	Spain	Inst. Esp. Oceanografia	2,788	85.0%	38.3%	21.8%
Europe	France	CNRS	22,575	71.3%	28.4%	18.1%
Europe	France	IRD	9,131	74.2%	28.5%	18.2%
Europe	France	IFREMER	5,602	77.9%	33.0%	20.5%
Europe	France	Aix-Marseille Uni.	4,477	76.4%	30.0%	18.7%

Region	Country	Institution	Pubs	Share of women participication	Share of Women as 1st author	Share of Women as last author
Europe	France	INRAE	4,398	78.8%	33.5%	20.4%
Europe	France	Uni. Bretagne Occidentale	3,841	72.2%	30.2%	20.7%
Europe	France	Muséum	2,087	76.2%	33.3%	20.0%
Europe	United Kingdom	Uni. Southampton	6,364	66.0%	27.5%	15.0%
Europe	United Kingdom	NERC	5,532	75.5%	30.8%	19.4%
Europe	United Kingdom	Uni. Plymouth	2,925	68.1%	32.5%	19.3%
Europe	United Kingdom	Brit. Antarctic Survey	2,497	77.1%	32.0%	20.3%
Europe	Italy	CNR	9,919	82.3%	38.2%	28.6%
Europe	Italy	Sta. Zoologica AD Napoli	2,014	90.8%	46.6%	40.0%
Europe	Netherlands	Utrecht Uni.	5,019	71.2%	31.9%	15.7%
Europe	Netherlands	Wageningen Uni. Res. Centre	4,804	71.9%	31.1%	19.1%
Europe	Netherlands	TUDelft	4,725	43.3%	16.3%	10.4%
Europe	Netherlands	NIOZ	2,002	78.0%	39.4%	15.3%
Europe	Norway	Uni. Bergen	4,559	71.3%	32.4%	19.1%
Europe	Norway	UiT Arctic Uni. Norway	3,706	70.8%	36.5%	22.9%
Europe	Norway	Inst. Marine Res.	3,395	76.1%	35.2%	20.4%
Europe	Norway	SINTEF	2,747	52.3%	23.0%	15.0%
Europe	Poland	PAS	3,973	74.5%	38.0%	22.7%
Europe	Portugal	Uni. Porto	5,301	84.5%	47.8%	28.6%
Europe	Portugal	Uni. Algarve	2,845	84.4%	43.7%	28.1%
Europe	Russia	RAS -Shirshov Inst. Oceanology	3,399	59.7%	25.5%	19.4%
Europe	Sweden	Stockholm Uni.	4,094	78.1%	34.8%	23.9%
Europe	Sweden	Uni. Gothenburg	2,994	74.8%	33.8%	22.3%
International	Australia	James Cook University Queensland	5,483	73.1%	35.3%	20.9%
International	Brazil	Universidade de Sao Paulo	8,783	72.0%	34.4%	20.2%
International	Canada	University of British Columbia	6,120	68.0%	32.5%	18.7%
International	Canada	Fisheries and Oceans Canada	5,367	72.9%	34.3%	20.0%
International	China	Ocean University of China	15,291	46.6%	11.1%	9.7%
International	Japan	Japan Agency for Marine-Earth Science and Techno	4,781	51.2%	15.1%	8.2%
International	Korea	Korea Institute of Ocean Science & Technology	3,257	31.3%	8.7%	4.2%
International	New Zealand	University of Otago	2,615	70.1%	31.4%	19.8%
International	United States	National Oceanic and Atmospheric Administration	14,705	68.7%	29.9%	19.6%
International	United States	Woods Hole Oceanographic Institution	5,941	71.7%	31.7%	19.8%
International	South Africa	University of Cape Town	2,734	70.6%	33.3%	23.3%

Annex 11. Top 20 scientific journals in which German authored publications in Ocean Science and related sub-areas were published (2012–2022).

Ocean Science & sub-areas of research	Journal	Germany Pubs	All pubs
Global Ocean Science	PLoS ONE	1,205	13,822
	Scientific Reports	1,109	10,280
	Science of the Total Environment	959	13,789
	Frontiers in Marine Science	916	7,734
	Atmospheric Chemistry and Physics	722	2,481
	Biogeosciences	722	2,373
	Geophysical Research Letters	680	6,005
	Earth and Planetary Science Letters	539	2,855
	Quaternary Science Reviews	527	2,267
	Journal of Geophysical Research: Oceans	526	5,437
	Nature Communications	522	2,238
	Palaeogeography, Palaeoclimatology, Palaeoecology	477	3,079
	Frontiers in Microbiology	470	3,992
	Geochimica et Cosmochimica Acta	459	2,090
	Zootaxa	447	5,636
	Proceedings of the National Academy of Sciences of the United States of America	432	2,678
	Remote Sensing	390	4,925
	Journal of Geophysical Research	379	3,762
	Geochemistry, Geophysics, Geosystems	371	1,711
	Environmental Science and Technology	357	4,400
Blue Growth	Marine Drugs	346	5,195
	Frontiers in Marine Science	325	3,382
	Marine and Petroleum Geology	280	4,050
	PLoS ONE	246	3,827
	Science of the Total Environment	242	3,819
	Marine Policy	206	3,726
	Scientific Reports	161	2,149
	Sustainability (Switzerland)	144	2,821
	Aquaculture	141	7,912
	Ocean and Coastal Management	134	2,972
	Proceedings of the International Conference on Offshore Mechanics and Arctic Engineering - OMAE	130	2,418
	ICES Journal of Marine Science	123	1,765
	Journal of Physics: Conference Series	120	1,735
	Proceedings of the International Offshore and Polar Engineering Conference	117	1,778
	Marine Pollution Bulletin	115	2,435
	Hydrobiologia	113	1,355
	Water (Switzerland)	103	1,807
	Fisheries Research	101	2,763
	Frontiers in Microbiology	85	862
	Energies	85	1,856

Ocean Science & sub-areas of research	Journal	Germany Pubs	All pubs
Marine ecosys functions & processes	Frontiers in Marine Science	489	3,694
	PLoS ONE	465	4,752
	Biogeosciences	446	1,490
	Science of the Total Environment	352	4,507
	Scientific Reports	329	2,846
	Frontiers in Microbiology	200	1,440
	Marine Ecology Progress Series	198	3,118
	Limnology and Oceanography	190	1,376
	Palaeogeography, Palaeoclimatology, Palaeoecology	176	1,162
	Hydrobiologia	163	1,990
	Marine Biology	155	1,241
	Proceedings of the National Academy of Sciences of the United States of America	150	912
	Quaternary Science Reviews	149	521
	Journal of Geophysical Research: Oceans	148	1,684
	Geochimica et Cosmochimica Acta	148	644
	Nature Communications	138	565
	Ecology and Evolution	137	1,352
	Journal of Marine Systems	136	1,356
	ISME Journal	134	562
	Estuarine, Coastal and Shelf Science	134	2,065
Ocean crust & marine geohazards	Earth and Planetary Science Letters	384	2,116
	Chemical Geology	342	1,668
	Geochemistry, Geophysics, Geosystems	299	1,462
	Marine and Petroleum Geology	280	4,050
	Quaternary Science Reviews	262	1,042
	Geochimica et Cosmochimica Acta	244	1,060
	Marine Geology	222	1,825
	Tectonophysics	220	1,293
	Geology	214	1,476
	Scientific Reports	213	1,561
	Journal of Geophysical Research: Solid Earth	213	1,600
	Geophysical Research Letters	208	2,101
	Geophysical Journal International	189	1,208
	Palaeogeography, Palaeoclimatology, Palaeoecology	188	1,477
	Lithos	181	1,642
	Frontiers in Marine Science	167	1,355
	Environmental Earth Sciences	160	2,122
	Biogeosciences	160	509
	International Journal of Earth Sciences	135	550
	Gondwana Research	135	1,090

Annex 11. Top 20 scientific journals in which German authored publications in Ocean Science and related sub-areas were published (2012–2022).

Ocean Science & sub-areas of research	Journal	Germany Pubs	All pubs
Ocean & Climate	Atmospheric Chemistry and Physics	620	2,161
	Quaternary Science Reviews	427	1,774
	Geophysical Research Letters	427	3,739
	Journal of Geophysical Research	379	3,762
	Journal of Geophysical Research: Oceans	376	3,500
	Biogeosciences	373	1,241
	Frontiers in Marine Science	341	2,152
	Climate of the Past	332	907
	Climate Dynamics	331	3,468
	Scientific Reports	276	2,053
	Palaeogeography, Palaeoclimatology, Palaeoecology	275	1,579
	Cryosphere	230	829
	Journal of Climate	214	4,114
	PLoS ONE	203	1,793
	Remote Sensing	201	2,104
	Science of the Total Environment	201	2,793
	Nature Communications	194	791
	Earth and Planetary Science Letters	192	815
	Global and Planetary Change	166	809
	Geoscientific Model Development	164	616
Biodiversity use & protection	Science of the Total Environment	406	5,262
	Frontiers in Marine Science	401	3,415
	PLoS ONE	322	3,935
	Scientific Reports	229	2,292
	Biogeosciences	215	710
	Frontiers in Microbiology	185	1,552
	Marine Policy	150	2,089
	Hydrobiologia	129	1,491
	Ecological Indicators	122	1,794
	ISME Journal	115	482
	Ecology and Evolution	112	1,103
	Water (Switzerland)	111	1,794
	Estuarine, Coastal and Shelf Science	107	1,573
	Marine Ecology Progress Series	105	1,940
	Limnology and Oceanography	100	704
	Global Change Biology	99	829
	Proceedings of the National Academy of Sciences of the United States of America	98	636
	Marine Pollution Bulletin	89	2,196
	Sustainability (Switzerland)	87	1,469
	Ocean and Coastal Management	87	1,729

Ocean Science & sub-areas of research	Journal	Germany Pubs	All pubs
Ocean observation & Marine data	Marine Ecology Progress Series	283	4,573
	Frontiers in Marine Science	268	1,939
	Atmospheric Chemistry and Physics	248	829
	Journal of Geophysical Research: Oceans	235	2,378
	Geophysical Research Letters	162	1,594
	Science of the Total Environment	155	1,612
	PLoS ONE	152	1,905
	Remote Sensing	151	1,469
	Cryosphere	138	477
	Journal of Marine Systems	136	1,356
	Journal of Geophysical Research	132	1,292
	Biogeosciences	130	477
	Atmospheric Measurement Techniques	109	346
	Scientific Reports	107	1,145
	Limnology and Oceanography: Methods	101	663
	Earth System Science Data	89	239
	Ocean Science	87	416
	Climate Dynamics	86	884
	Geoscientific Model Development	82	303
	Environmental Monitoring and Assessment	76	2,910
Ocean technology	Proceedings of the International Conference on Offshore Mechanics and Arctic Engineering - OMAE	224	4,313
	Proceedings of the International Offshore and Polar Engineering Conference	183	5,542
	Ocean Engineering	101	5,552
	Proceedings of SPIE - The International Society for Optical Engineering	95	1,482
	Ship Technology Research	62	123
	International Geoscience and Remote Sensing Symposium (IGARSS)	58	565
	IFAC-PapersOnLine	55	549
	Proceedings of the International Astronautical Congress, IAC	55	338
Human health & well-being	Marine Drugs	174	2,191
	Science of the Total Environment	139	2,055
	PLoS ONE	113	1,418
	Frontiers in Marine Science	107	963
	Harmful Algae	105	1,198
	Frontiers in Microbiology	65	789
	Desalination and Water Treatment	58	3,724
Carbon neutrality	WasserWirtschaft	125	177
	Journal of Physics: Conference Series	118	1,096
	Proceedings of the International Offshore and Polar Engineering Conference	112	1,006
	Proceedings of the International Conference on Offshore Mechanics and Arctic Engineering - OMAE	94	1,255
	Energies	85	2,000
	Energy Procedia	67	787
	Renewable Energy	53	1,991

Annex 11. Top 20 scientific journals in which German authored publications in Ocean Science and related sub-areas were published (2012–2022).

Ocean Science & sub-areas of research	Journal	Germany Pubs	All pubs
Ocean health	Marine Pollution Bulletin	318	8,677
	Environmental Pollution	260	4,490
	Environmental Science and Pollution Research	241	7,495
	Science of the Total Environment	181	2,134
	Frontiers in Marine Science	89	683
	PLoS ONE	84	831
	Atmospheric Chemistry and Physics	83	310
	Biogeosciences	62	212
	Regional Environmental Change	59	384
	Scientific Reports	52	574
Social science & humanities related to ocean	Geomorphology	81	1,362
	Geographische Rundschau	73	80
Prevent & eliminate pollution	Marine Pollution Bulletin	56	1,643