

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

An analysis of transnational collaboration
for the period 2012-2021



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3. NAPA, National Agency of Protected Areas, Albania
4. BMBWF, Federal Ministry of Education, Science and Research, Austria
5. FWF, Austrian Science Fund, Austria
6. EAA, Umweltbundesamt, Austria
7. BelSPO, Belgian Science Policy Office, Belgium
8. F.R.S.-FNRS, Fonds De La Recherche Scientifique, Belgium
9. FWO, The research Foundation - Flanders, Belgium
10. SPW-ARNE, Service public de Wallonie (Agriculture-Ressources naturelles-Environnement), Belgium
11. VL O, Vlaams gewest / Flemish region, Belgium
12. BNSF, Bulgarian National Science Fund, Bulgaria
13. ExEA, Executive Environment Agency, Bulgaria
14. MoEW, Ministry of Environment and Water, Bulgaria
15. MESD, Ministry of Economy and Sustainable Development, Croatia
16. MOECYS, Ministry of Education, Culture, Sport and Youth, Cyprus
17. NCA CZ, Národní klastrová asociace, Czech Republic
18. MoE CR, Ministry of the Environment, Czech Republic
19. TA CR, Technologická Agentura Ceske Republiky, Czech Republic
20. IFD, Innovation Fund Denmark, Denmark
21. MoE of DK, Ministry of Environment of Denmark, Denmark
22. ETAg, Estonian Research Council, Estonia
23. MEM, Ministry of Rural Affairs of the Republic of Estonia, Estonia
24. MoE_EE, Estonian Ministry of the Environment, Estonia
25. The Faroese Research Council, Granskingarráðið, Faroe Island
26. AKA, Suomen Akatemia, Finland
27. MoE_FI, Ministry of the Environment, Finland
28. ANR, Agence Nationale de la Recherche, France
29. FRB, Fondation pour la Recherche sur la Biodiversité, France
30. MTECT, Minitère de la Transition Ecologique et de la cohésion des territoires, France
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32. MEPA, Ministry Of Environmental Protection And Agriculture, Georgia
33. SRNSFG, Shota Rustaveli National Science Foundation, Georgia
34. BMBF, Bundesministerium für Bildung und Forschung, Germany
35. BMUV, 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. GSRI, General Secretariat for Research and Innovation, Greece
40. NKFIH, Nemzeti Kutatási, Fejlesztési és Innovációs Hivatal, Hungary
41. Rannis, Icelandic Centre for Research, Iceland
42. DHLGH, Department of Housing, Local Government and Heritage, Ireland
43. EPA, Environmental Protection Agency, Ireland
44. MOEP, 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/Bozen South Tyrol, Italy
48. RKS, 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 taryba, Lithuania
52. MECSD, The Ministry of the Environment, Climate and Sustainable Development, Luxembourg
53. NARD, Agentia Nationala Pentru Cercetare Si Dezvoltare, Moldova
54. EPA_M, Environment Protection Agency of Montenegro, Montenegro
55. MESRSI, Ministère de l'Enseignement Supérieur, Recherche Scientifique et Innovation, Morocco
56. LNV, Ministry of Agriculture, Nature and Food quality, The Netherlands
57. NWO, 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. UEFISCDI, Executive Agency for Higher Education, Research, Development and Innovation Funding, Romania
64. MoER SR, 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. MVZI, Ministry of Higher Education, Science and Innovation, Slovenia
68. DSI, Department of Science and Innovation, South Africa
69. AEI, Agencia Estatal de Investigación, Spain
70. CDTI, Centre for Industrial technological Development, Spain
71. DACC, Departament 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, Swedish
78. SNSF, Swiss National Science Foundation, Switzerland
79. MHESRS, Ministry of Agriculture and Forestry/General Directorate of Agricultural Research and Policies, Tunisia
80. TAGEM, 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

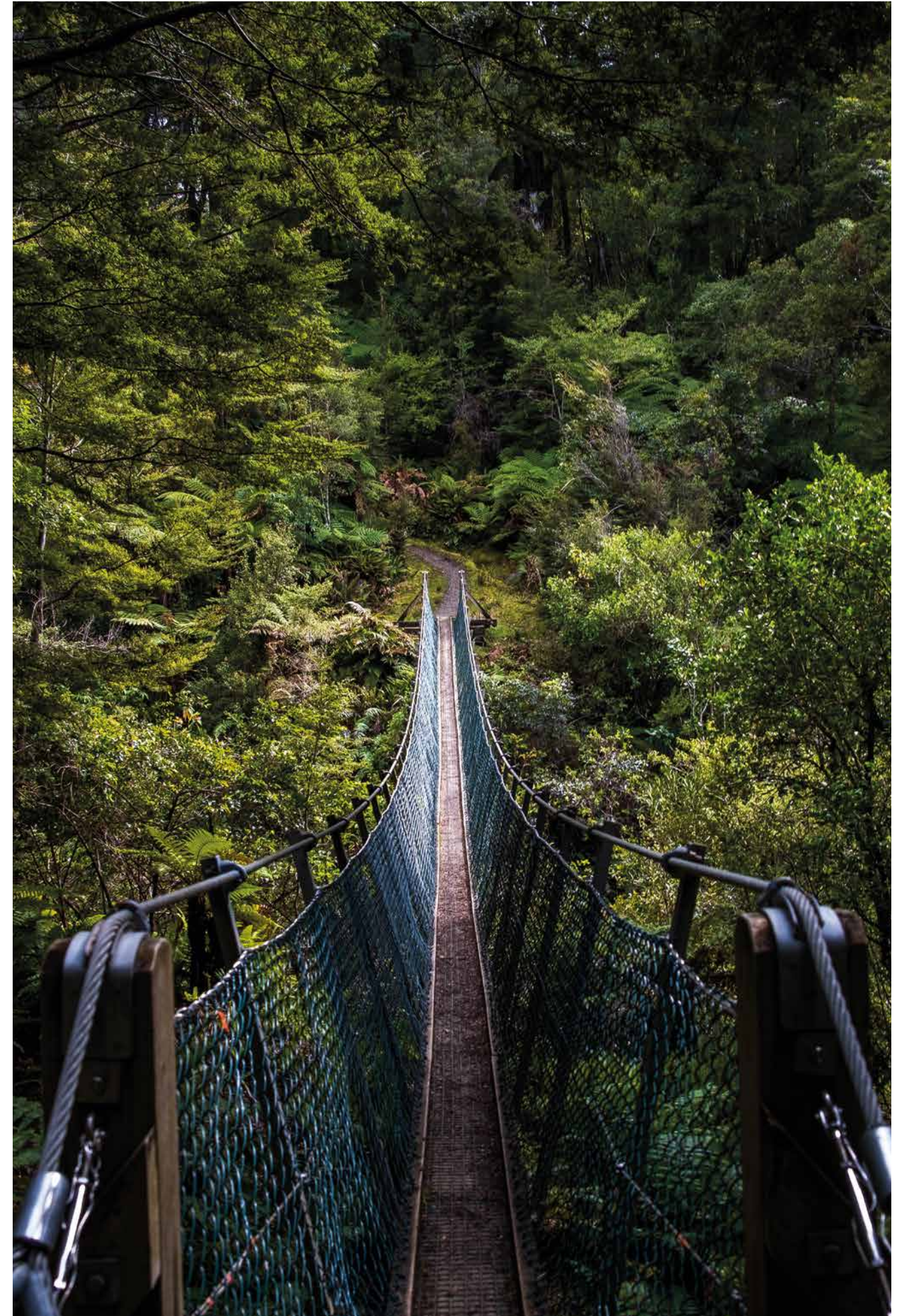


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List of acronyms:

- 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 ¹. 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.

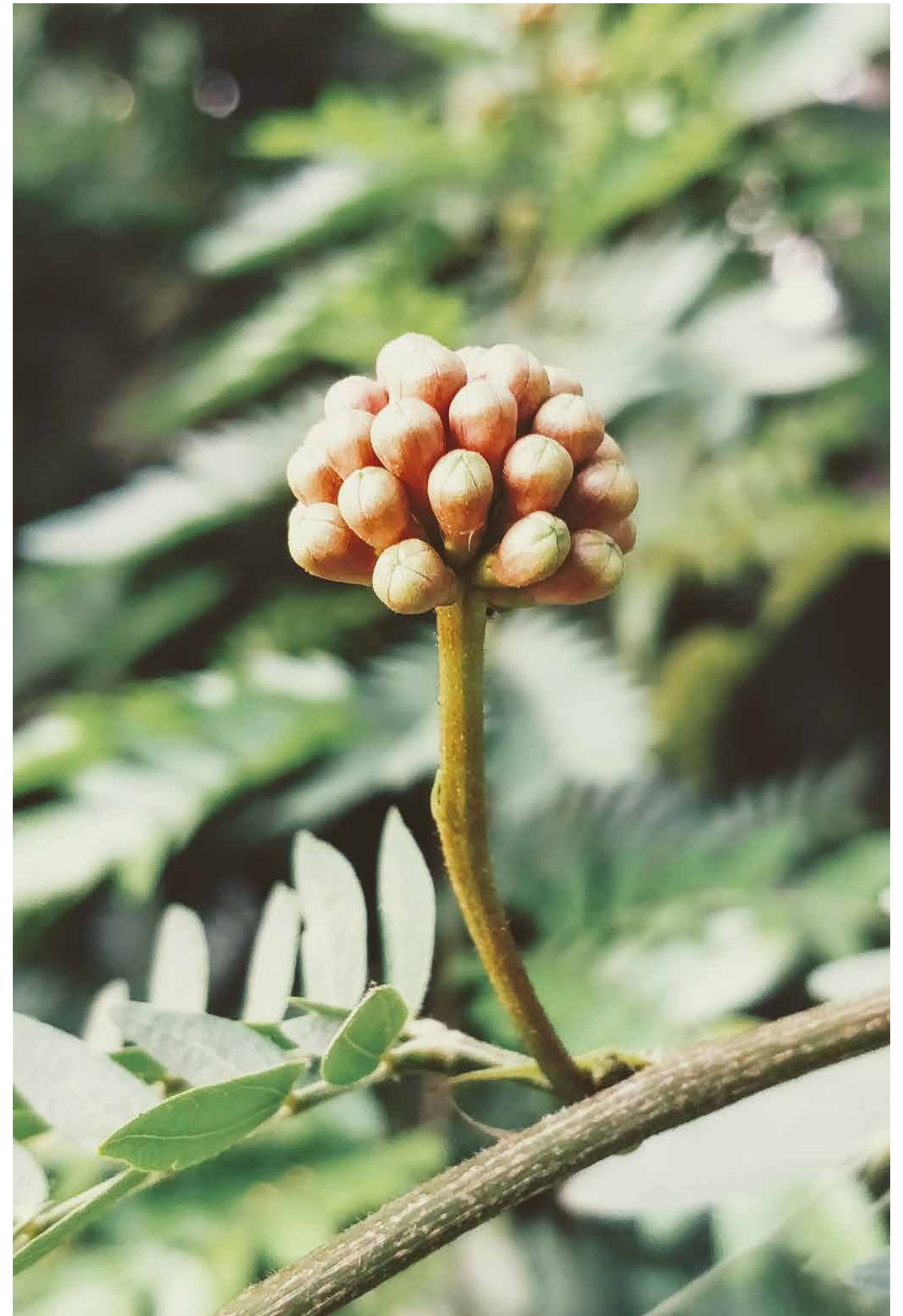
The overarching aim of this mapping is to facilitate the assessment of the research landscape of transnational (and in particular bi-regional) collaborations, to guide priorities for research funders to reinforce the internationalization of research in the biodiversity domain. This mapping exercise will also contribute to the promotion of coordinated action to strengthen biregional 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”.

1. IPBES (2019) Global Assessment Report on Biodiversity and Ecosystem Services (https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf)



Methodology



Methodology

Bibliographic review

The source of information used for this analysis was the scientometric platform Web of Science². 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 databasew³”) of the Clarivate citation databases (WoS, ANELIS PLUS⁴ 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 Africa: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Republic of the Congo, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Countries in Asia: Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Bhutan, Brunei, Cambodia, India, Indonesia, Iran, Iraq, Japan, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, North Korea, Oman, China, 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 Kingdom⁵ (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 Island, 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, multi-faceted 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>
3. <https://clarivate.com/webofsciencelibrary/solutions/web-of-science/>
4. <http://www.anelisplus.ro/>
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.

DOCUMENTS

RESEARCHERS

Search in: Web of Science Core Collection Editions: All

DOCUMENTS

CITED REFERENCES

STRUCTURE

Topic

Example: oil spill* mediterranean
"Amphibian diversity" or "Diversity of amphibians" or "Animal diversity" or "Diversity of"

And

Year Published

Example: 2001 or 1997-1999
2012-2021

+ Add row

+ Add date range

Advanced Search

X Clear

Search

Figure. 1 Querying Web of Science Core Collection (screenshot)

These publications were scientometric 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

| Region* | Color | RGB | | | HEX Code |
|--------------------|-------|-----|-----|-----|----------|
| Africa | | 192 | 0 | 0 | #C00000 |
| Asia | | 255 | 192 | 0 | #FFC000 |
| ERA | | 2 | 164 | 167 | #02A4A7 |
| ERA - OCTs and ORs | | 175 | 238 | 238 | #AFEEEE |
| LAC | | 152 | 192 | 30 | #98C01E |
| North America | | 0 | 112 | 192 | #0070C0 |
| Oceania | | 112 | 48 | 160 | #7030A0 |
| Other Europe | | 16 | 59 | 96 | #103B60 |

*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 software⁶.

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 cloud⁷ 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/>).

6. <http://gephi.org>
7. <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).

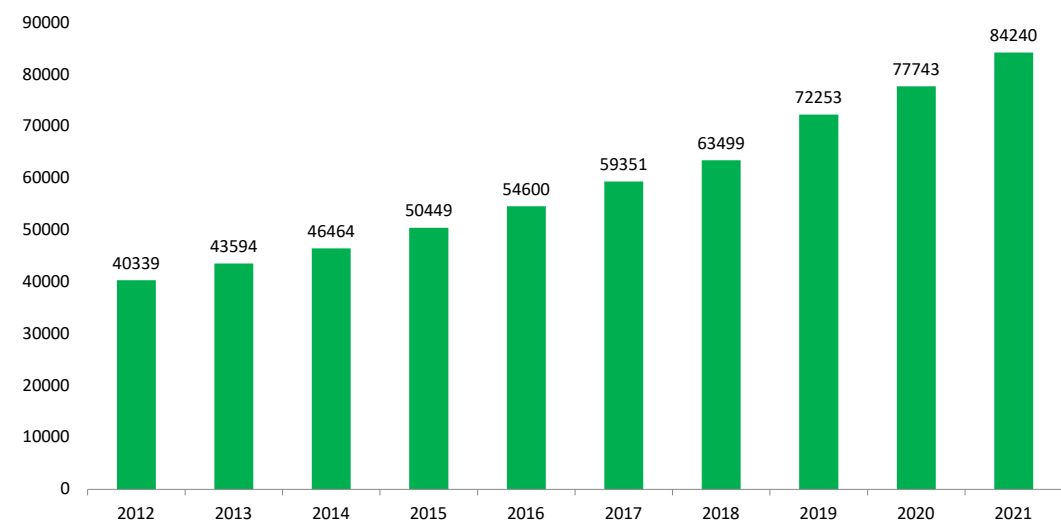


Figure 2. Trend in biodiversity publications. Analysis of WoS with keywords for biodiversity mentioned above according to the criterion "Publication years by all World Regions (2012-2021)"

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).

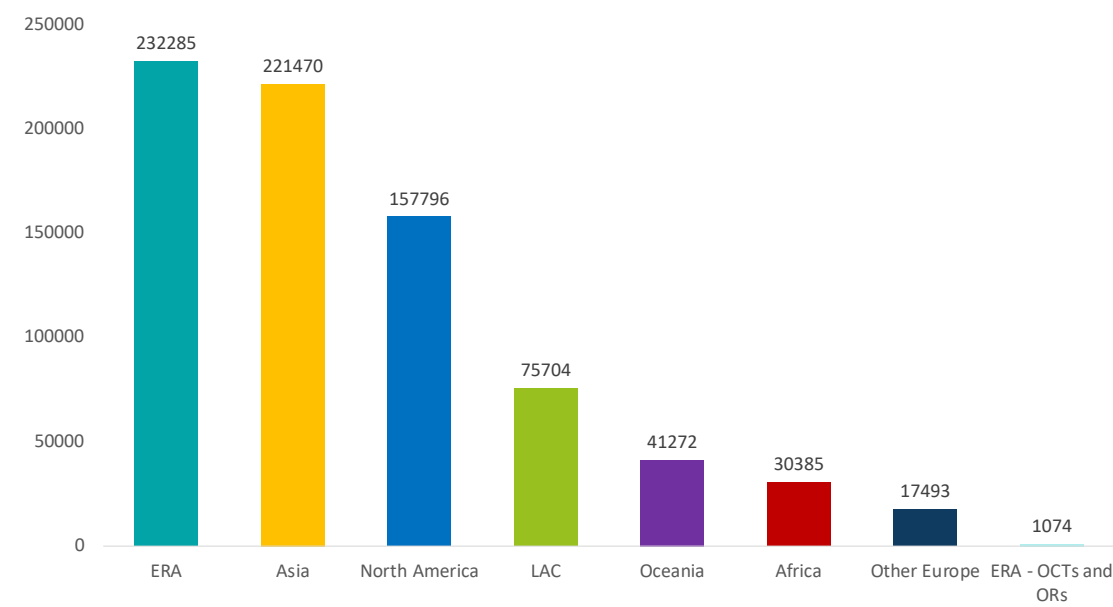


Figure 3. The distribution of biodiversity publications on World Regions

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.

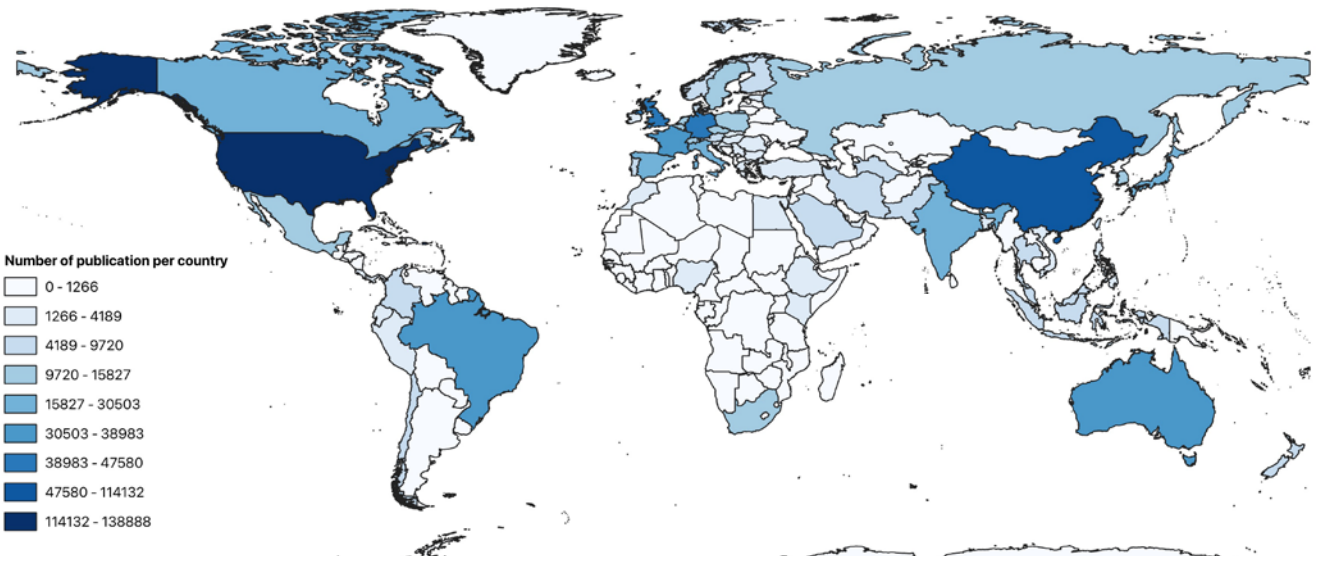


Figure 4. Visualisation of the quantity of biodiversity papers published by each country

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.

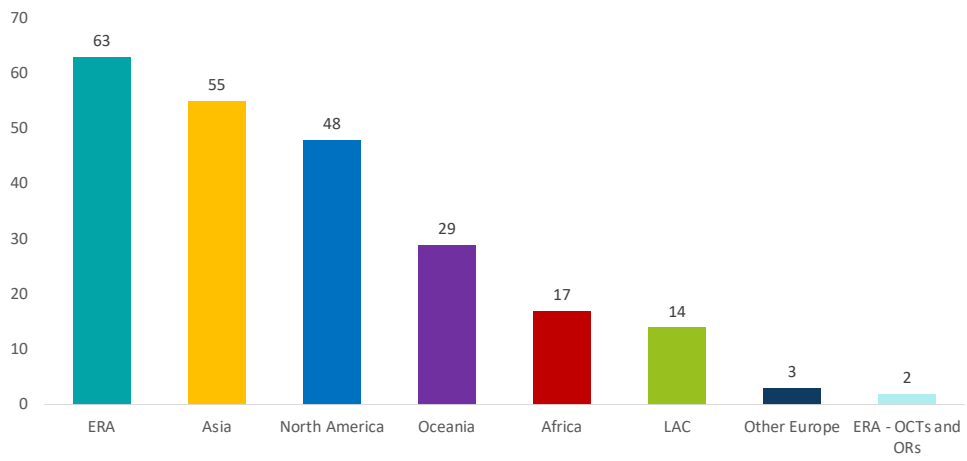


Figure 5. Hot Papers (HP) distribution within World Regions

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 focusses on transnational collaboration between the ERA and the other world region. 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 publication, followed by North America (27.02%) and Asia (15.29%) (Figure 7).

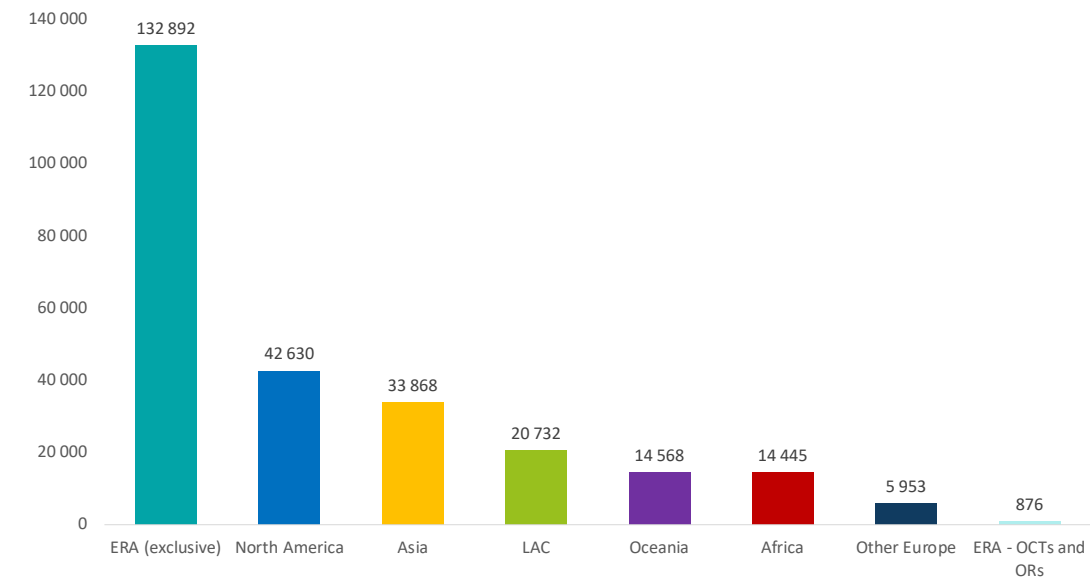


Figure 6. Number of ERA co-authorship publications at the World Regions level

In figure 7 another perspective from the world regions side is taken.

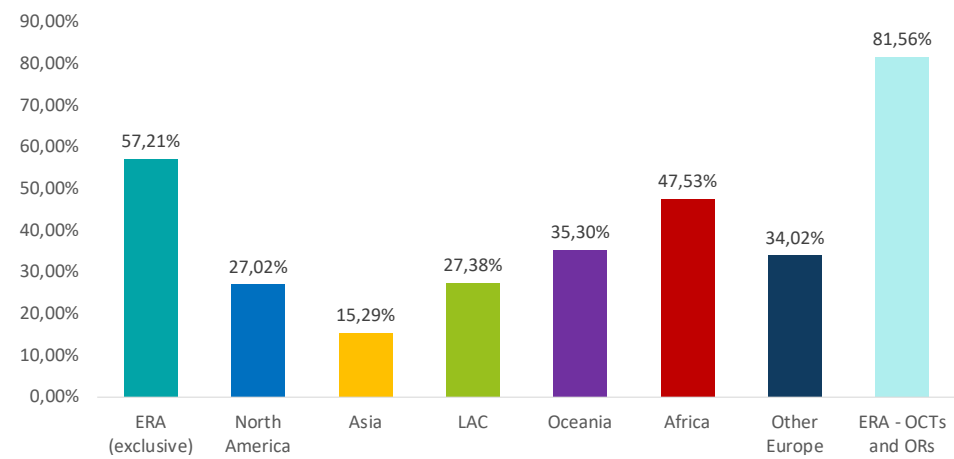


Figure 7. The percentage of each World Region co-authorship publications with ERA

The high percentage of 81.56% for ERA OCTs and ORs co-authorship with ERA shows how this region prioritises research in co-authorship with ERA, followed by the preference in collaboration between European countries (57.21%

ERA exclusive). Among the non-European regions, a similar tendency can be observed between ERA-Africa co-authorship (47.53%) (Figure 7).

*ERA exclusive = articles only with authors from ERA

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.

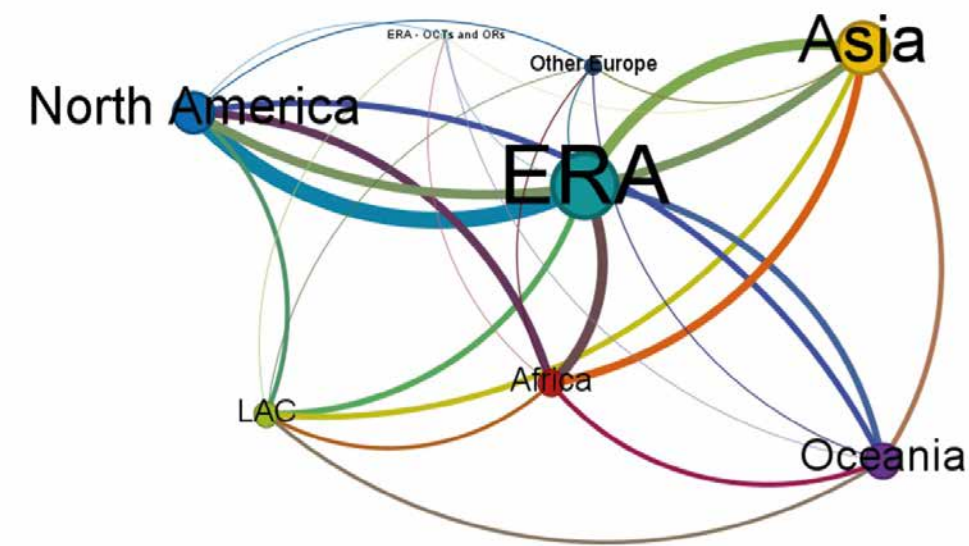


Figure 8. Inter-regional collaborations for hot papers co-authorship

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.

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

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.



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 in the field of biodiversity belongs to the ERA partner region, thus for the ERA-Asia collaboration, China is leading as the most important country within co-authorship biodiversity publications, for ERA-North America the country with the most publications is the United States of America, for ERA-Africa the country with the most publications is South

Africa, for ERA-LAC the country with the most publications is Brazil, for ERA-Oceania the country with the most publications is Australia and for ERA-Other Europe 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](#)).

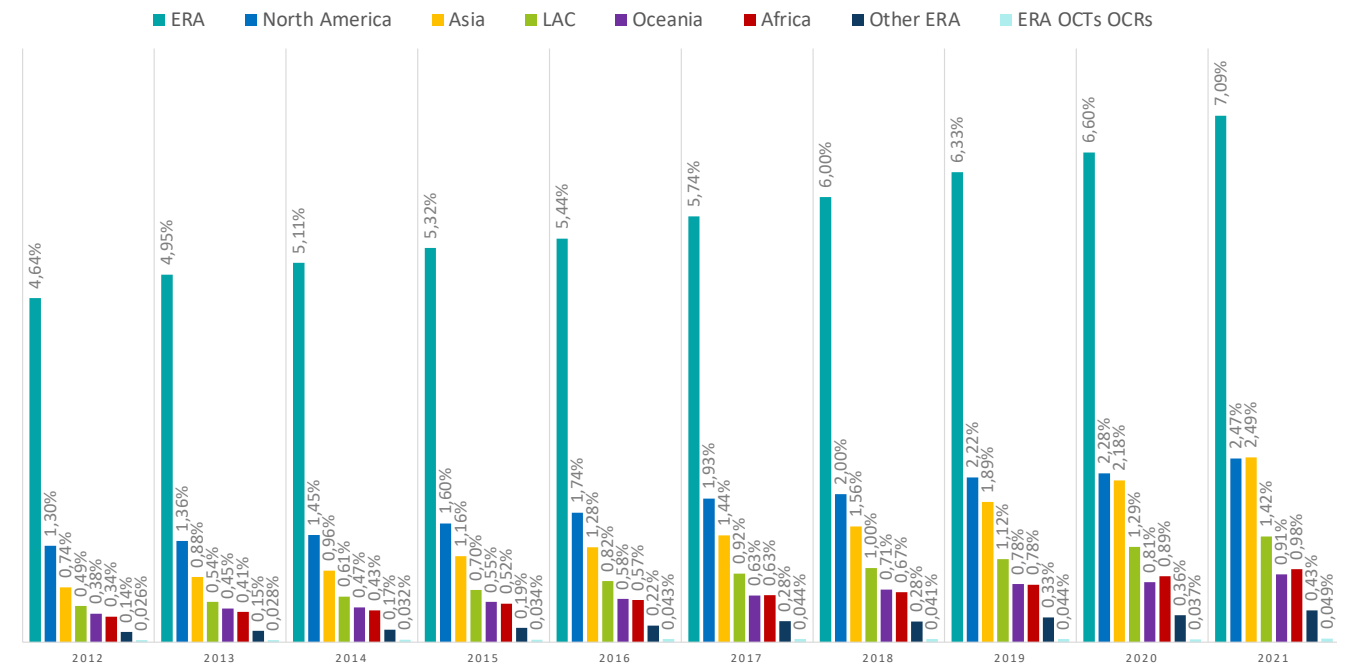
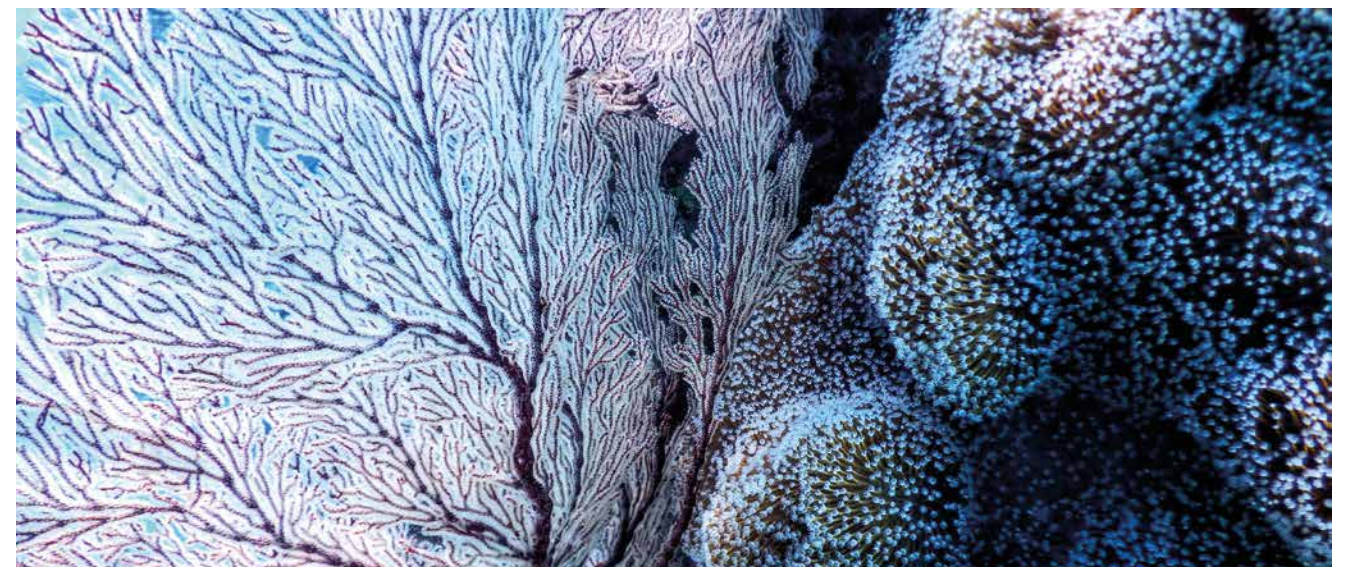


Figure 9. Collaboration evolution 2012-2021

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

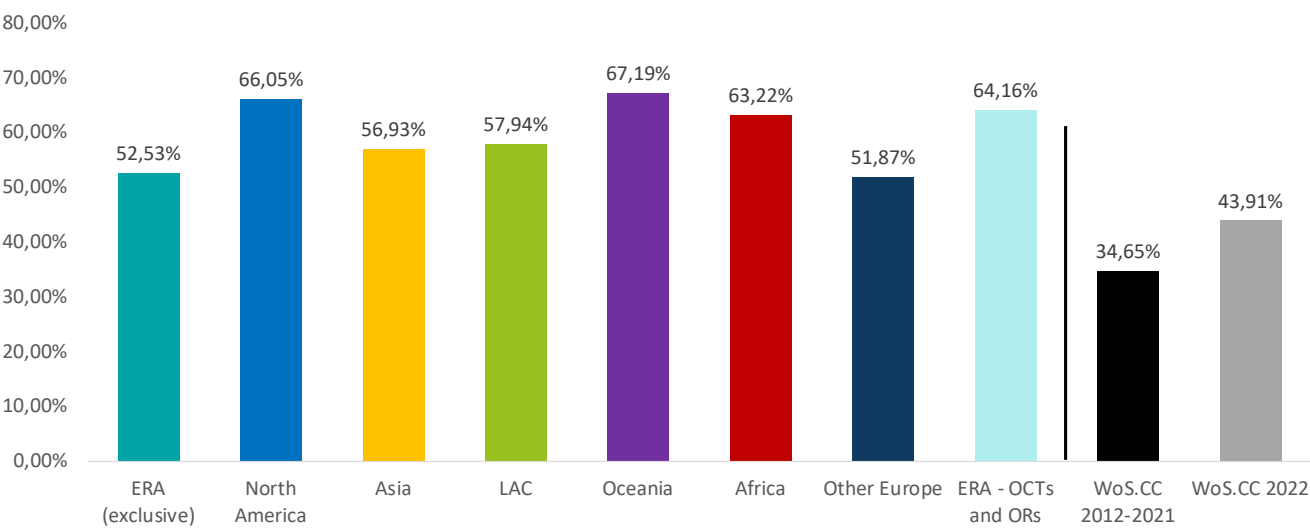


Figure 10. Open access percentages. Abbreviations: CC=Core Collection – all domains.

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 than in other domains. Therefore, a higher visibility is available within WoS platform for biodiversity publications.

from the point of open access percentage (Figure 10).

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.



8. https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-data-management/open-access_en.htm

Most used words in biodiversity publications



Figure 11. Most used words related to the hot papers in the biodiversity field

Using “Most Cited Papers” (Highly Cited Papers or Hot Papers) filter, from Web of Science informatic 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.



A scenic landscape photograph featuring a field of purple flowers in the foreground, a rocky coastline, and a blue body of water under a clear sky. The word "Conclusions" is overlaid on the left side of the image.

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).

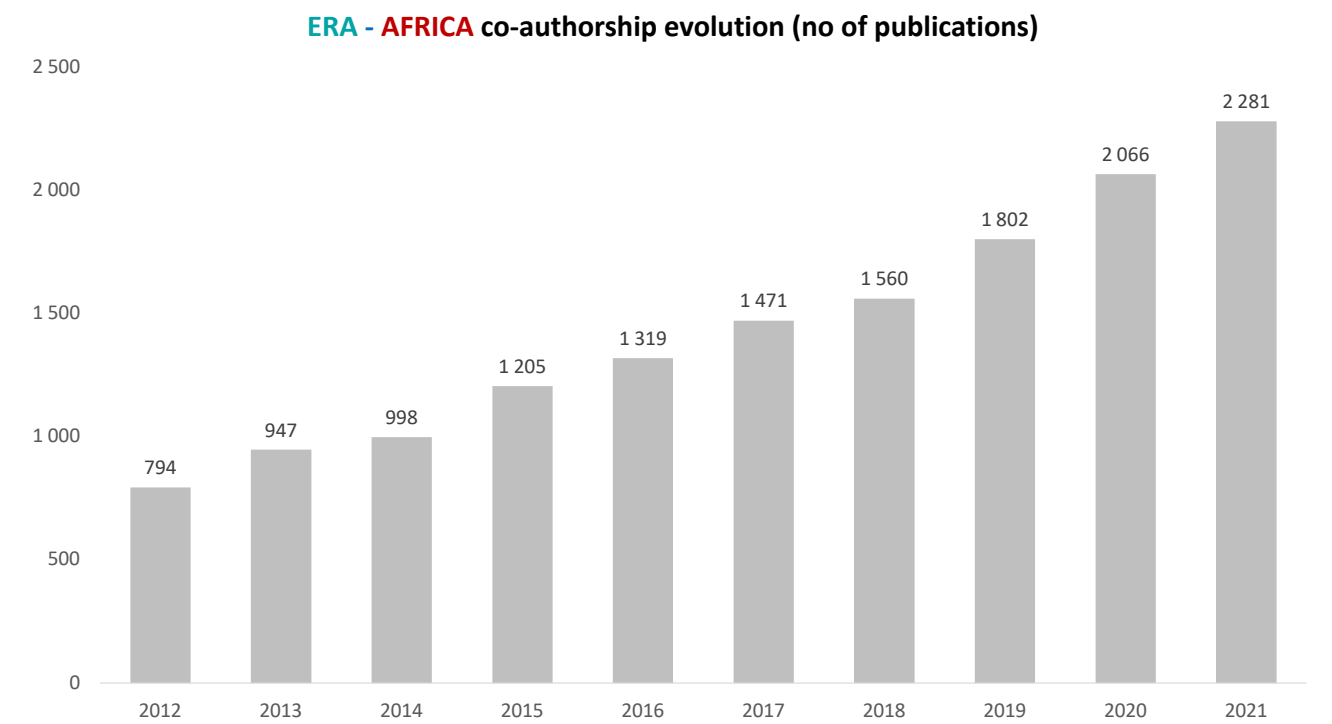
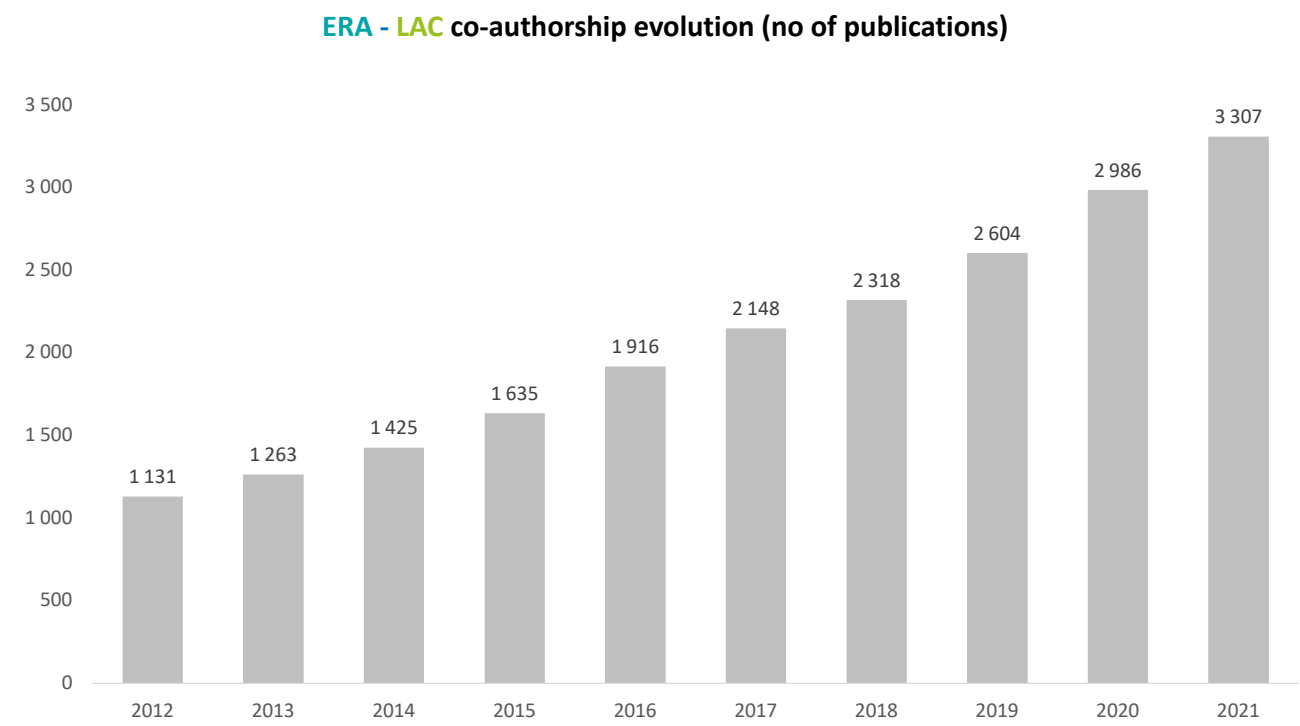
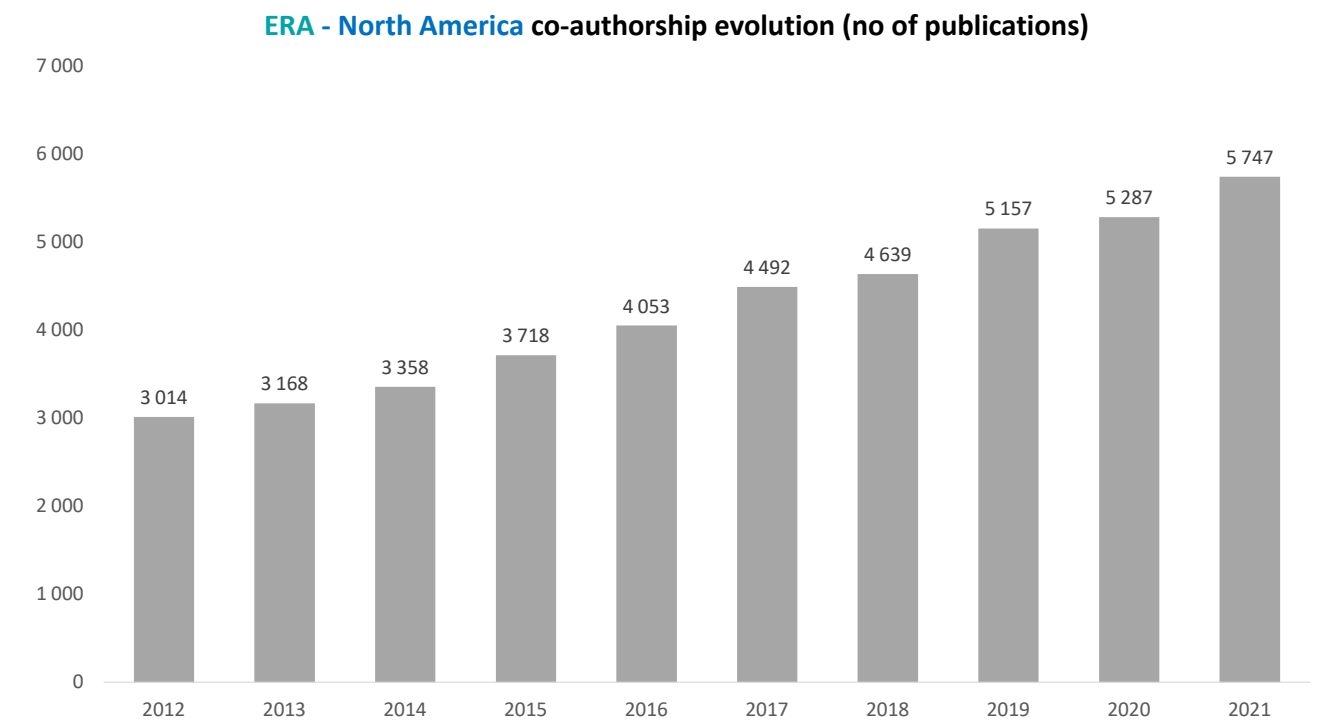
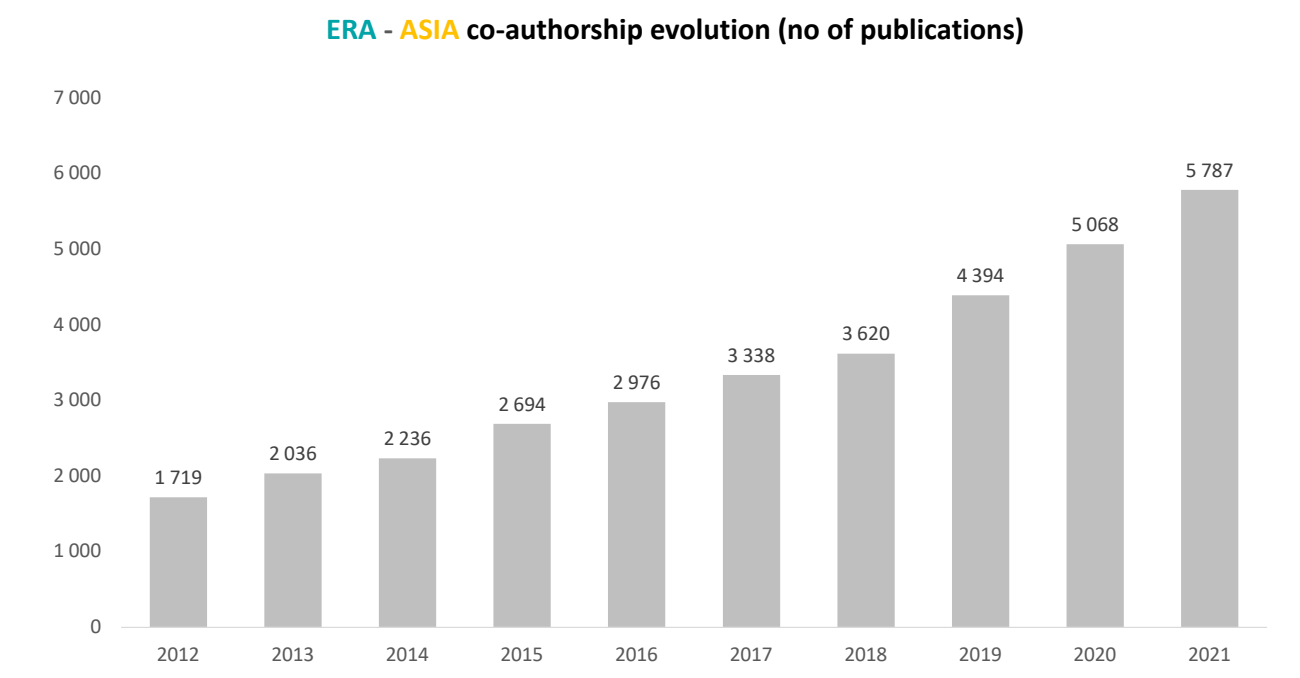
Biodiversa+ (the European Biodiversity Partnership) intends to use the results of this mapping exercise to strengthen areas that have not yet been covered completely and bridge knowledge gaps. Furthermore, it aims to engage funders from new countries to enhance scientific collaborations.

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.

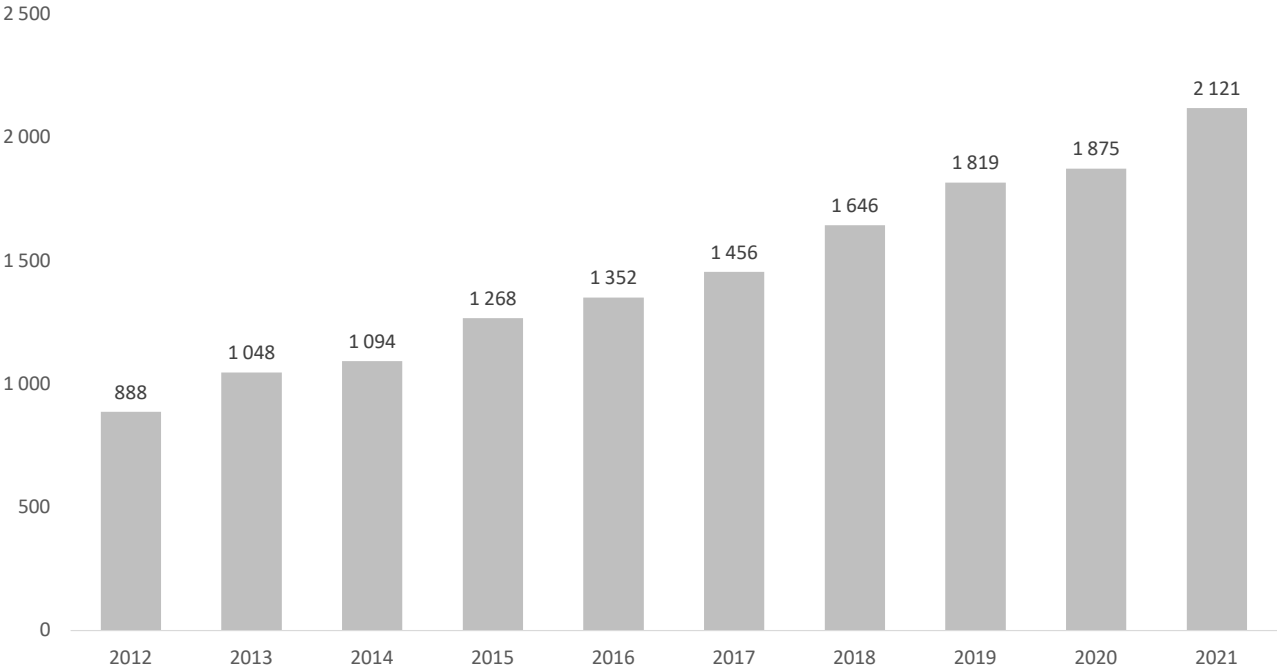
Ultimately, this report serves as a foundation for promoting the internationalization of biodiversity research between Europe and all World Regions, while also serving as a guide for future cooperation in upcoming topics.



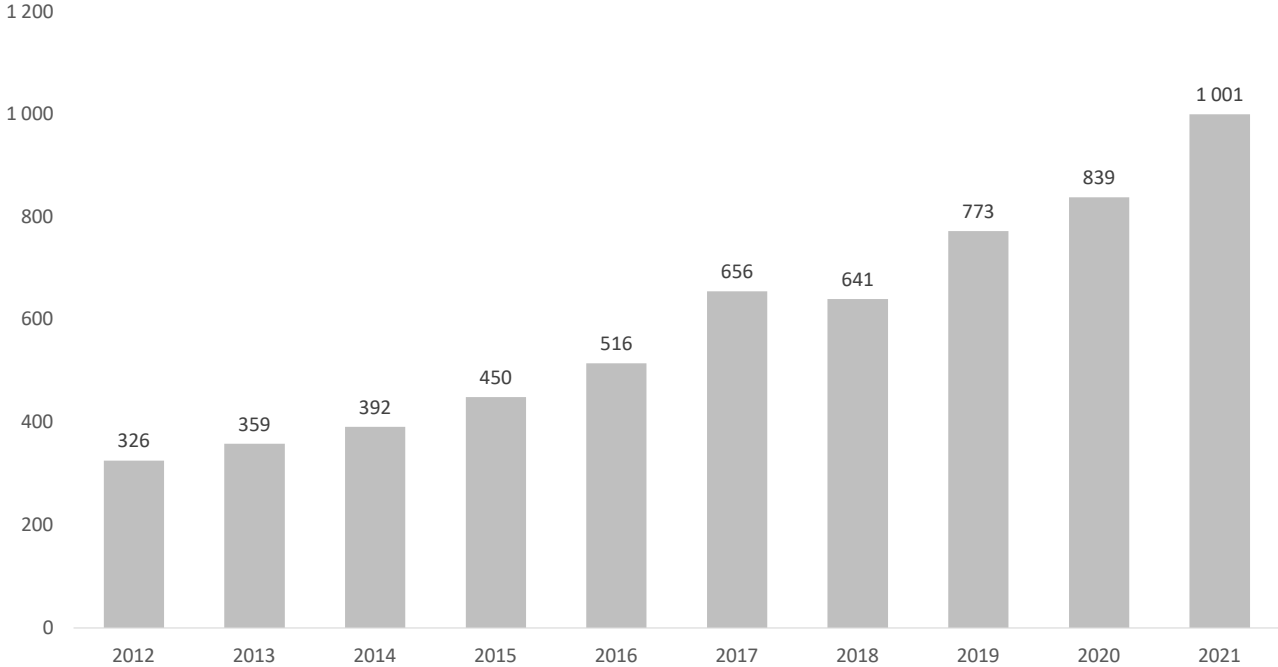
ANNEX 1 - Publications evolution of bi-regional collaborations



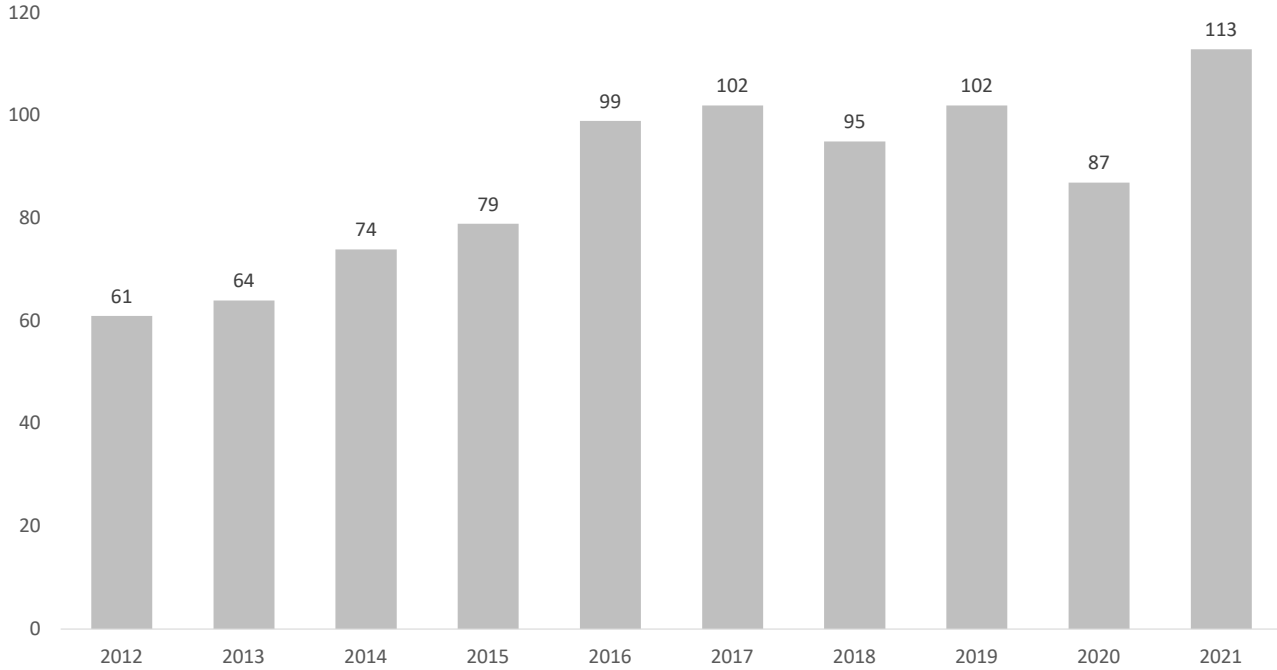
ERA - OCEANIA co-authorship evolution (no of publications)



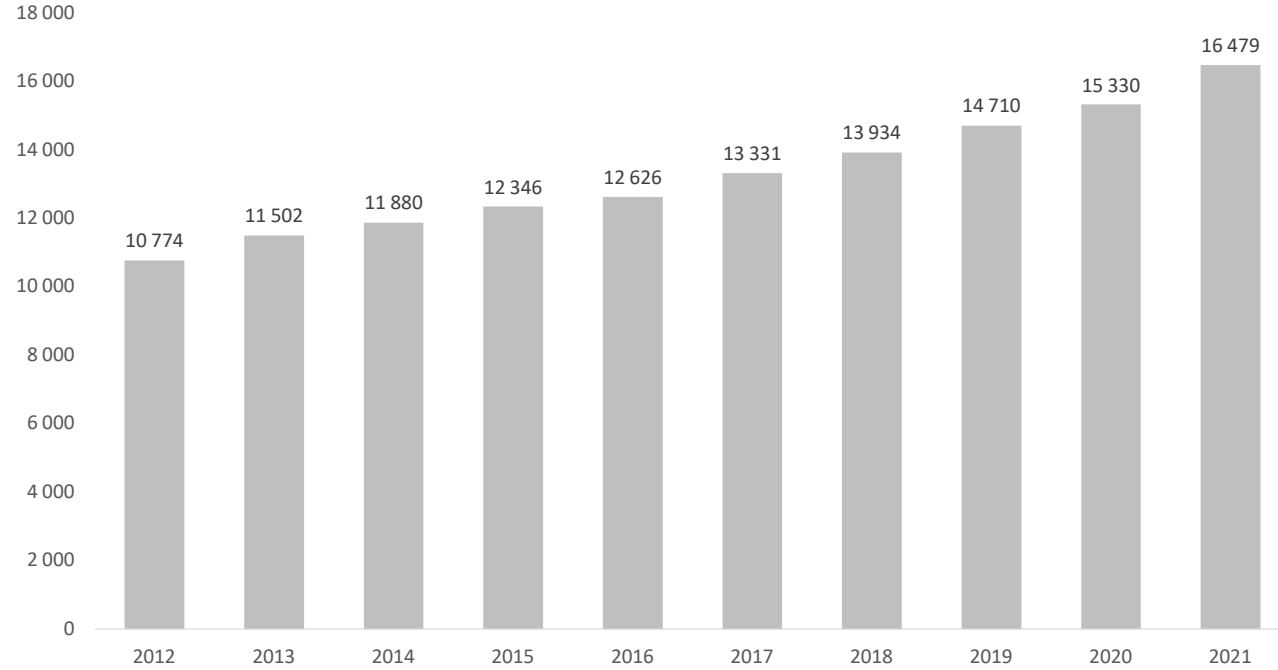
ERA - OtherEurope co-authorship evolution (no of publications)



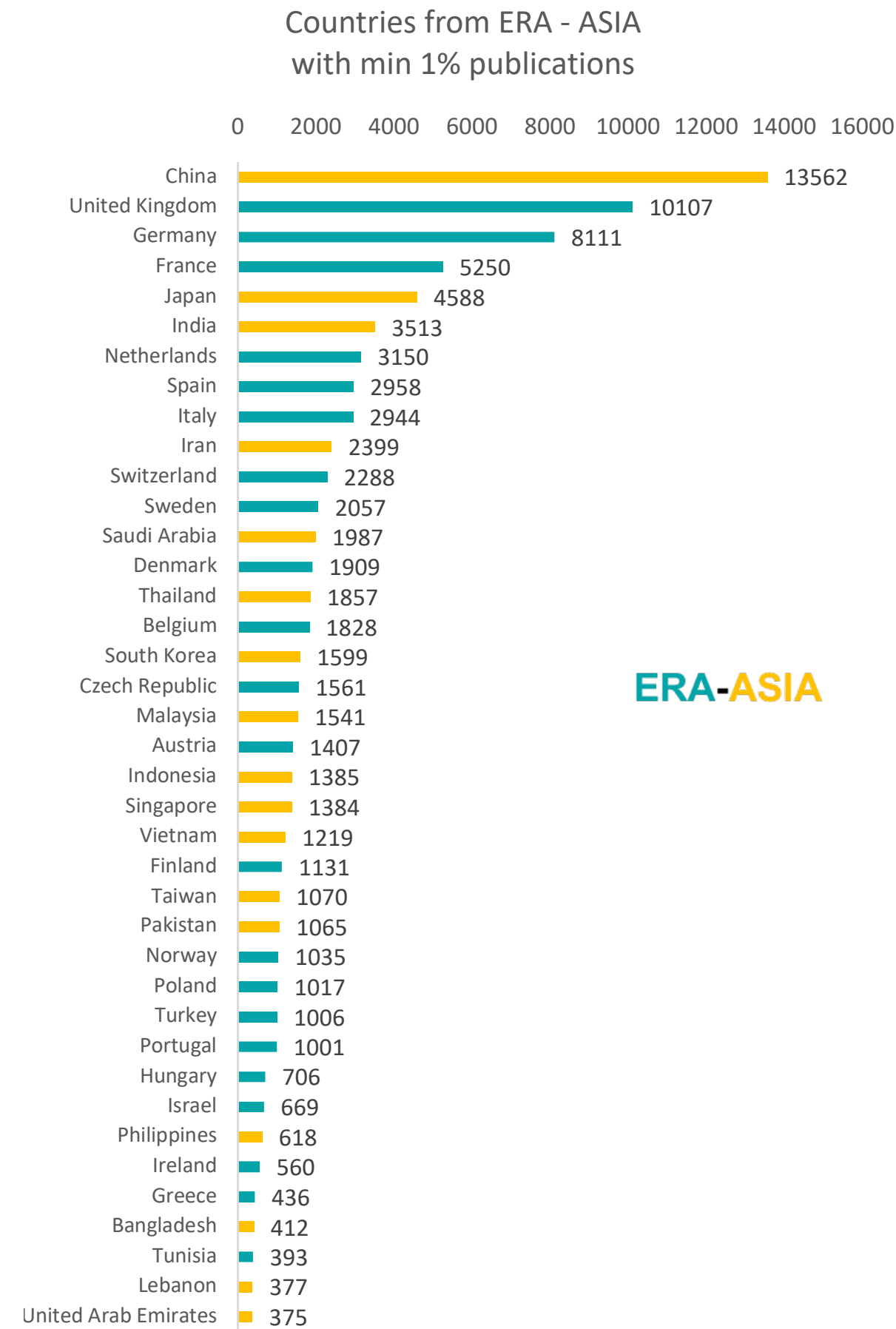
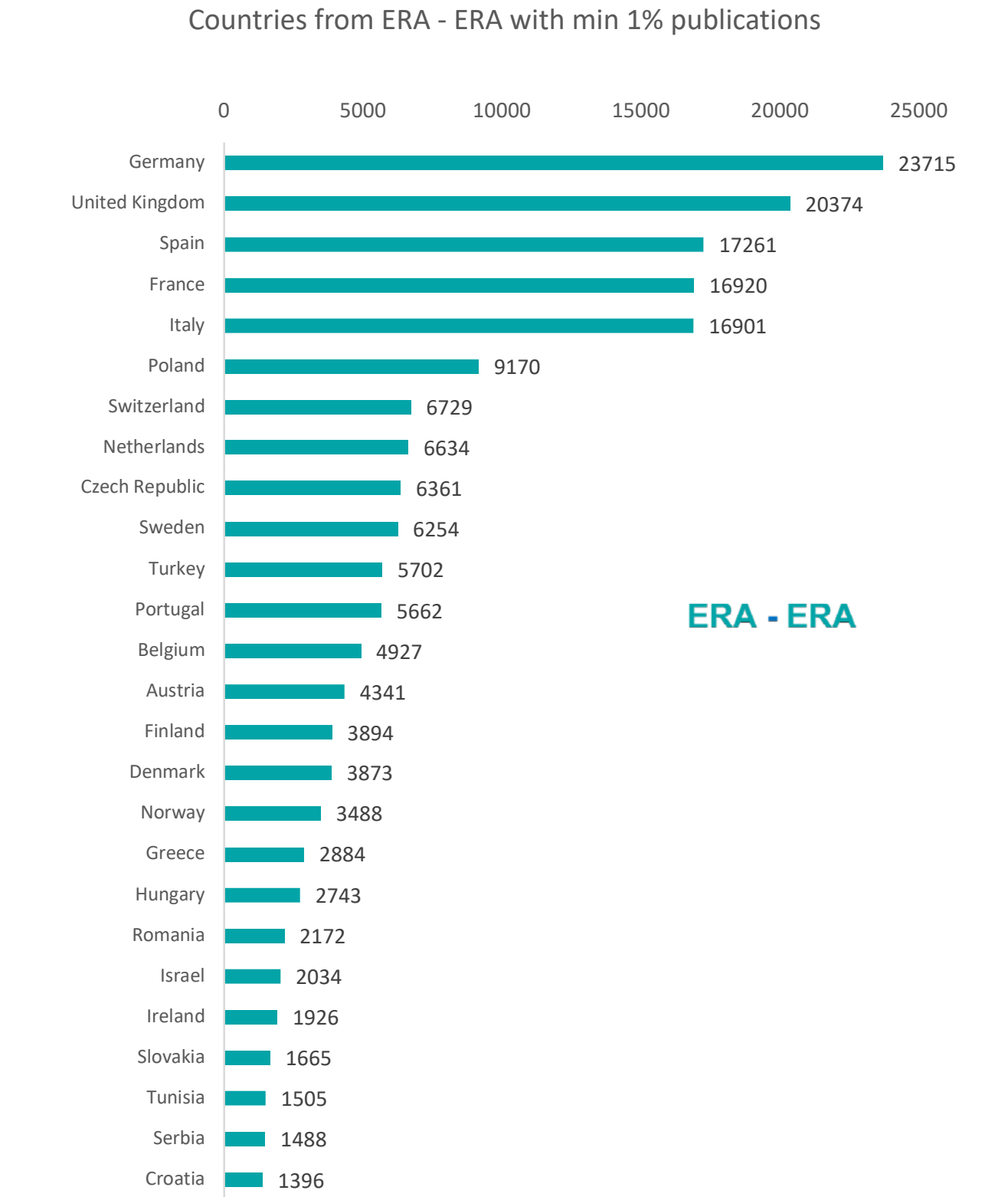
ERA - ERA-OCTs and ORs co-authorship evolution (no of publications)

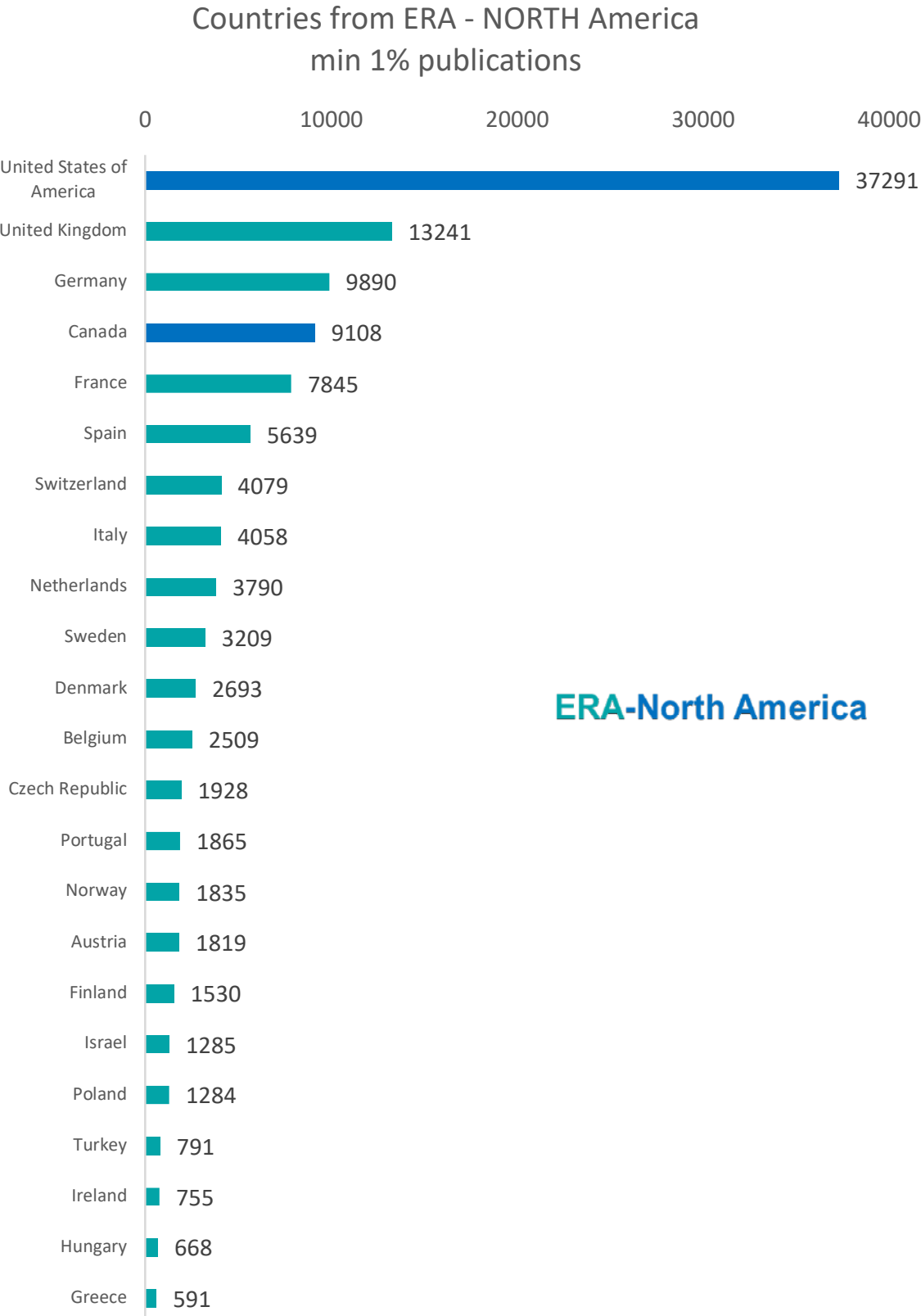


ERA - ERA co-authorship evolution (no of publications)

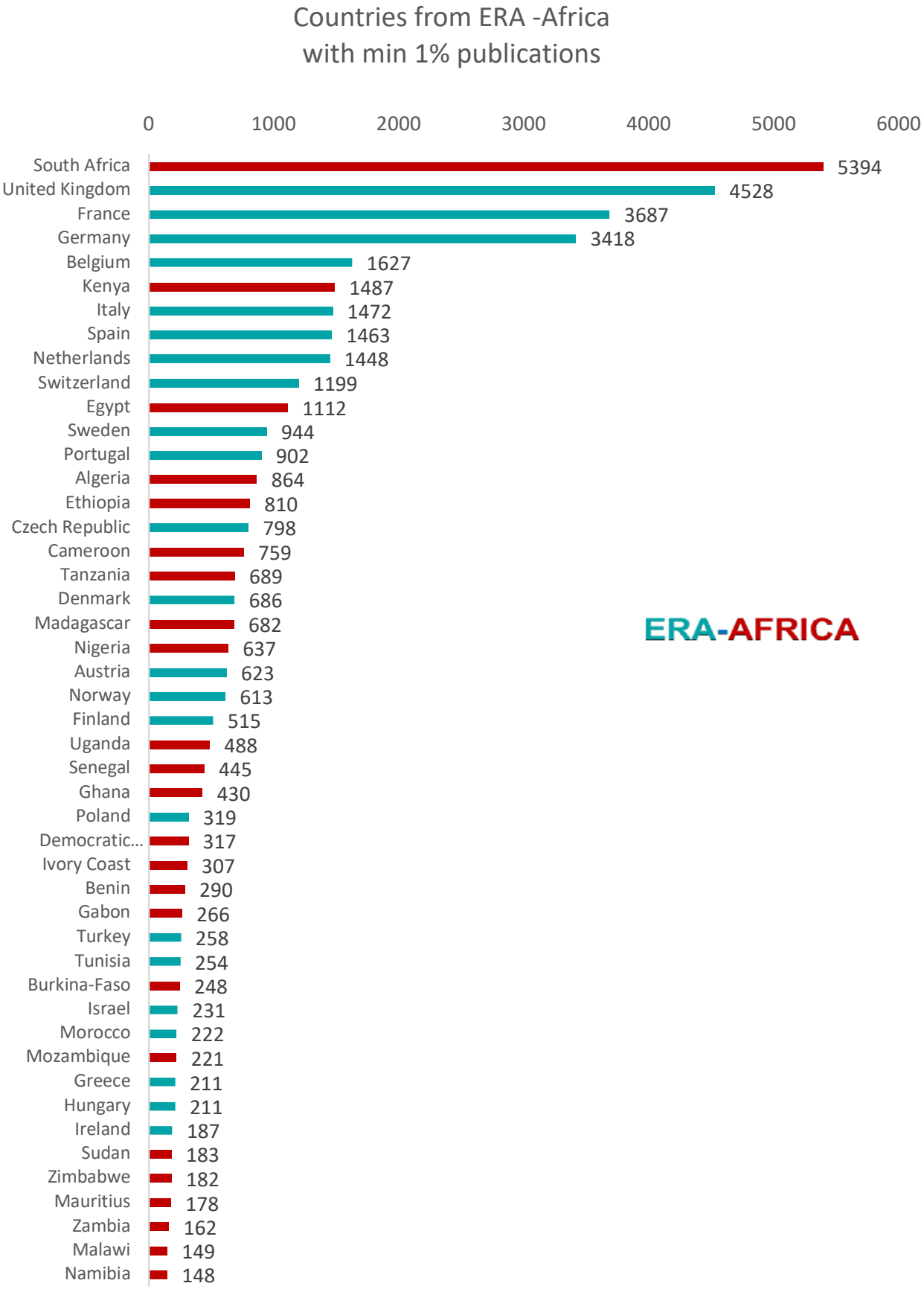


ANNEX 2 - Main countries involved in bi-regional collaborations



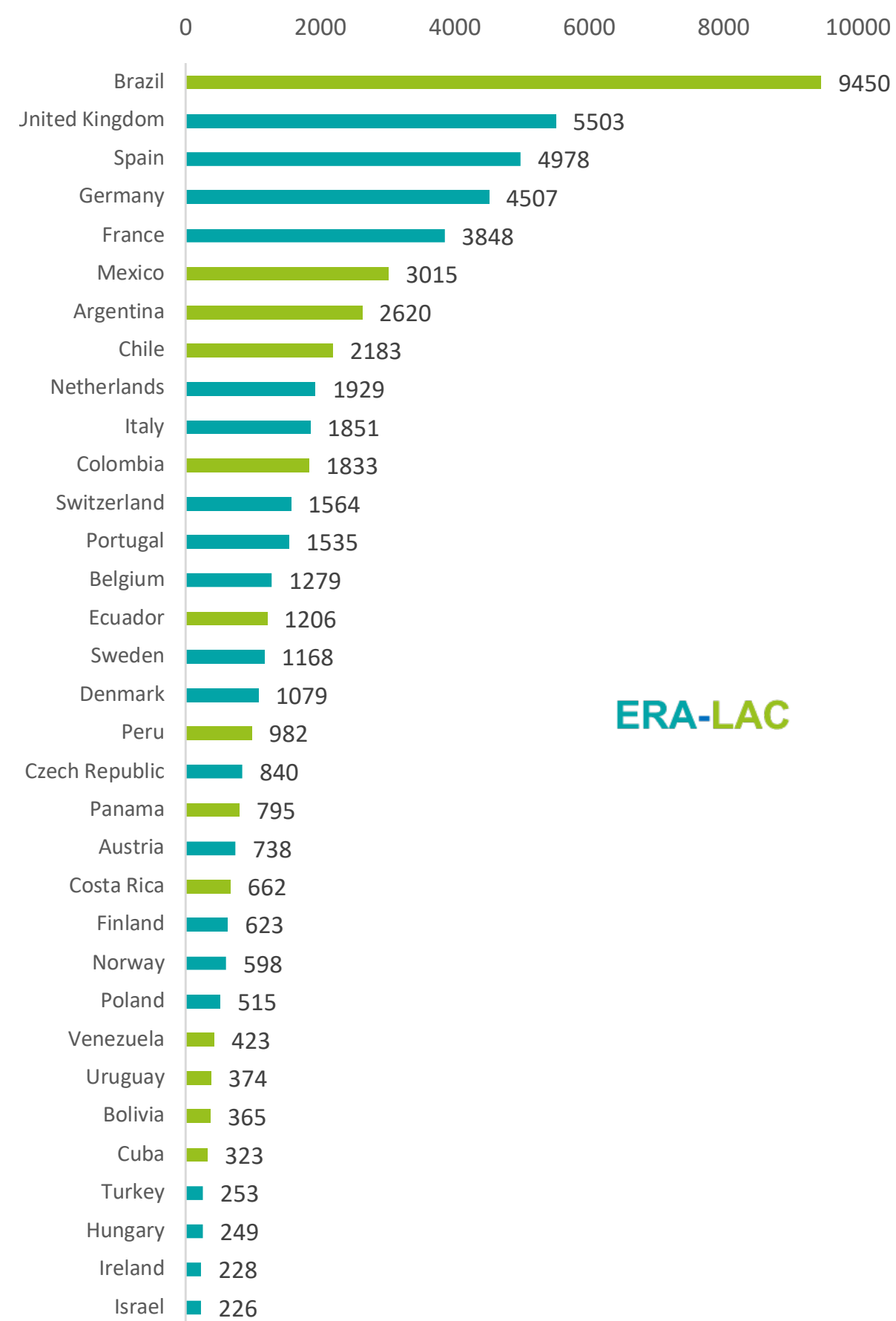


ERA-North America



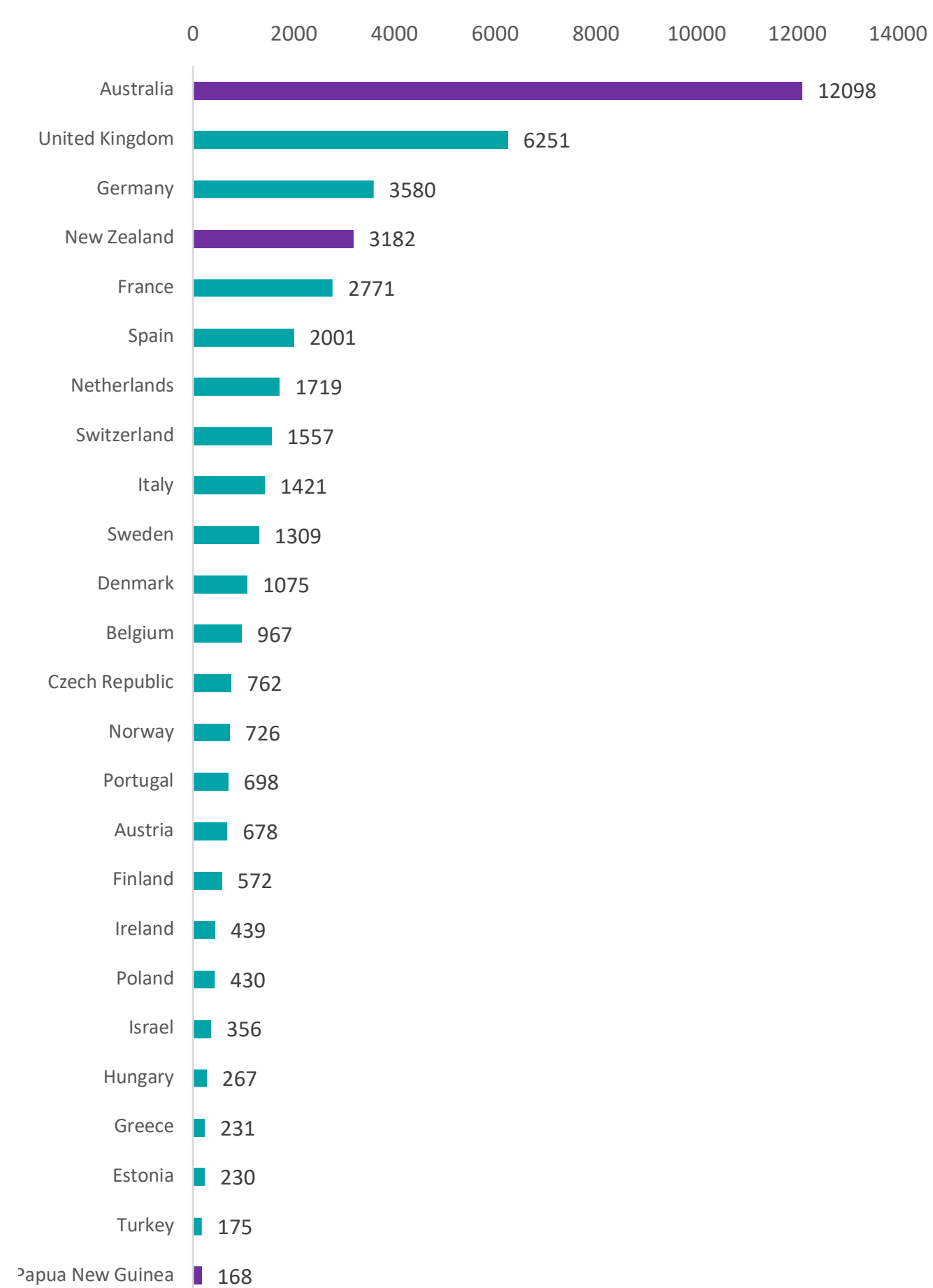
ERA-AFRICA

Countries from ERA - LAC
with min 1% publications



ERA-LAC

Countries from ERA - Oceania
with min 1% publications

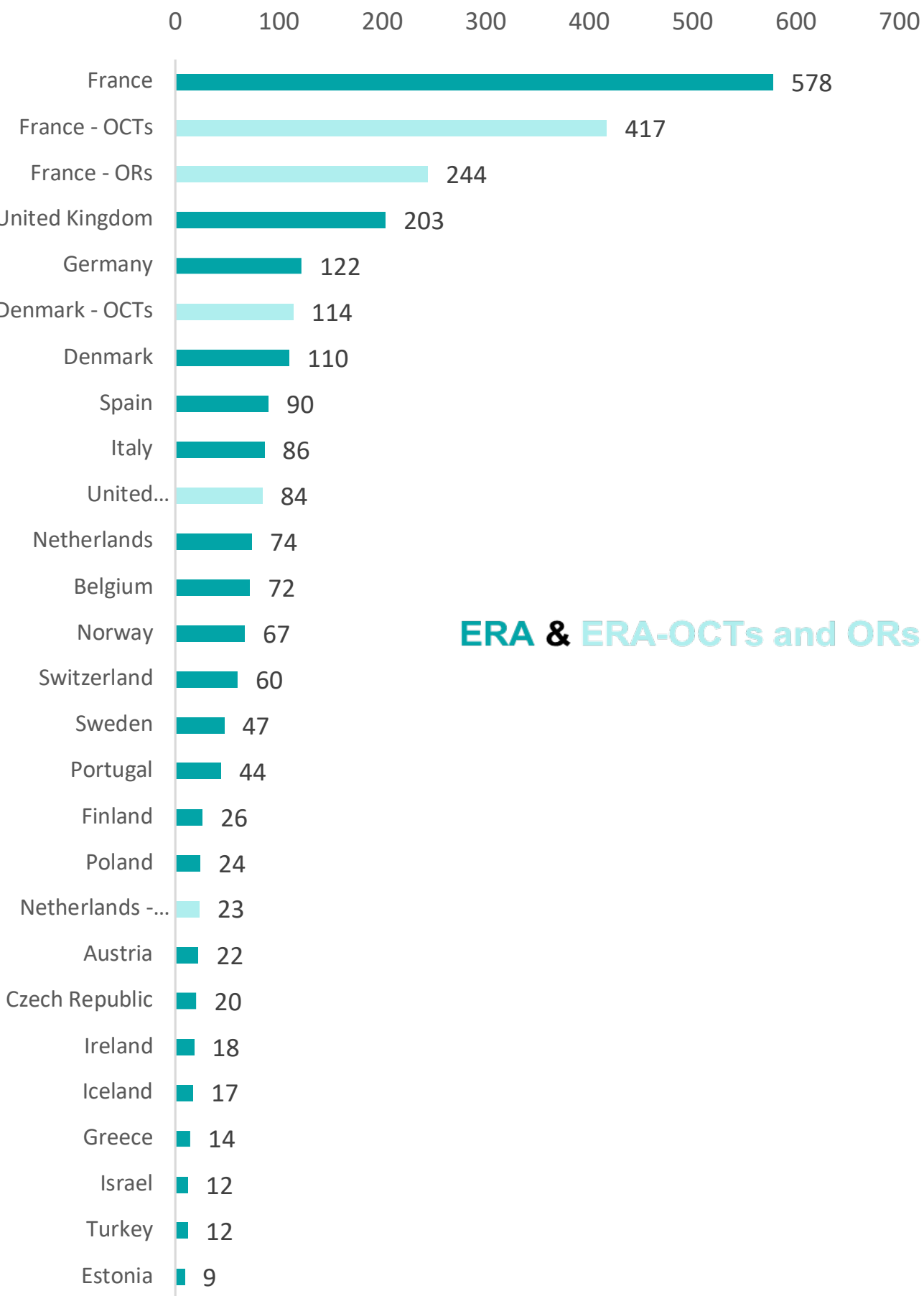


Countries from ERA - Other Europe
with min 1% publications



ERA-OtherEurope

Countries from ERA - ERA OCTs and ORs
with min 1% publications



ERA & ERA-OCTs and ORs

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



biodiversa+
European Biodiversity Partnership

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



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