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# Science as a Public Good: The Role of Community and Digital Technologies for Equity, Sustainability and Development in the Global South

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Knowledge generation is a recursive and community process that evolves by building on prior knowledge. The non-rivalrous and non-excludable nature of science, that allows it to be a public good, is reinforced when it takes place on the World Wide Web. Digital technologies are keystones for science to provide universal benefit and for enabling the community to collectively sustain it and lead it. Paywalls entail exclusion which affects the least resourced countries and regions. Science as a public good creates a more equitable ecosystem, particularly beneficial for the Global South. The prevailing ecosystem in the Latin American region for the communication of science has been sustained mainly with public funds and it includes non-APC Open Access journals, repositories, and infrastructures. The aim of this paper is to reflect on how information technologies, the WWW and Diamond Open Access (OA) enable science as a public good, also to explore, through the Redalyc database, the involvement of the community in the sustainability of Diamond OA journals and to find evidence on the "universality" of the benefit for authors and readers. The results show that Diamond OA journals are public goods that provide an equitable benefit for authors and readers, and that the academic community are the main sustainers of Diamond OA journals.

**Keywords:** Diamond Open Access, Science Communication, Public Good, Latin America, World Wide Web, Open Science

## Introduction

Sharing won't deplete science, on the contrary, science is advanced when it is shared. This is the principle of the Open Access (OA) movement, now under the umbrella of the Open Science (OS) framework. It is also the spirit of public goods.

However, this is not the driving force of different models to achieve Open Access and Open Science. Journal publishing, particularly in developed countries, has gone from a pay-to-read inflationary crisis to a pay-to-publish inflationary crisis, as a consequence of losing control and ownership of the publishing enterprise and let commercial publishers dominate the field.

Fortunately, this did not happen in all regions. Latin America kept scientific publication in the hands of the academy, with a model free of charges, either for reading or publishing, that is, Diamond Open Access (DOA) and funded mainly by public organizations.

Article Processing Charges (APCs), consolidated by "transformative agreements", are market concepts that operationalize the new form of commodification of scientific knowledge. APCs are regulated by private interests which are not necessarily those of the academic community and they also break the nature of science as a global public good by excluding researchers from low-income countries, such as the ones in the Global South.

The UNESCO Recommendation on Open Science includes, as a guiding principle, the collective benefit, and it states that:

As a global public good, Open Science should belong to humanity in common and benefit humanity as a whole. To this end, scientific knowledge should be openly available and its benefits universally shared. The practice of science should be inclusive, sustainable and equitable (United Nations Educational, Scientific and Cultural Organization[1].

Thus, the approach of "science as a global public good" was again introduced in the international discussion on Open Science. In 2002, the Budapest Open Access Initiative (BOAI) referred to the concept of public good in the context of Open Access to scientific knowledge[2].

As a global public good, science entails two conditions:

1) Non-rivalry. Science as a global public good is accessible by all and the usage of it does not affect the availability for others or subsequent use. The World Wide Web and digital technologies enable the non-rivalry nature of digital public goods. When someone

reads or downloads a scientific paper, for instance, it doesn't take away another's right to access it.

2) Non-excludability. Individuals should not be excluded from having access or consuming a public good. In science, paywalls, subscriptions, publication fees such as APCs are common ways to create excludability. Since Diamond Open Access does not charge readers or authors, it is non-excludable by definition.

Then, it is important to reflect on the implications and conditions for Open Access and Open Science models to be "science as global public good" compliant, particularly in the context of the Internet and information technologies. Two dimensions, among others, are worth to be examined in order to assess a public good: 1) sustainability (to secure the availability of the public good) and 2) "universality" of the benefit (to secure the non-rivalry and non-excludability conditions).

The emergence of digital technologies and the Web brought the unique opportunity to advance science with the vision of public good. The importance of technology and the need to have equitable access to it is widely accepted. In 2022, United Nations officials stressed "how rapid scientific progress can be leveraged to address pressing global challenges, as long as the technology emerging is accessible to all"[3]. (United Nations, 2022).

Funding and usage of science are also important variables to assess the sustainability and universal use of science, so as to be examined as a global public good. Yin et al. found that a field's public funding is strikingly aligned with the field's collective public use[4].

Latin America is a good illustration of prevalent public funding. The weight of the government sector in funding R&D in the region represents 56% of the total invested. On the other hand, the participation of companies is lower, being responsible for 36% of R&D funding. This is a distinctive characteristic of the countries of the Latin American region with respect to more developed countries, in which investment by the business sector exceeds that of the government. Regarding the sector of execution of resources, higher education institutions represent 42%, the government sector 26% and companies 31%[5].

This study is not focused on funding of science directly but on the publication and usage phases of the science generation and communication cycle. It is conducted based on 1) the publisher institutions as funders of journals to analyze the sustainability of publishing and 2) the usage by the community of authors and readers to assess the "universality" of the benefit that Diamond OA journals provide. The data source is a database composed of 692,173 scientific articles published in 1,581 Diamond Open Access Journals indexed in Redalyc.

## The Web and information technologies enabling digital public goods for science communication

Since its inception, the Web has revolutionized the world and changed the ways scientists communicate, collaborate and educate[6] and also how information is produced and exchanged[7].

The nature of the World Wide Web implies universality. Anyone has the possibility of accessing and contributing content on the net. This principle of universality is, for Berners-Lee (2013), close to that of decentralization and it has been critical to the Web's growth[8].

Many public goods achieve their nature by existing on the Web and because they are enabled as such by digital technologies, then they can become "digital public goods". According to the United Nations (2020), digital public goods are essential in unlocking the full potential of digital technologies and data to attain the Sustainable Development Goals, in particular, for low- and middle-income countries[9].

The Digital Public Goods Alliance created a standard with specifications and guidelines designed to identify whether a digital solution, such as Open Source software, Open AI systems, Open Data or Open Contents collections, conforms to the definition of a digital public good. This standard is composed of the following nine indicators: relevance to Sustainable Development Goals, use of approved open licenses, clear ownership, platform independence, documentation, mechanism for extracting data, adherence to privacy and applicable laws, adherence to standards and best practices and do no harm by design[10].

The non-commercial ecosystem for scholarly and scientific communication, which includes, Diamond OA journals and the articles published in them, Open Infrastructures, repositories, Open Content and Open Data shared in Diamond OA journals or archived in repositories, Open Source software or Open AI that contributes to sustain this ecosystem could be considered public goods. It is important for all those components to be examined with criteria for digital public goods to identify areas of opportunity to achieve that condition.

In 2002, the Budapest Open Access Initiative highlighted the role of the Internet to achieve a public good in the context of science and research.

“An old tradition and a new technology have converged to make possible an unprecedented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment. The new technology is the internet. The public good they make possible is the world-wide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students, and other curious minds.”

The Web and the network paradigm together with the emergence of social media of Web 2.0 has facilitated the democratization in the contribution and access to information, which has allowed the construction of a participatory space. Which, in turn, has been enriched by the technologies of the semantic and ubiquitous Web.

However, not only the Web as a space where people interact and share, but also many other technological developments have an impact on enabling journals and infrastructures as digital public goods.

Such is the case of technologies for adding structure and semantics to metadata and full texts of scientific articles or Artificial Intelligence to model openly available information. Those are developments that not only contribute to the innovation and improvement of information retrieval but also to visibility and impact of the scientific content (the outreach of journals as public goods). They also help to automate editorial digital workflows, with a positive impact in lowering the costs of production of digital journals, that is, technology contributes to the sustainability of journals as public goods as well.

## Community-owned, -sustained and -led science communication

Boulton (2021) highlighted that “the concept of public goods assumes that citizens stand in a relationship with one another which encourages them to create and maintain facilities or arrangements on the grounds that they serve common interests and produce public value, from which many individually benefit”[11].

In its twentieth anniversary the BOAI published a set of recommendations in which the harms caused by commercial strategies to achieve Open Access were acknowledged, such as proprietary infrastructure and commercial control of research access, commercial control of research assessment indicators, journal-based research metrics, journal rankings, journal business models that exclude authors on economic grounds, embargoes, and publisher exclusive rights. Also, the recommendations underlined the need to favor open infrastructure, academic or nonprofit control of research access and assessment indicators, policies to ensure non embargoed OA, inclusive journal business models, and fundamental changes to research culture[12].

The role of community in the sustainability, ownership and leadership of science communication is essential to create, sustain, develop, and preserve science communication components as public goods. The responsibility of building open infrastructure, sustaining journals and repositories as digital public goods rely on the community of research institutions, universities, public and non-profit organizations.

In this way, developing countries would gain autonomy in the generation and circulation of knowledge, and most importantly, they would get independence from the market where their communities are rather excluded or patronized. This would allow countries of the Global South to invest in owned and sustainable infrastructure and take control of the publishing and Open Science endeavors.

Such is the case of Latin America, whose scientific publication sector remained outside the commercial circuits, due to different circumstances, including the lack of economic resources to access commercial scientific publications. This led the region to develop a scientific publishing sector anchored to universities and academic organizations, mainly supported by public resources, with great solidity, particularly for the areas of Social Sciences and Humanities.

The ecosystem in Latin America encompasses a bit more than 14,000 journals online, out of which 3,569 have met the criteria of Latindex Catalog 2.0. Also, several platforms and infrastructures have emerged in the region as key digital components in the communication of science. Latindex[1] Redalyc[2], Scielo[3], CLACSO[4], AmeliCA[5], LaReferencia[6], as well as hundreds of journal portals at institutional and country levels, disciplinary and institutional repositories, and repository networks are part of the regional infrastructure.

Latindex is a network of 24 institutions that operate in a coordinated manner to gather and disseminate information on scientific journals produced in the region. It offers two main services in Open Access: 1) Directory, with bibliographic and contact information of journals and 2) Catálogo 2.0, made up of online journals that meet the Latindex quality criteria.

Redalyc, based on the Autonomous University of the State of Mexico, holds a collection of 1,581 Diamond OA journals from 756 institutions from 31 countries and it hosts more than 800 thousand full-text scientific articles in various formats including machine readable data and semantic knowledge bases.

Although Redalyc emerged as a Latin American platform, in 2018 it expanded the geographical scope and now it indexes exclusively OA journals that do not charge authors (Diamond Open Access journals) and meet the Redalyc quality and editorial criteria. It provides services for evaluation of journal quality, XML JATS markup, and automatic generation of ePUB, HTML and PDF formats for journal articles, full-text hosting and information retrieval search engines. It also provides micro-sites for institutions, authors, countries, journals and disciplines, interoperability and discovery services, metrics of usage, co-authorship and publication, as well as integration with Linked Open Data.

Scielo works in a decentralized model with country-level platforms in charge of indexing the journals published in the country and hosting full-text articles. LaReferencia aggregates 12 country-level nodes of repositories indexing more than 5 million documents.

Regarding AmeliCA, this initiative supported by UNESCO and led by Redalyc and CLACSO aims to articulate the dialogue with different actors in order to strengthen the recognition and sustainability of Diamond OA publishing and non-commercial Open Science.

This study will delve into the nature of the organizations that sustain Diamond OA journals in Latin America based on the Redalyc data, and the use by authors and readers.

### Objectives of the study

- To better understand the role of information technologies, the WWW and Diamond Open Access in enabling science as a public good.
- To examine the role of the community in the sustainability of Diamond Open Access journals.
- To examine the "universality" in the benefit provided by Diamond Open Access Journals for authors and readers.

## Methodology

### Data source

The database of Redalyc was consulted for screening of articles of the current study. The resultant dataset for the analysis is composed of 692,173 articles published in 1,581 Diamond OA journals. The journals are published by 756 institutions from 31 countries. The journal collection includes publications of 39 fields of science (Table 1).

Table 1 — Journals by discipline

| Discipline | Number of journals | Discipline | Number of journals |
|---|---|---|---|
| Social Sciences | | Sciences | |
| Accounting and Management | 89 | Agriculture | 59 |
| Anthropology | 35 | Biology | 39 |
| Information Science | 19 | Earth Sciences | 26 |
| Communication | 34 | Computational Sciences | 8 |
| Demography | 6 | Physics, Astronomy and Mathematics | 9 |
| Law | 54 | Geology | 3 |
| Economics and Finance | 57 | Engineering | 76 |
| Education | 151 | Mathematics | 3 |
| Agricultural Sciences | 7 | Medicine | 132 |
| Environmental Sciences | 9 | Multidisciplinary (Sciences) | 20 |
| Cultural Studies | 18 | Chemistry | 15 |
| Tourism | 11 | Veterinary | 19 |
| Territorial Studies | 31 | Total Sciences | 409 |
| Social Geography | 13 | Arts and Humanities | |
| Multidisciplinary (Social Sciences) | 125 | Architecture | 13 |
| Politics | 39 | Arts | 23 |
| Psychology | 107 | Philosophy | 41 |
| International Relations | 13 | History | 68 |
| Health | 59 | Language and Literature | 71 |
| Sociology | 65 | Theology | 1 |
| Total Social Sciences | 942 | Total Arts and Humanities | 217 |
| Multidisciplinary (Social Sciences and Humanities) | 13 | | |

The metadata is in Dublin Core format and the dataset include publisher institution, author affiliation, journal name, journal eISSN, publisher country, author institution, author country, sectoral category of publisher institution, sectoral category of author institution, legal nature of publisher institution and legal nature of author institution.

The data from author affiliations have been normalized, in order to associate the name of the institutions to unique names and IDs, also to include the institutions of lower levels within major institutions. This process has been done automatically with an algorithm that matches similarities in names combined with other metadata such as country, and the result has been supervised by people in Redalyc. The same process has been done for the publisher institutions of journals.

For this study, author names disambiguation was not necessary. Then, each author record is called an author form which includes the following metadata: name, last name and affiliation. The total number of author forms of the dataset is 1,788,539, with 40,764 affiliation institutions from 182 countries.

## Method

The scientific output, published in the journals' collection, is analyzed based on the methodology for assessing science in Diamond Open Access[13], which proposes a framework to characterize the way scientific communities generate knowledge and in which journals they publish it. As a result, a diversity of cartographies of scientific communication are drawn to show different dynamics of scholarly publishing, scientific collaboration and readership of research published in Diamond OA journals.

The current study uses statistical analysis of institutions, journals, authors, and readers in order to gain insights into the sustainability of journals, as means of communication of science, and the outreach of the service they provide for authors and readers.

The analysis is based on indicators of the following two dimensions of science communication:

1) **Publishing**. It refers to the dynamics of communication of scientific knowledge through the identification of publishing flows. For this purpose, two variables are considered: a. The provenance of authors is examined by extracting both institutions and countries from author affiliations, b. The institutions and countries where the journals are published. Finally, flows between institutions and countries are identified based on the origin of authors and journals.

2) **Collaboration and outreach**. It aims to identify the patterns of co-authorship and the geographical distribution of authors, to find out the universality of the contribution that Open Access journals provide, as far as the journals' community of authors concern, and in the use by the diversification of the reading community.

The method for calculating the frequencies of authorship for two or more co-authors on a paper when disaggregated by country or institution count as one paper for each author form for the country or institution which is affiliated with.

The analysis of usage in terms of users and backlinks was done with the external service Semrush and the user queries with Google tools.

## Analysis

### Collective sustainability of Diamond Open Access Journals

As discussed in previous sections, the responsibility in the sustainability of a public good relies on the community as a collective endeavor. What follows is an account of who sustains Diamond OA journals, which organizations, sectors and the nature of the resources used for that purpose.

Even though Redalyc currently indexes journals from all over the world, the analysis presented in this section is based on the case of Latin America and the Caribbean. This is because this region is better represented in Redalyc due to its geographical base and because at the beginning of this platform Redalyc used to index only journals from this region.

The set of 1,581 journals was filtered to retrieve only the ones published in a country of Latin America and the Caribbean. The resultant dataset includes 1,327 journals. It is important to note that also starting in 2018, Redalyc hardened its journal indexing criteria regarding the nature of publishing institutions, prioritizing the academic, public, and non-profit sector, due to the proliferation of predatory journals by commercial publishers with questionable practices.

The results are presented in the form of a quadruple helix representation (Fig. 1). The participation of different sectors as journal publishers shows that 93% of the total number of journals are published by academic institutions, 4.1% are sustained by governmental organizations and 0.8% by the health sector, such as hospitals or medical institutions. As it can be anticipated, only 2.1% of journals are published by the private sector.

Within the academic sector, the participation of universities is very strong (Fig. 2), they publish 993 journals (74.8%), followed by academic associations with 182 journals (13.7%), research centers publish 33 (2.5%) journals and colleges 26 (2%). In the private sector, foundations (18 journals), commercial publishers (0.3%), non-profit publishers (0.3%) and businesses or other companies (0.2%) were considered.

It is important to consider that Redalyc does not index journals from commercial publishers or companies; however, journals' context is dynamic, for example, some journals can be purchased by commercial publishers or the nature of the publishing organization changes. For this reason, regular re-evaluation periods are carried out to detect and, where appropriate, discard journals. This explains the minimal participation of commercial publishers in this analysis.

It is worth noting that since the sustainability of journals is strongly dependent on the academic sector, then the composition and nature of the higher education systems in the countries are reflected in the results.

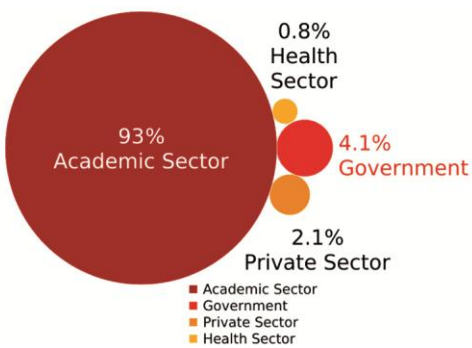


Fig. 1 — Quadruple helix chart of publisher institutions of Diamond OA journals (source: Redalyc)

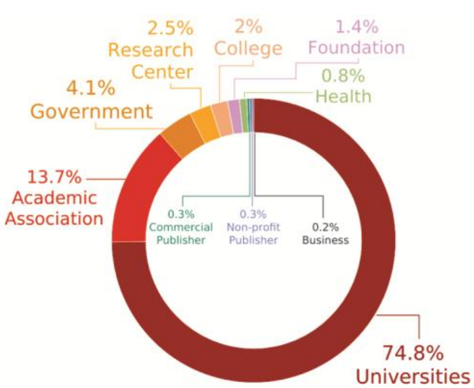


Fig. 2 — Diamond OA journals' publisher institutions by sectoral classification (source: Redalyc)

In Figure 3 the proportion of public institutions compared to private and non-profit organizations can be seen. What stands out in the chart is that most journals (907 journals) are published by public institutions (68.3%) while private organizations publish 31% of journals.

A breakdown of the sectoral classification of publisher institutions by country (Top 12) shows that some of them such as Ecuador, Colombia or Costa Rica rely very strongly on universities as journal publishers while for Uruguay, Argentina, Brazil, Perú and Mexico the participation of academic associations as publishers is notable. In contrast, Cuba has a more diversified participation of different sectors in journal publishing and an important contribution from the governmental and health sectors can be observed in the country. (Fig. 4)

In terms of the nature of the organizations that publish journals, a closer inspection by country (Fig. 5) confirms that public institutions are the main sustainers of journals in the majority of the Latin American and the Caribbean countries except from the cases of Chile, Peru, and Colombia where the participation of private institutions of higher education and research is strong.

Another significant aspect of the sustainability of Diamond OA journals is the contribution of platforms and infrastructures to them. They provide services that complement the journals' own capabilities and add value, in terms of visibility, quality or metrics.

As it was previously mentioned, in Latin America, an ecosystem of journals, platforms and

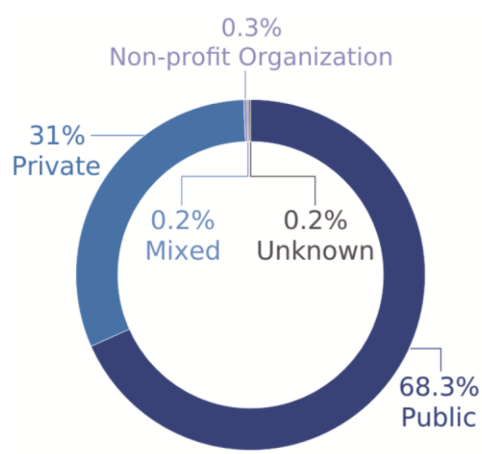


Fig. 3 — Diamond OA journals' publisher institutions by legal nature (source: Redalyc)

infrastructures has been organically created, which share the sustainability of journals in various ways. Such is the case of Redalyc, an infrastructure that, in addition to indexing, quality improvement and discovery services, provides tools for editorial workflow (Fig. 6). In that sense, it is important to examine the sustainability of platforms and infrastructures as well.

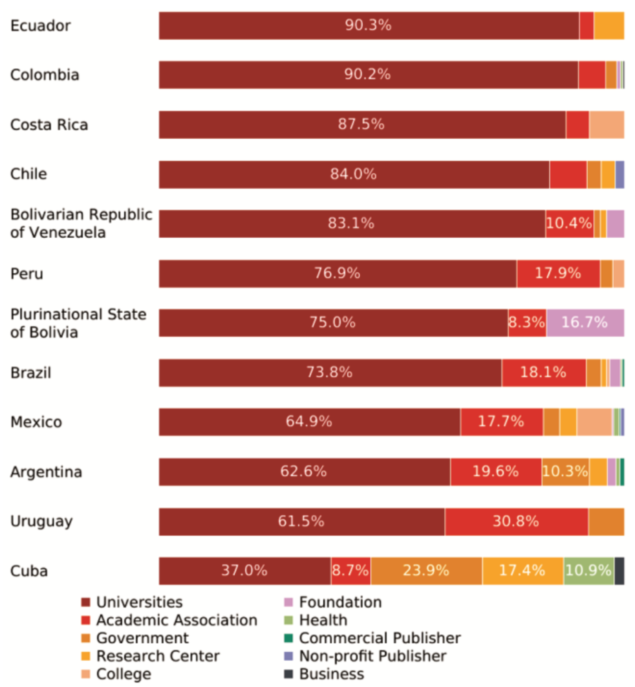


Fig. 4 — Sectoral classification of diamond OA journals' publishers. Breakdown by country (top 12 countries) (source: Redalyc)

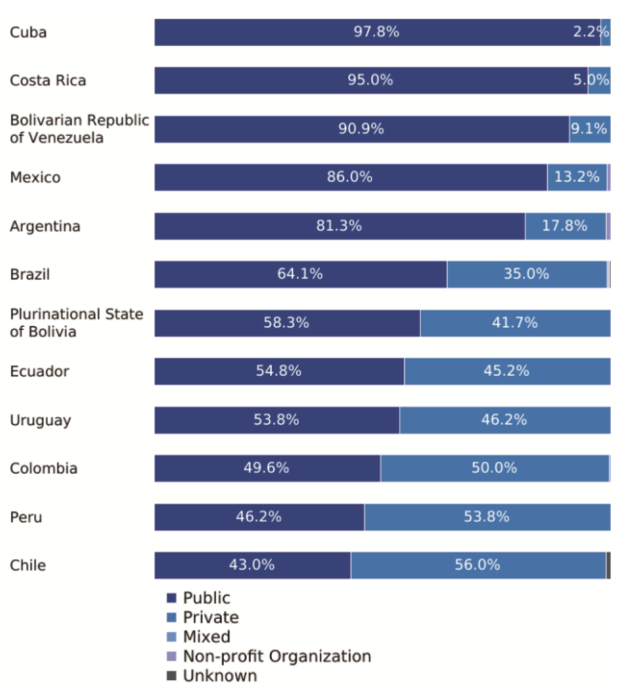


Fig. 5 — Nature of diamond OA journals' publishers. Breakdown by country (source: Redalyc)

Redalyc, for example, is supported by the Autonomous University of the State of Mexico (UAEMex), which is a public university. It is also supported by contributions from dozens of universities from countries such as Australia, Belgium, Canada, Denmark, France, the United States and Switzerland, among others.

It is not the aim of this study to examine the sustainability of infrastructures. However, it is important to notice that not only Redalyc is based and sustained by a public entity, but it is also the case of Latindex, sustained by the National Autonomous University of Mexico (UNAM) and various platforms of Scielo based on governmental organizations in different countries.

## Diamond OA journals as digital public goods for equitable participation of authors

A scientific journal is a formal vehicle of communication of science, a means par excellence of scientific knowledge validation and a public community builder of authors and readers. When a journal is open and free of APCs, it enables a non-excludable and non-rivalrous good for authors and readers.

As can be seen from the map in Figure 7, journals indexed by Redalyc are mainly based in the Latin American region. This is because, from 2002 to 2018, Redalyc only indexed journals from Ibero America. However, as of 2019 Redalyc started to index journals from all over the world, if they pass the selection criteria, in which the non-APC condition of a journal is one of the mandatory elements.

It has commonly been assumed that journals are rather "mainstream" or "peripheral / regional". The former term is basically used to denote a journal indexed in commercial databases, and the latter to indicate that a journal is outside commercial circuits of dissemination of science. However, the evidence from this study suggests that journals' reach depends on to what extent journals succeed in building trust around a quality and effective device for keeping the scientific conversation around a field going. An effect that is maximized when it is published in immediate non-APC Open Access.

Although Redalyc's geographical coverage is greater for the Latin American region, the following charts shows that Diamond OA journals have a global

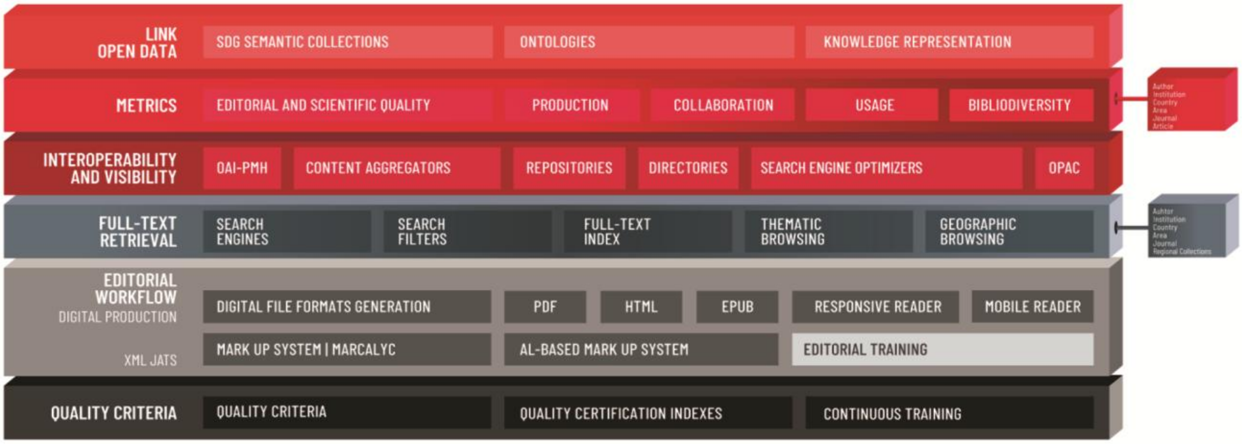


Fig. 6 — Redalyc services


Fig. 7 — Redalyc journals by country

outreach, generally limited by area of knowledge, for the case of authors, and unrestricted for the case of readers.

The results show that the collection of 1,581 journals published in 31 countries received articles written by authors from 182 countries. Thus, in this case 182 countries are benefiting from the investment of 17% of those countries (countries which sustain the journals). The following map shows this interaction between authors (red dots) and countries of publication (blue dots). (Fig. 8)

It is worth noting that Diamond OA journals provide an inherent universal service, in this case for authors, but as it will be shown in the next section, also for readers.

Closer analysis of the flow of articles from countries of authors to countries of publication can be seen in the left column of Figure 9. In terms of author forms, from the analyzed dataset, Brazil concentrates 33.48% out of the total, i.e. 598,838, Mexico 14.65% (262,018), Colombia 10.54% (188,513) and Spain 9.87% (176,586). Interestingly, the United States and France are the countries outside the Ibero American region with more author forms recorded in Redalyc journals.

The weight of countries as publishers of journals is also shown in the right column of Figure 9. The journals published in Brazil concentrate 30.53% of the total number of papers of the study (211,322), Mexican journals publish 16.34% (113,087 papers) and the Colombian ones 14.54% (100,658 papers).

Fig. 8 — Map of countries of authors (red dots) and countries of publication (blue dots) in Diamond Open Access journals indexed by Redalyc.

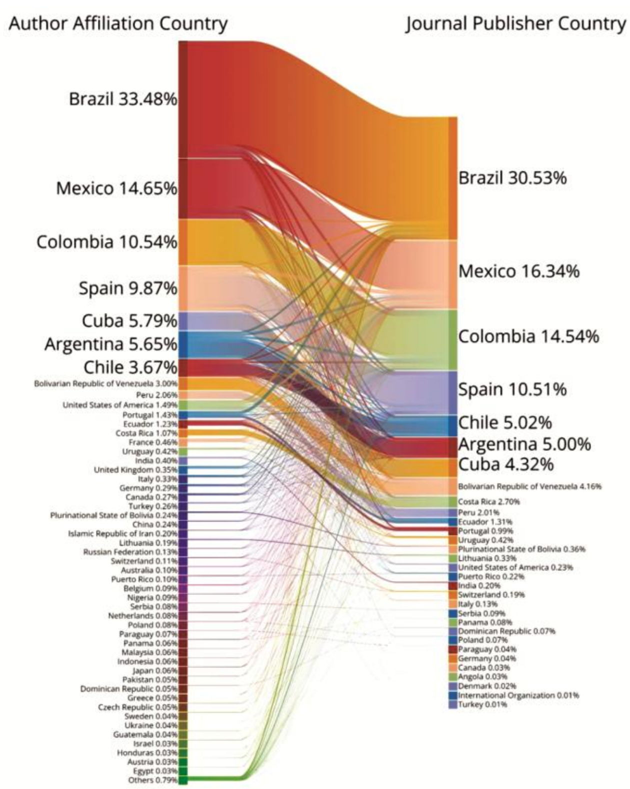


Fig. 9 — Flow of articles between author affiliation countries and countries of journals publishers

The flows between countries of authors and countries of publications are also set out in Figure 9. High rates of domestic publication (papers published in the same country of the author affiliation) are present in various countries.

Authors from Brazilian institutions published 186,557 articles in Brazilian journals, 4,793 in journals from Colombia, 3,891 in journals from Spain and 3,060 articles in Mexican journals, just to mention some of the flows.

Similarly, authors based in Mexican institutions published 84,300 articles in Mexican journals, 6,198 in journals from Colombia and 3,137 in journals from Spain.

The domestic publishing behavior cannot be detected for countries with low numbers of indexed journals in Redalyc. However, what is interesting about the data in the flowchart of Figure 9 for those countries is that their authors still receive the benefit (non-APC publishing) from the investment of other countries that sustain journals.

For example, the authors coming from institutions of the United States of America published 4,557 articles in Mexican journals, 3,559 articles in Brazilian journals and 2,705 in journals from Colombia. Likewise, authors based in France published 2,075 articles in Brazilian journals, 1,270 in Mexican journals and 812 in journals from Colombia.

Turning now to statistical analysis by institutions, it is worth noting that, likewise countries, there are two roles for each institution, as an author institution or as a publisher.

As shown in the left column of Figure 10, the University of Sao Paulo from Brazil is the institution with more author forms (2.74% of the total, 48,932 author forms), followed by the National Autonomous University of Mexico with 40,758 author forms (2.28%) and the National University of Colombia with 26,148 (1.46%).

These institutions also lead the list of top publisher institutions, although in different order. The journals

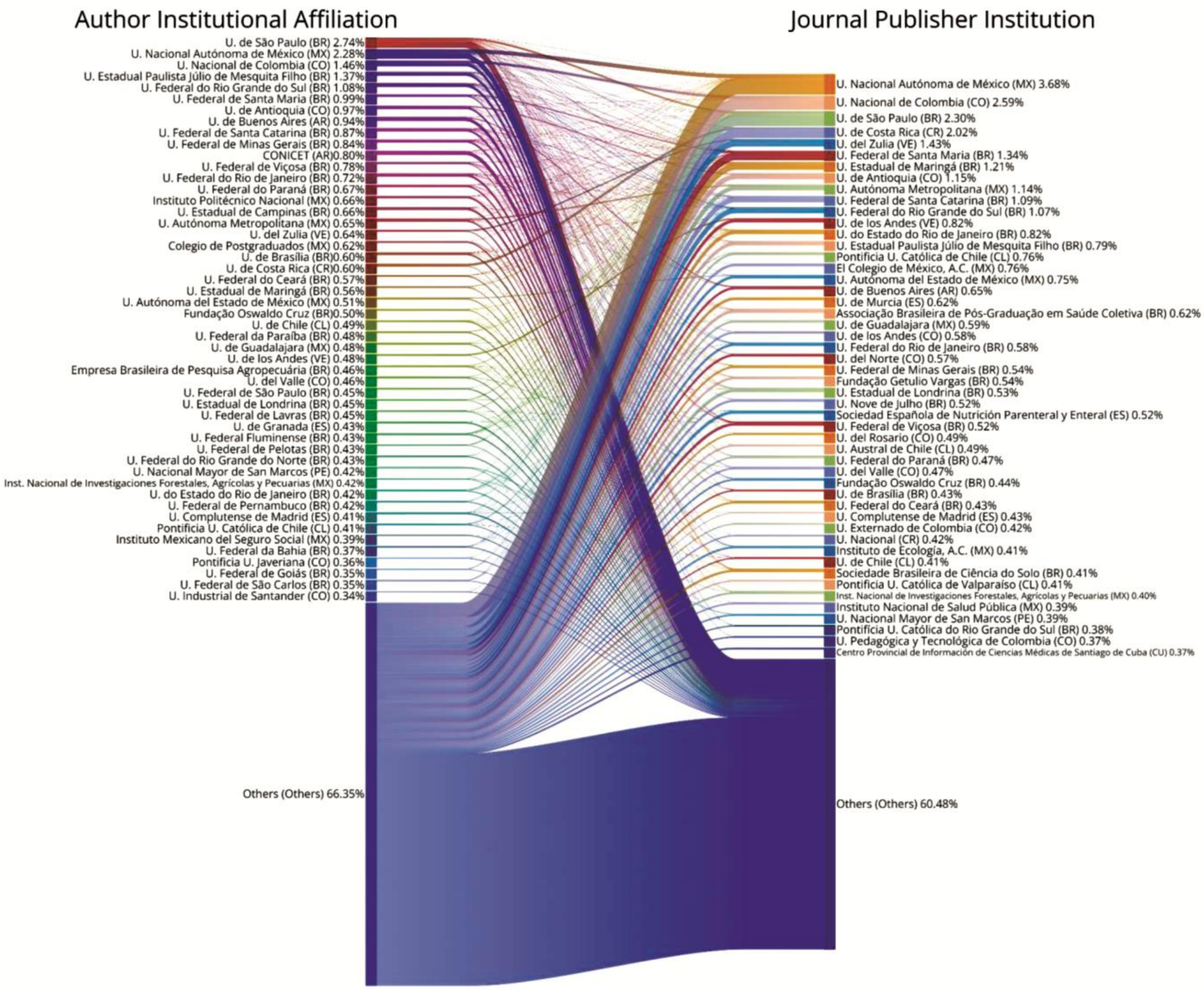


Fig. 10 — Flow between author institutional affiliations and institutions of journals publishers

sustained by the National Autonomous University of Mexico published 25,441 articles (3.68% out of the total), 17,914 articles are published in journals from the National University of Colombia (2.59%) and 15,948 articles are published in journals from the University of Sao Paulo in Brazil (2.3%).

## Diamond OA journals as digital public goods for readers

The usage of digital scientific content can be assessed in various ways. For the purpose of the current analysis, users' geographic provenance, categories of referring domains, and top user queries are examined.

Turning now to the evidence on users who access or download articles from Redalyc, it can be seen from Figure 11 that the users are widely distributed across multiple countries.

Redalyc reached 0.9 million monthly users in 2024. 68.08% out of which are female according to the information available in Semrush[1]. Demographics of users also show that users ranging from 25 to 34 years old are the most frequent users in Redalyc (Fig. 12).

Turning now to the analysis of backlinks to find out the incoming hyperlinks from other websites to Redalyc, the results show that there are 8 million backlinks to redalyc.org coming from 47,100 referring domains (consultation date: May 30, 2024). Considering that a backlink is a reference comparable to a citation, this analysis shows to what extent other websites trust on the content available in Redalyc for linking them.

Table 2 — Top categories of referring domains for Redalyc.org (source Semrush)

| Categories of Referring Domains | Total of backlinks |
|---|---|
| Jobs & Education > Education > Standardized & Admissions Tests | 4.1K |
| Jobs & Education > Education > Distance Learning | 3.9K |
| Jobs & Education > Education > Colleges & Universities | 3.2K |
| Jobs & Education > Education > Study Abroad | 2.8K |
| Jobs & Education > Education > Vocational & Continuing Education | 2.8K |

Table 3 — Top countries of referring domains for Redalyc.org (source Semrush)

| Country | Referring Domains |
|---|---|
| United States of America | 26,506 |
| Germany | 1,897 |
| France | 1,509 |
| Spain | 1,480 |
| Brazil | 784 |
| Russian Federation | 716 |

Fig. 11 — Geographical distribution of user downloads of articles published in journals indexed by Redalyc

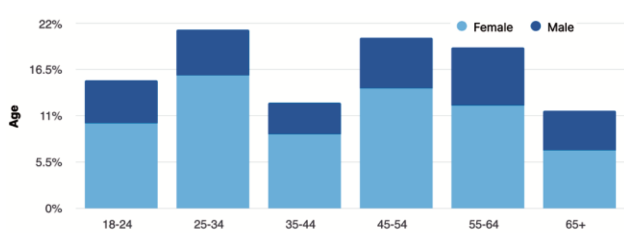


Fig. 12 — Breakdown of Redalyc unique visitors by age and sex (source: Semrush)

The education sector seems to be the most active in referring backlinks to Redalyc content, particularly from web pages on admission tests, distance learning, colleges and universities, study abroad and vocational and continuing education (Table 2). Diamond OA content is highly used for educational purposes.

Based on referring IPs, the top countries that link to Redalyc are the United States of America, Germany, France, Spain, Brazil and Russia (Table 3).

Of interest of the queries users send to Redalyc servers is the presence of local research agendas. This is exemplified in a sample of top queries recorded in Redalyc server logs in which the terms "Dengue" and "Rural migration" appeared as top in the list. A couple of topics which are particularly relevant for countries of the Global South.

These observations may support that Diamond OA journals, when leveraged by technology, behave like public goods, in terms of the beneficiaries of the services they provide.

## Discussion

The present results are significant in at least two major respects. On one hand, when the instruments of communication of science, such as journals, are conceived as public goods, the collective sustainability of them is required and it is important the involvement of the community in securing it as public good in terms of ownership, nature of funds, governance and other aspects.

Furthermore, additional research is needed to better assess the Open Access journals and infrastructures progress towards digital public goods. The standard of the Digital Public Goods Alliance could be useful for this task.

As public goods, they must provide an equitable and participatory service. The findings reported here confirmed that digital dissemination of knowledge in Diamond Open Access can achieve an unrestricted participation of authors and a global access by readers. A universal benefit is reached as long as a critical mass of journals is created. Thus, a concerted effort among the academic, governmental and not for profit sectors is needed to achieve that critical mass of journals at regional and international levels.

Unfortunately, the so-called gold Open Access (Open Access based on APCs) and transformative agreements are business models that keep science privatized. These commercial strategies break the nature of public good of science and treat it as a commodity. This approach entails exclusion, particularly damaging the countries of the Global South, not only for restricting authors but also for surrounding limitations in terms of author rights, archive policies, processability of content, data mining and more. Further studies, which take these variables into account, will need to be undertaken.

Research questions that could be asked include, to what extent the expenditure in gold Open Access and transformative agreements undermine the investment in Diamond Open Access? Why are countries, particularly from the Global North, reluctant to contribute to the critical mass of Diamond OA journals? What strategies should research assessment initiatives include to strengthen the vision of science as public good? Do developments in monitoring Open Access and Open Science take this paradigm into account?

## Conclusion

The approach of "science as public good" challenges various solutions of Open Access and Open Science in the economic, social, and technical implementations. When equity is placed at the core of the discussion on Open Access, the approach of the commons has a lot to contribute. It allows us to rethink the very foundations of science as a collective and inclusive enterprise.

At present, the concept of public good seems to be far from the implementations of Open Access in various countries. The industry of prestige and the use of economic resources in scholarly communication should be critically assessed in terms of the essential values of science and the mertonian norms such as universalism and communality.

The present study and the insights from the Latin American scholarly communication ecosystem raise the fact that this approach is feasible and successful. However, the transition to Open Access is usually examined in terms of, for example, the number of articles available in Open Access. In this kind of strategy to guide the adoption of OA, neither the conditions nor the consequences for equity are visible, which results in distorted paths that are far from building public goods.

The progress of Open Access needs to be evaluated in terms of the commons. Then the discussion can focus on solving inequity, losses, distortions, or exclusion with the leverage of digital technologies, a sine qua non condition to achieve science as global public good.

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