Mapping of international collaboration between scientists of the ERA and other regions

An analysis of transnational collaboration for the period 2012-2021

Co-funded by the European Union
To cite this report

Acknowledgement
We thank all Biodiversa+ active partners and other organisations who contributed on the final form of this report.

Layout
Thibaut Lochu

Photography credits
Cover page: © Sebastien Goldberg, Unsplash
p. 5 © Sylvain Cleymans, Unsplash
p. 6-7 © Sylvain Cleymans, Unsplash
p. 9 © Ayush Sharma, Unsplash
p. 10-11 © David Clide, Unsplash
p. 13 © Sebastien Goldberg, Unsplash
p. 15 © Pascal van de Vendel, Unsplash
p. 16-17 © Mohammed Abdullatif, Unsplash
p. 22 © Nathan Cima, Unsplash
p. 23 © Tomoe Steinke, Unsplash
p. 24 © Andy Chilton, Unsplash
p. 25 © Sylvain Cleymans, Unsplash
p. 26-27 © Magnus Lunay, Unsplash
p. 29 © Sebastien Goldberg, Unsplash

The Biodiversa+ partners (May 2023)
Biodiversa+ currently gains 81 partners from 40 countries:

1. AAKSH, National Agency for Scientific Research and Innovation, Albania
2. MTE_AL, Ministry of Tourism and Environment Albania, Albania
3. NAPA, National Agency of Protected Areas, Albania
4. BMBWF, Federal Ministry of Education, Science and Research, Austria
5. PWF, Austrian Science Fund, Austria
6. EAA, Umweltbundesamt, Austria
7. Belspo, Belgian Science Policy Office, Belgium
8. FA-ENRS, Fonds De La Recherche Scientifique, Belgium
9. FVÖ, The research Foundation - Flanders, Belgium
10. WWF-ARNE, Service public de Wallonie (Agriculture-Ressources naturelles-Environnement), Belgium
11. VL, Vlaams gewest / Flemish region, Belgium
12. BNSF, Bulgarian National Science Fund, Bulgaria
13. ExEa, Executive Environment Agency, Bulgaria
15. MESD, Ministry of Economy and Sustainable Development, Croatia
16. MOCCZY, Ministry of Education, Culture, Sport and Youth, Cyprus
17. NCA CZ, Národní klastrová asociace, Czech Republic
18. MdC, Ministry of the Environment, Czech Republic
19. TA CR, Technologická Agentura České republiky, Czech Republic
20. IFD, Innovation Fund Denmark, Denmark
21. MdE, Ministry of the Environment of Denmark, Denmark
22. ETAg, Estonian Research Council, Estonia
23. MEM, Ministry of Rural Affairs of the Republic of Estonia, Estonia
24. MdE, Estonian Ministry of the Environment, Estonia
25. The Faroe Research Council, Grønkvægnaralid, Faroe Island
26. AKA, Suomen Akatemia, Finland
27. MdE, Ministry of the Environment, Finland
28. ANR, Agence Nationale de la Recherche, France
29. FRB, Fondation pour la Recherche sur la biodiversité, France
30. MTETT, Ministère de la Transition Écologique et de la cohésion des territoires, France
31. OFB, Office Français de la Biodiversité, France
32. MEPA, Ministry Of Environmental Protection And Agriculture, Georgia
33. SPNSF, Shota Rustaveli National Science Foundation, Georgia
34. BMBF, Bundesministerium für Bildung und Forschung, Germany
35. BMU, Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, Germany
36. DFG, Deutsche Forschungsgemeinschaft e.V. (German Research Foundation), Germany
37. DLR, Deutsches Zentrum für Luft- und Raumfahrt, Germany
38. VDI/VDE-IT, VDI/VDE Innovation + Technology GmbH, Germany
39. GSR, General Secretariat for Research and Innovation, Greece
40. NKFIH, Nemzeti Kutatási, Fejlesztési és Innovációs Hivatal, Hungary
41. Rannis, Icelandic Centre for Research, Iceland
42. DHLGHI, Department of Housing, Local Government and Heritage, Ireland
43. EPA, Environmental Protection Agency, Ireland
44. MGBP, Ministry of Environmental Protection, Israel
45. MASE, Ministry of Environment and Energy Security, Italy
46. MUR, Ministry of Universities and Research, Italy
47. BOZEN, Autonomous Province of Bolzano/Bolzano South Tyrol, Italy
48. IRS, Environmental Protection Agency, Kosovo
49. LZP, Latvian Council of Science, Latvia
50. MES, Ministry of Education and Science Republic of Latvia, Latvia
51. LMT, Lietuvos mokslo taikyba, Lithuania
52. MECSD, The Ministry of the Environment, Climate and Sustainable Development, Luxembourg
53. NARD, Agenția Națională Pentru Cercetare Si Dezvoltare, Moldova
54. EPA, Environment Protection Agency of Montenegro, Montenegro
55. MESRGI, Ministère de l’Enseignement Supérieur, Recherche Scientifique et Innovation, Morocco
56. LNV, Ministry of Agriculture, Nature and Food quality, The Netherlands
57. NWIO, The Dutch Research Council, The Netherlands
58. NEA, Norwegian Environment Agency, Norway
59. RCN, Research Council of Norway, Norway
60. NCN, Narodowe Centrum Nauki, Poland
61. FCT, Fundação para a Ciência e a Tecnologia, I.P., Portugal
62. FRCT, Fundo Regional para a Ciência e Tecnologia, Portugal
63. UFESCDI, Executive Agency for Higher Education, Research, Development and Innovation Funding, Romania
64. MoEP, Ministry of Environment of the Slovak Republic, Slovakia
65. SAS, Slovak Academy of Sciences, Slovakia
66. SNC, SR, State Nature Conservancy of the Slovak Republic, Slovakia
67. MVL, Ministry of Higher Education, Science and Innovation, Slovenia
68. DSI, Department of Science and Innovation, South Africa
69. AEBI, Agência Estatal de Investigação, Spain
70. CDTI, Centre for Industrial technological Development, Spain
71. DACC, Departamento d’Acció Climàtica, Alimentació i Agenda Rural, Spain
72. FECYT, Fundación Española para la Ciencia y Tecnología, Spain
73. FB, Fundación Biodiversidad, Spain
74. Formas, Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, Sweden
75. SEPA, Swedish Environmental Protection Agency, Sweden
76. SwAM, Swedish Agency for Marine and Water Management, Sweden
77. SNSA, Swedish National Space Agency, Sweden
78. SNSF, Swiss National Science Foundation, Switzerland
79. MHESR, Ministry of Agriculture and Forestry/General Directorate of Agricultural Research and Policies, Tunisia
80. TAGE, General Directorate of Agricultural Research and Policies, Turkey
81. TUBITAK, Scientific and Technological Research Council of Turkey, Turkey
What is Biodiversa+

Biodiversa+ is the European co-funded biodiversity partnership under Horizon Europe, supporting excellent research on biodiversity with an impact for policy and society. It was jointly developed by BiodivERsA and the European Commission (DG Research & Innovation and DG Environment) and was officially launched on 1 October 2021.

Biodiversa+ aims at making the bridge between science, policy and practice as part of the European Biodiversity Strategy for 2030.

Biodiversa+ currently gathers more than 80 research programmers and funders and environmental policy actors from 40 European and associated countries to work on 5 main objectives contributing to a sustainable ecological transition in Europe:

1. Plan and support research and innovation on biodiversity through a shared strategy, annual joint calls for research projects and capacity-building activities
2. Set up a transnational network of harmonised schemes to improve monitoring of biodiversity and ecosystem services across Europe
3. Contribute to high-end knowledge for deploying Nature-based Solutions and valuation of biodiversity in the private sector
4. Ensure efficient science-based support for policy-making and implementation in Europe
5. Strengthen the relevance and impact of pan-European research on biodiversity in a global context

More information at:
www.biodiversa.eu
# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>8</td>
</tr>
<tr>
<td>METHODOLOGY</td>
<td>10</td>
</tr>
<tr>
<td>RESULTS</td>
<td>16</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>26</td>
</tr>
<tr>
<td>ANNEX 1</td>
<td>30</td>
</tr>
<tr>
<td>ANNEX 2</td>
<td>32</td>
</tr>
</tbody>
</table>

## List of acronyms:
- CBD - Convention on Biological Diversity
- DG – Directorate General
- ERA - European Research Area
- EU - European Union
- IPBES - Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
- LAC - Latin America and Caribbean
- OCT - Outermost Countries and Territories
- OR - Outermost Regions
- UN – United Nations
- WoS – Web of Science
Introduction

Biodiversity, encompassing genetic, species, and ecosystem diversity, along with nature’s contributions to humanity, constitutes our shared natural heritage. This heritage holds intrinsic value and forms the foundation for our well-being, health, quality of life, livelihoods, food security, diverse diets, and economies. However, the Global Assessment published by the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES), reveal an alarming trend: global biodiversity is declining at an unprecedented rate in human history, while the underlying pressures driving this decline are growing in intensity. In light of the ongoing biodiversity crisis and its numerous drivers, there is a critical need to strengthen our understanding of biodiversity status, dynamics, and trends through science-based knowledge, in Europe and globally.

The overarching aim of this mapping is to facilitate the assessment of the research landscape of transnational (and in particular bi-regional) collaborations, to guide priorities for research funders to reinforce the internationalization of research in the biodiversity domain. This mapping exercise will also contribute to the promotion of coordinated action to strengthen bi-regional dialogue on science between Europe and other world regions and could potentially pave the way to future joint activities between regions.

Bibliographic analyses serve as a valuable tool in evaluating research collaborations on biodiversity between the European Research Area (ERA) and other global regions. By quantifying scientific bi-regional cooperation, these analyses provide insights into the structure and dynamics of research networks. As scientific publications are the outcome of collaborations among researchers and institutions, they offer a comprehensive view of international research networks. Thus, assessing co-authoring networks, their temporal trends, geographical presence, and covered domains allows for the evaluation of initiatives aimed at fostering international collaboration.

In this mapping covering the 2012-2021 period, Biodiversa+ reports the results obtained from the analysis of the publications involving authors from the European research area and other regions of the world published to study transnational research collaboration on biodiversity.

Biodiversity is defined here according to the Convention on Biodiversity Diversity as “the variety among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”.

Methodology
Methodology

Bibliographic review

The source of information used for this analysis was the scientometric platform Web of Science. The search was conducted on the Web of Science Core Collection (“The robust evaluation and curation of our data make the Web of Science Core Collection the world’s most trusted publisher-independent global citation database”) of the Clarivate citation databases (WoS, ANELIS PLUS Consortium access) and of the scientific literature published between 2012-2021—covering 10 years completely (the year 2021 was fully indexed in WoS around the end of August 2022).

We retrieved all the publications with at least one author affiliated in one of the seven world regions as defined by the following taxonomy:


**Countries in Asia:** Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Bhutan, Brunei, Cambodia, China, India, Indonesia, Iran, Iraq, Japan, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, North Korea, Oman, Pakistan, Palestine, Philippines, Qatar, Saudi Arabia, Singapore, South Korea, Sri Lanka, Syria, Taiwan, Tajikistan, Thailand, Timor Leste, Turkmenistan, United Arab Emirates, Uzbekistan, Vietnam, Yemen

**Countries in the ERA (countries from EU plus EU member states and associated countries):** Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark (incl. OCTs and ORs), Estonia, Finland, France (incl. OCTs and ORs), Georgia, Germany, Greece, Hungary, Ireland, Israel, Italy, Norway, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Monaco, Montenegro, Morocco, Netherlands (incl. OCTs and ORs), North Macedonia, Norway, Poland, Portugal (incl. OCTs and ORs), Romania, San Marino, Serbia, Slovakia, Slovenia, Spain (incl. OCTs and ORs), Sweden, Switzerland, Tunisia, Turkey, United Kingdom (incl. OCTs and ORs), Vatican.

**Countries in Latin America and the Caribbean (LAC) region (Latin America and Caribbean countries):** Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Seychelles, Saint Kitts and Nevis, Saint Lucia, Saint Vincent, Suriname, Trinidad and Tobago, Uruguay, Venezuela.

**Countries in North America region:** Canada, United States of America.

**Countries of Oceania region:** Australia, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.

**Countries Other Europe region:** Belarus, Kosovo, Russia, Ukraine.

In order to obtain the data set relevant for the research and as biodiversity is a broad, multifaceted concept, the following keywords were used to identify publications corresponding to research collaboration on biodiversity:

1. Amphibian diversity, / Diversity of amphibian*.
2. Animal diversity, / Diversity of animal*.
3. Bacteria* diversity, / Diversity of bacteria,
4. Biodiversity,
5. Biodivers*.
6. Biological conservation,
7. Biological diversity, / Diversity of biology,
8. Biological invasion*,
9. Bird diversity, / Diversity of bird*,
10. Ecological service,
11. Ecosystem diversity, / Diversity of ecosystem*.
12. Ecosystem service,
13. Environmental impact statement / Statement of environmental impact,  
14. Fish diversity, / Diversity of fish*,
15. Frog diversity, / Diversity of frog*,
16. Functional diversity,
17. Functional group*,
18. Functional trait*,
19. Functional type*,
20. Fung* diversity, / Diversity of fung*,
21. Genetic diversity, / Diversity of genetic*,
22. Genetic resource*, / Resources of genetic,
23. Habitat conservation, / Conservation of the habitat*,
24. Habitat diversity, / Diversity of habitat*,
25. Insect diversity, / Diversity of insect*,
26. Invasive species,  
27. Landscape diversity, / Diversity of landscape,
28. Mammal diversity, / Diversity of mammal,
29. Microbial diversity, / Diversity of microbial,
30. Phylogen*,
31. Plant diversity, / Diversity of plant*,
32. Reptile diversity, / Diversity of reptil*,
33. Species conservation, / Conservation of species,
34. Species diversity, / Diversity of species,
35. Species loss, / Loss of species,
36. Species richness, / Richness of species,
37. Taxonom*,
38. Tree diversity / Diversity of tree*,
39. Virus diversity, / Diversity of virus*,
40. Weed diversity / Diversity of weed*.  
The asterisk (*) represents a rephrase of the keywords in order to enclose all the specific publications.

2. https://www.webofscience.com
5. 5. United Kingdom (England, Scotland, Wales, North Ireland) is included in the ERA in the complete study period including the eleven months after the Brexit on January 31, 2020
The study was conducted by querying in the Web of Science Core Collection the “topic” field with the set of key words/phrases described above, as well as the “Year published” field with the period 2012-2021 (Figure 1). Following the search, we retrieved 592,532 publications.

These publications were scientometrically analysed by applying a set of criteria in the “Analyse Results” section, available in the new interface of Web of Science platform (launched in 2021). The following information was identified:

- publishing dynamics in the analysed period (Figure 2);
- distribution of publications on the regions defined above (Figure 3);
- countries with the most publications (Figure 4);
- collaboration between ERA and each region (Figures 6 - 8).

The publications were also analysed for the following labels that these are tagged with by Web of Science:

- “Highly Cited Papers” or “Hot Papers” - the most cited papers in the field (Figure 5);
- “Open Access” (Figure 10).

In order to identify the number of publications from each region, the countries that changed their names during the analysed period were renamed and regions or countries under the administration/government of another country/region were regrouped. The platform was subsequently queried on the new groupings according to the “countries” criterion.

In the whole mapping report, each region has an individual color matching the HEX code used by Biodiversa+ network (see details in the following table).

Table 1. World Regions colors

<table>
<thead>
<tr>
<th>Region*</th>
<th>Color</th>
<th>RGB</th>
<th>HEX Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>Red</td>
<td>192</td>
<td>0</td>
</tr>
<tr>
<td>Asia</td>
<td>Red</td>
<td>255</td>
<td>192</td>
</tr>
<tr>
<td>ERA</td>
<td>Yellow</td>
<td>2</td>
<td>164</td>
</tr>
<tr>
<td>ERA - OCTs and ORs</td>
<td>Green</td>
<td>175</td>
<td>238</td>
</tr>
<tr>
<td>LAC</td>
<td>Green</td>
<td>152</td>
<td>192</td>
</tr>
<tr>
<td>North America</td>
<td>Blue</td>
<td>0</td>
<td>112</td>
</tr>
<tr>
<td>Oceania</td>
<td>Blue</td>
<td>112</td>
<td>48</td>
</tr>
<tr>
<td>Other Europe</td>
<td>Purple</td>
<td>16</td>
<td>59</td>
</tr>
</tbody>
</table>

*by alphabetical order

Analysis and mapping of co-authoring and co-publication networks

After applying a criterion in the “Analysed results” section of Web of Science, a web page was obtained from which the data was downloaded in .txt format. These data were imported into Excel to produce relevant graphs.

International networks of researchers were analysed based on the address of the authors included in their research papers. The information on the countries of scientists co-authoring a given paper was transformed into a link between countries collaborating in this paper. Finally, a triangular matrix was computed to identify the links between each pair of countries based on the number of papers co-authored by these countries.

The co-publication network analysis and mapping, was performed using the open source Gephi software.

Two-dimension spatial mappings were performed using the Force-Atlas algorithm in Gephi. This algorithm creates a visual representation of nodes (countries) connected by edges based on co-authorship according to the following rules: 1) node size represents the number of publications, 2) all nodes are attracted to the centre, i.e., the country with the highest number of publications, 3) all nodes repel each other to prevent visual overlapping of the nodes, 4) all nodes that are connected by an edge attract each other, according to the weight of the edge, i.e., the number of publications with co-authorship between the two countries/regions. Two nodes are thus spatially closer if authors of these countries strongly publish together.

To create the world cloud specific to this analysis, the metadata (article title, author keywords, keyword plus, abstracts) of the hot papers identified among the retrieved publications were used and analysed using WordArt (https://wordart.com/).
Results
Results

Temporal and Spatial trends of biodiversity publications

For the analysed period, 2012-2021, we retrieved 592,532 publications, published and indexed worldwide. The number of papers analysed based on the keywords, mentioned above, increased steadily over the years (i.e., an increase of 108.83% between the start and end of the analysed time period) reflecting growing interest in biodiversity research (Figure 2).

The distribution of biodiversity publication per World region as defined in the methodology shows that the ERA is the top ranked region followed closely by Asia in terms of the number of publications (Figure 3).

At the country level, the number of publications is dominated by the United States of America, followed by China and the United Kingdom (Figure 4). In the top twenty, nine countries from the ERA can be found. The countries with the most publications in biodiversity are constantly United Kingdom, Germany, France and Spain.

From a qualitative perspective, in the scientometrics WoS platform, the most cited publications are marked with the logo of Hot Papers. At the World Regions level, the distribution of the 110 hot papers identified within the 592,532 publications are presented in the Figure 5. The number of Hot Papers represents the number of most cited publications available in WoS platform at the moment of interrogation according to the Clarivate methodology for tagging as Hot Papers.

The publications, and their associated authors, that have been cited the most and classified as Hot Papers come from the ERA region.

*Hot Paper (HP): A paper that was published between 2020 - 2022 and receive enough citations in March/April 2022 to place it in the top 0.1% of papers in its academic field.
Transnational collaborations

This section focuses on transnational collaboration between the ERA and the other world regions. Figure 6 shows how often researchers from the ERA publish on biodiversity topics exclusively with other authors from the ERA or the other world regions by comparing the number of publications of the total number of publications with co-authorship from the ERA and other world regions. From the total of 232,285 ERA publications, ERA exclusive* is leading with 57.21% of all co-authored publications, followed by North America (27.02%) and Asia (15.29%) (Figure 7).

Using the clustering tool as Gephi graph, the collaboration degree between the World Regions it is drawn below (Figure 8) by the size of arches’ thickness that connect each of two World Regions. For instance, the most productive collaboration in respect with the hot papers was between ERA and North America, followed by ERA with Asia and ERA with Africa.

For the entire analysed period, an increasing trend of articles published in the field of biodiversity can be observed in Table 2 and also in the graphs in Annex 1.

Table 2. Trends of articles published in the field of biodiversity 2012-2021.

<table>
<thead>
<tr>
<th>Co-authorship</th>
<th>2012</th>
<th>2021</th>
<th>Increasing trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERA-ERA</td>
<td>10,774</td>
<td>16,479</td>
<td>52.95%</td>
</tr>
<tr>
<td>ERA-ASIA</td>
<td>1,719</td>
<td>5,787</td>
<td>236.65%</td>
</tr>
<tr>
<td>ERA-North America</td>
<td>3,014</td>
<td>5,747</td>
<td>90.68%</td>
</tr>
<tr>
<td>ERA-AFRICA</td>
<td>794</td>
<td>2,281</td>
<td>187.28%</td>
</tr>
<tr>
<td>ERA-OCEANIA</td>
<td>888</td>
<td>2,121</td>
<td>138.85%</td>
</tr>
<tr>
<td>ERA - ERA-OCTs and ORs</td>
<td>61</td>
<td>113</td>
<td>85.25%</td>
</tr>
<tr>
<td>ERA-Other Europe</td>
<td>326</td>
<td>1,001</td>
<td>207.06%</td>
</tr>
</tbody>
</table>

Following the trends in the table, can be observed that the largest increase has been recorded in co-authorship between ERA countries and Asia. Collaboration between ERA and Other Europe shows a very high increase, ranking second in the identified trends, followed by collaborations with Africa and Oceania. In this context it can be observed that ERA authors are increasingly oriented towards collaborations with authors from outside the ERA region (the highest increase was registered in the ERA – Asia co-authorship of 236.65%, followed by ERA – Other Europe co-authorship of 207.06%), whereas the ERA-ERA co-authorship increased least (52.95%), however being still the highest in total numbers with nearly threefold as much as the ERA-Asia co-authorships. For a more in-depth analysis, the collaborations between ERA and “ERA-OCTs and ORs” have been addressed separately, showing an increase of 85.25% during the period analysed.

*ERA exclusive = articles only with authors from ERA
The infographics in Annex 1 represent the annual amount (number of publications) of each type of co-authorship analysed between 2012-2021.

The graphs in Annex 2 highlight for each type of collaboration the countries in the two regions with the most publications. For an “easy” graphical representation, only countries with a minimum of 1% of publications of the total type of collaboration have been selected. It can be noted that in the case of ERA – non-ERA collaborations the country with the most publications is Russia. In the case of ERA-ERA OCTs and ORs collaboration the country with the most publications is France, due to its historical collaboration with those regions.

In terms of ERA – non-ERA collaboration top ranked countries are as following: for Asia are China, Japan, India; for North-America are United State of America and Canada; for LAC are Brasil, Mexico, Argentina; for Africa are South Africa, Kenya and Egypt; for Oceania are Australia and New Zealand; for Other Europe are Russia and Ukraine; for OCTs and ORs are France OCTs, France ORs and Denmark OCTs. The above World Region order was established based on 2021 rankings (Table 2).

Figure 9 shows the percentages of publications of each bi-regional collaborations (marked by the specific colour), for each year of the period analysed, in relation to the total number of publications identified in the field of biodiversity (592,532 publications).

During the analysed period (2012-2021), bi-regional collaborations have shown a steady growth trend in terms of publications in the field of biodiversity. In this framework, ERA-Asia collaborations in the last year (2021) surpassed collaborations with North America (which dominated the period 2012-2020) due to the highest growth rate recorded in comparison with all other bi-regional collaborations, therefore positioning Asia on first place within ERA - non-ERA region collaborations. Another change of position in the ranking of bi-regional collaborations is registered between ERA-Africa and ERA-Oceania. If at the beginning of the analysed period the ERA-Oceania collaboration was in 4th position in the ranking, we note that from 2020 onward these collaborations are overtaken by ERA-Africa ones.
Open Access

In line with the EU policy regarding the open access of the funded publications, we analysed the whole publications as shown in Figure 3 from the point of open access percentage (Figure 10).

The above graph shows that all the world regions (ERA, including OCTs and ORs, North America, Asia, LAC, Oceania, Africa, Other Europe) do not differ much regarding their percentage of open access publications in biodiversity field (51.87% - 67.19%). Each of the world region percentage of biodiversity open access publications exceeds the WoS Core Collection average of 34.65 % for the same period (2012-2021) and also for the last indexed year in WoS (2022). This tendency of open access publications for biodiversity domain is more evident thanking into consideration the average percentage on WoS publications that is calculated for the entire indexed domains in the platform. Therefore, a higher visibility is available within WoS platform for biodiversity publications.

Starting with the mandatory request of Horizon 20208 (2014 – 2020) for open access, the percentage grew steadily (data not shown), and was above 43% in 2022. The increase in this percentage is also supported by the global interest in finding solutions to resolve biodiversity issues (e.g., global warming, saving resources), and open access to publications in the field might help find faster or better documented solutions.

Using “Most Cited Papers” (Highly Cited Papers or Hot Papers) filter, from Web of Science infor- matic platform, were retrieved the most 110 terms cited. Based on Word Art generator and using article titles, keywords and abstract, the keywords featuring most in the publications include use, soil, function, date, species, plant, change, learned, system, global and genome.

---

Conclusions
Conclusions

The analysis of biodiversity publications from 2012 to 2021 has revealed a consistent and substantial increase in volume since 2012. This upward trend has been observed across all World Regions and countries, with particular attention given to collaborations between the European Research Area (ERA) and other global regions, where the rise in biodiversity publications has continued.

Through network analysis using the Force-Atlas algorithm in Gephi, it is evident that ERA researchers have established a highly interconnected cooperation network, supported by significant funding from the European Union (EU). Simultaneously, research collaborations with authors from all continents have increased, with particularly strong connections to North America, Asia, and LAC (Latin America and the Caribbean). Asia has shown notable progress in the ranking of collaborative efforts over the studied period.

From a qualitative standpoint, the study highlights the ERA’s leading position in terms of the most cited publications (hot papers), followed by Asia and North America. The Asia region has emerged as the main partner of the ERA in the field of biodiversity, both in terms of the number of bi-regional collaborations and the number of highly cited publications.

In terms of open access publishing in biodiversity fields, the highest ranking in bi-regional collaboration is seen in ERA-Oceania, ERA-North America, and ERA-OCTs (Overseas Countries and Territories).

Biodiversa+ (the European Biodiversity Partnership) intends to use the results of this mapping exercise to strengthen areas that have not yet been covered completely and bridge knowledge gaps. Furthermore, it aims to engage funders from new countries to enhance scientific collaborations.

It is important to note that this report provides a snapshot of a specific time period, and further analyses can be conducted for subsequent periods or expanded to delve deeper into specific regions, areas of interest, research fields, influential journals, and funding agencies involved in highly cited papers on biodiversity.

Ultimately, this report serves as a foundation for promoting the internationalization of biodiversity research between Europe and all World Regions, while also serving as a guide for future cooperation in upcoming topics.
ANNEX 1 - Publications evolution of bi-regional collaborations

ERA - ASIA co-authorship evolution (no of publications)

ERA - North America co-authorship evolution (no of publications)

ERA - LAC co-authorship evolution (no of publications)

ERA - AFRICA co-authorship evolution (no of publications)
ANNEX 2 - Main countries involved in bi-regional collaborations

Countries from ERA - ERA with min 1% publications

<table>
<thead>
<tr>
<th>Country</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>23715</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>20374</td>
</tr>
<tr>
<td>Spain</td>
<td>17261</td>
</tr>
<tr>
<td>France</td>
<td>16920</td>
</tr>
<tr>
<td>Italy</td>
<td>16901</td>
</tr>
<tr>
<td>Poland</td>
<td>9170</td>
</tr>
<tr>
<td>Switzerland</td>
<td>6729</td>
</tr>
<tr>
<td>Netherlands</td>
<td>6634</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>6361</td>
</tr>
<tr>
<td>Sweden</td>
<td>6254</td>
</tr>
<tr>
<td>Turkey</td>
<td>5702</td>
</tr>
<tr>
<td>Portugal</td>
<td>5662</td>
</tr>
<tr>
<td>Belgium</td>
<td>4927</td>
</tr>
<tr>
<td>Austria</td>
<td>4341</td>
</tr>
<tr>
<td>Finland</td>
<td>3894</td>
</tr>
<tr>
<td>Denmark</td>
<td>3873</td>
</tr>
<tr>
<td>Norway</td>
<td>3488</td>
</tr>
<tr>
<td>Greece</td>
<td>2884</td>
</tr>
<tr>
<td>Hungary</td>
<td>2743</td>
</tr>
<tr>
<td>Romania</td>
<td>2172</td>
</tr>
<tr>
<td>Israel</td>
<td>2034</td>
</tr>
<tr>
<td>Ireland</td>
<td>1926</td>
</tr>
<tr>
<td>Slovakia</td>
<td>1665</td>
</tr>
<tr>
<td>Tunisia</td>
<td>1505</td>
</tr>
<tr>
<td>Serbia</td>
<td>1488</td>
</tr>
<tr>
<td>Croatia</td>
<td>1396</td>
</tr>
</tbody>
</table>

Countries from ERA - ASIA with min 1% publications

<table>
<thead>
<tr>
<th>Country</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>13562</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>10107</td>
</tr>
<tr>
<td>Germany</td>
<td>8111</td>
</tr>
<tr>
<td>France</td>
<td>5250</td>
</tr>
<tr>
<td>Japan</td>
<td>4588</td>
</tr>
<tr>
<td>India</td>
<td>3513</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3150</td>
</tr>
<tr>
<td>Spain</td>
<td>2958</td>
</tr>
<tr>
<td>Italy</td>
<td>2944</td>
</tr>
<tr>
<td>Iran</td>
<td>2399</td>
</tr>
<tr>
<td>Switzerland</td>
<td>2288</td>
</tr>
<tr>
<td>Sweden</td>
<td>2057</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>1987</td>
</tr>
<tr>
<td>Denmark</td>
<td>1909</td>
</tr>
<tr>
<td>Thailand</td>
<td>1857</td>
</tr>
<tr>
<td>Belgium</td>
<td>1828</td>
</tr>
<tr>
<td>South Korea</td>
<td>1599</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1561</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1541</td>
</tr>
<tr>
<td>Austria</td>
<td>1407</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1385</td>
</tr>
<tr>
<td>Singapore</td>
<td>1384</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1219</td>
</tr>
<tr>
<td>Finland</td>
<td>1131</td>
</tr>
<tr>
<td>Taiwan</td>
<td>1070</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1065</td>
</tr>
<tr>
<td>Norway</td>
<td>1035</td>
</tr>
<tr>
<td>Poland</td>
<td>1017</td>
</tr>
<tr>
<td>Turkey</td>
<td>1006</td>
</tr>
<tr>
<td>Portugal</td>
<td>1001</td>
</tr>
<tr>
<td>Hungary</td>
<td>706</td>
</tr>
<tr>
<td>Iran</td>
<td>669</td>
</tr>
<tr>
<td>Philippines</td>
<td>618</td>
</tr>
<tr>
<td>Ireland</td>
<td>560</td>
</tr>
<tr>
<td>Greece</td>
<td>436</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>412</td>
</tr>
<tr>
<td>Tunisia</td>
<td>393</td>
</tr>
<tr>
<td>Lebanon</td>
<td>377</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>375</td>
</tr>
</tbody>
</table>
Countries from ERA - LAC with min 1% publications

0 2000 4000 6000 8000 10000
Brazil 9450
United Kingdom 5503
Spain 4978
Germany 4507
France 3848
Mexico 3015
Argentina 2620
Chile 2183
Netherlands 1929
Italy 1851
Colombia 1833
Switzerland 1564
Portugal 1535
Belgium 1279
Ecuador 1206
Sweden 1168
Denmark 1079
Peru 982
Czech Republic 840
Panama 795
Austria 738
Costa Rica 662
Finland 623
Norway 598
Poland 515
Venezuela 423
Uruguay 374
Bolivia 365
Cuba 323
Turkey 253
Hungary 249
Ireland 228
Israel 226

Countries from ERA - Oceania with min 1% publications

0 2000 4000 6000 8000 10000 12000 14000
Australia 12098
United Kingdom 6251
Germany 3580
New Zealand 3182
France 2771
Spain 2001
Netherlands 1719
Switzerland 1557
Italy 1421
Sweden 1309
Denmark 1075
Belgium 967
Czech Republic 762
Norway 726
Portugal 698
Austria 678
Finland 572
Ireland 439
Poland 430
Israel 356
Hungary 267
Greece 231
Estonia 230
Turkey 175
Papua New Guinea 168
Reading this mapping you will...

... discover the main geographical research collaborations on biodiversity

... find out more on trends of articles published in the field of biodiversity

... discover the distribution of biodiversity publications on World Region

Co-funded by the European Union