# *Promoting Open Knowledge and Open Science Report of the Current State of Repositories*

May 21, 2015

Produced by Confederation of Open Access Repositories (COAR) on behalf of the COAR Aligning Repository Networks Committee

Prepared by Kathleen Shearer, Executive Director, COAR with contributions from representatives from repository community around the world.

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About COAR

COAR, the Confederation of Open Access Repositories, is an international association with over 100 members and partners from five continents representing universities, research institutions, government research funders, and others. COAR's mission is to enhance the visibility and application of research outputs through a global network of open access digital repositories. COAR brings together the major repository initiatives in order to align policies and practices and acts as a global voice for the repository community.

## 1. Executive Summary

This briefing paper presents an overview of the international repository landscape. The paper has been produced by COAR on behalf of the Aligning Repository Networks Committee, a group of senior representatives from repository networks around the world. While principally intended for the Global Research Council (GRC), the paper has also been written with a broader audience in mind.

Over the last 20 years, open access repositories have been implemented around the world and are now fairly widespread across all regions. Repositories provide open access (OA) to research publications and other materials and enable the local management and preservation of research outputs. They are a key infrastructure component supporting the growing number of open access policies and laws, the majority of which recommend or require deposit of articles into an OA repository.

OA repositories are increasingly connected through thematic, national and regional networks. In turn, these regional and national networks are further aligning their practices globally through the COAR Aligning Repository Networks Initiative, making their collections more valuable as it enables new services to be built on top of their aggregated contents. These services include tracking of research outputs for funders and research administrators, monitoring usage of publications, facilitating text and data mining, as well as peer review overlay services.

Crucially, repositories represent a distributed and participatory model in which institutions manage content locally, but contribute to the global knowledgebase through adoption of common, open standards. Distributed systems, such as a global network of repositories, have an inherent sustainability. They increase the resilience of infrastructure and foster social and institutional flexibility and innovation. They also enable the research community to regain some influence over the scholarly communication system.

With a growing number of funding agencies adopting open access and open science policies that rely on repository infrastructure for adherence, it is critical that the repository and funder communities forge closer ties and find mechanisms to engage in regular dialogue. In addition, given that there are different approaches across regions in terms of both policies and infrastructure, it is important that the diversity perspectives are considered as we collectively move forward. COAR, and its members and partners, welcome further discussion with the Global Research Council as we chart a course for a sustainable and dynamic future for scholarly communication.

## 1. Introduction

The trend towards greater openness is being driven by a growing recognition that our substantial global investments in research could have a much greater impact if they are widely shared and openly available to everyone. While this may not have been possible in the pre-internet world, the digital, networked environment has made this objective eminently achievable and within our grasp. Within this context, over the past 15 years open access repositories have become increasingly important components of the global research infrastructure.

Open access repositories[1] play a variety of roles in the scholarly communication system, and these roles continue to expand and evolve. To date, their primary functions have been to provide visibility and open access to research outputs, with a focus on the journal literature, as well as to ensure archiving of this material over the long term. Much of the journal literature is currently only available through subscription and/or pay per view fees, creating a significant barrier to the widespread dissemination and use of this research knowledge. To improve the visibility and impact of their research, many funders have adopted policies that require open access to journal articles. Repositories are a key infrastructure component to support these policies. Indeed, the vast majority of open access policies and laws requiring or requesting authors to deposit articles into an open access repository.[2]

Beyond providing access to research articles and other research outputs, open access repositories are developing other functionalities, especially as services are built on top of the network of repositories. These include providing funders and institutions with the ability to track funded research output across repositories; delivering usage data; hosting collections of academic journals; supporting text mining of content for new discoveries; and linking related content across the network. As open access expands to the broader concept of open science, including a wider range of content types, open access repositories will become indispensable for managing, tracking, and providing access to the full range of outputs produced through research.

The purpose of this briefing paper is to provide a concise and up-to-date overview of the state of open access repositories around the world. The paper was prepared for the Global Research Council by the Confederation of Open Access Repositories (COAR) on behalf of the COAR Aligning Repositories Network Committee, a group of senior representatives from repository networks around the world.

[1] An open access repository is a set of services that provide open access to research or educational content created at an institution or by a specific research community. They may be institutionally-based or subject-based collections.

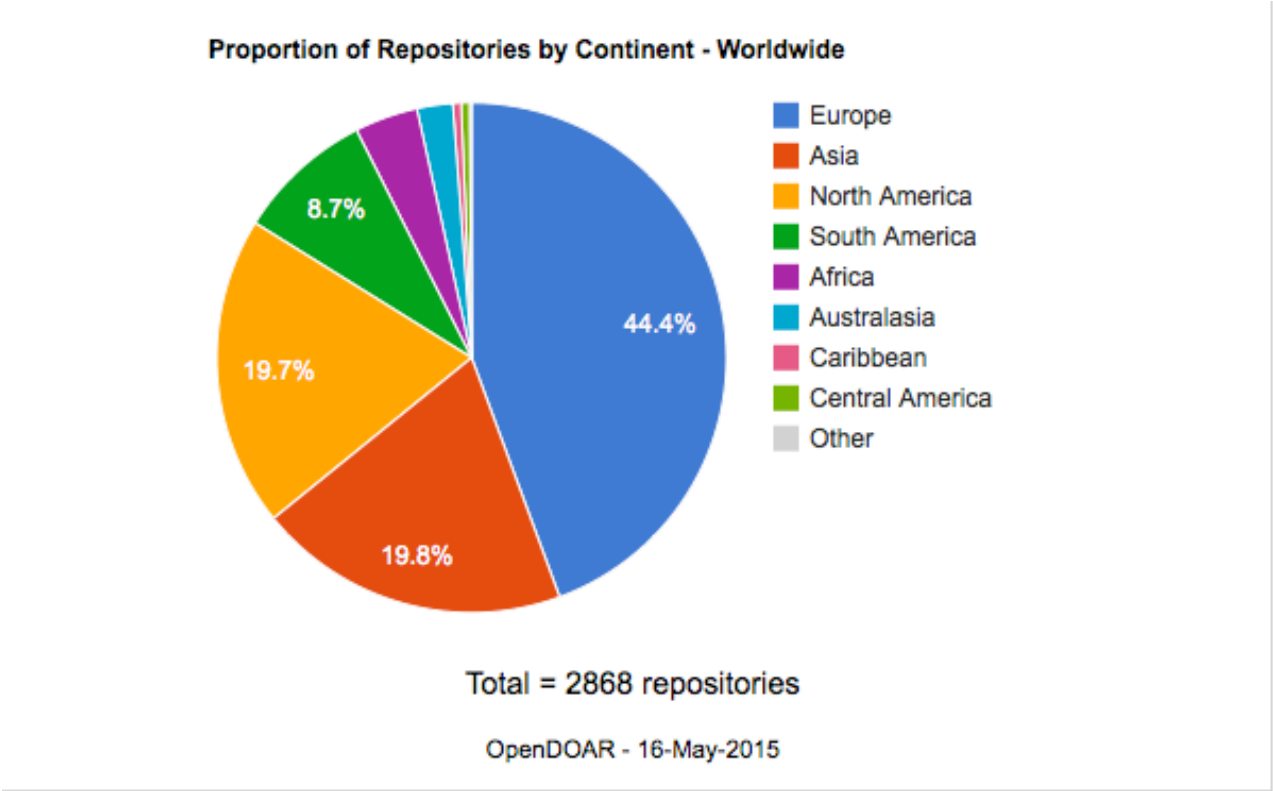
[2] http://pasteur4oa.eu/sites/pasteur4oa/files/deliverables/PASTEUR4OA%20Work%20Package%203%20Report%20final%2010%20March%202015.pdf

## 2. Repository Demographics

Repositories began to appear on the scholarly landscape in the late 1990's, but their real growth in numbers has occurred over that last ten years, mainly because of the availability of open source repository platforms and the establishment of the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), an interoperability protocol for exchanging information between repositories.[3]

As of May 16, 2015, OpenDOAR, a service that monitors repositories, listed 2874 repositories worldwide. These repositories are distributed across the world, but are most predominant in Europe, Asia, and North America. This graph taken from OpenDOAR shows the current geographic distribution of repositories around the world.

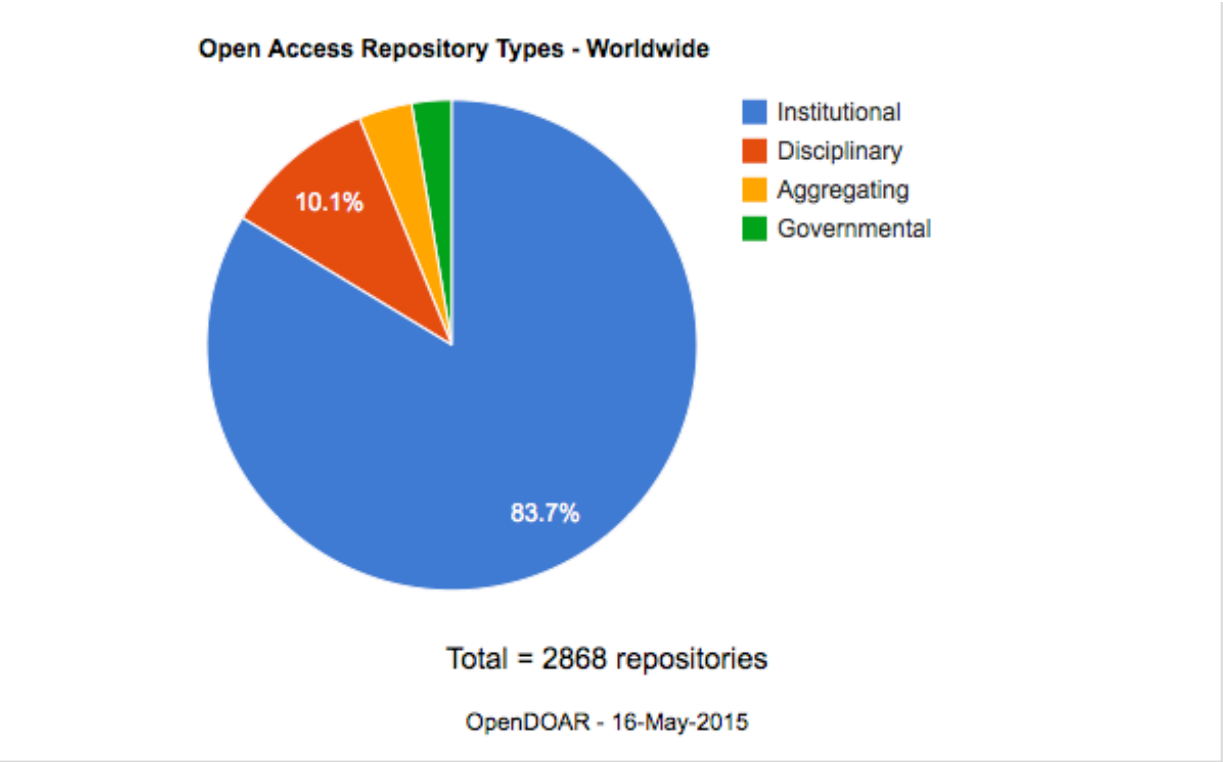
**OpenDOAR graph of Repositories by Continent[4]**




[3] Pinfield et.al. (2014): http://eprints.whiterose.ac.uk/76839/15/wrro_76839.pdf
[4] http://www.opendoar.org/find.php?format=charts

The vast majority of repositories, just under 85%, are institutional repositories hosted and managed mainly by research institutions or universities, but there are also some very important and highly valued thematic repositories, including arXiv and PubMed Central, and journal repositories, including SciELO and Redalyc.

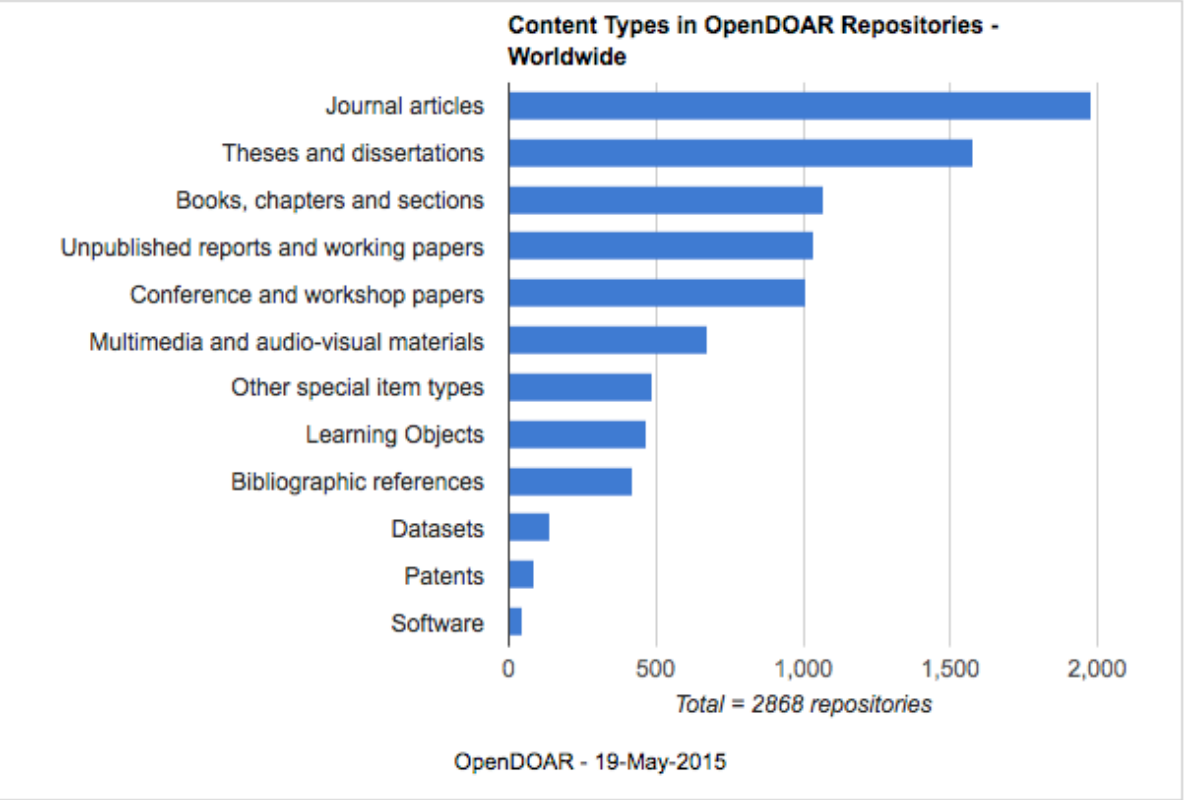
**OpenDOAR graph of Open Access Repository Types**[5]




The repository landscape is quite diverse. Repositories vary greatly in their size service models, and the range of content types they collect. Most predominantly, repositories collect journal articles, e-theses and dissertations, and book chapters; but increasingly they are including research datasets, images and videos, and more.

[5] http://www.opendoar.org/find.php?format=charts

**OpenDOAR Graph of Most Frequent Content Types**[6]




It is difficult to assess the total volume of items in the repositories around the world, however, the BASE Search Engine, which aggregates records from (mainly) repositories around the world currently harvests over 72 million records from over 3000 sources, with approximately 17 million of them are records of journal articles.[7]

Not all content in repositories is open access or full-text. A portion of the records in repositories either link out to published articles or have placed an embargo content on the full text item, usually because the publisher's policy requires this. The CORE (COnnecting REpositories) search service, run by Knowledge Media institute at the Open University in the UK harvests only records which are attached to full-text articles has just over 24 million records in its central database, the majority of which are housed in repositories.[8]

[6] http://www.opendoar.org/find.php?format=charts
[7] BASE is managed by Bielefeld University Library: http://www.base-search.net/Browse/DocType
[8] http://core.ac.uk/

## 3. Regional Repository Networks

There is already significant repository infrastructure in many countries and regions of the world, which are connected through national and thematic networks. These networks have been created by governments in order to better track their research outputs, something that cannot be done by using traditional search engines or indexing services. In addition to national and thematic networks, several regional repository networks are being developed to connect repositories across national boundaries. These networks have evolved based on the unique local requirements and mandates, and are at different stages of development. Some networks are very organized, cohesive and have robust services, while others are in their developmental stages. Several of these networks are described below, but it should be noted that there are also repository systems in other regional and national contexts including Australia, India among others.

### 3.1 Africa

In Africa there has been a marked response to OA and a steady development of institutional repository initiatives particularly among universities and research institutions. According to OpenDOAR, there are currently 116 repositories from 21 African countries.[9]

On the African continent, South Africa leads in terms of OA adoption among its public research and teaching institutions. In alignment to the GRC, the National Research Foundation (NRF) released an open access statement on January 30, 2015 that requires funded researchers to deposit their articles into an open access repository with an embargo period of no more that 12 months.[10] A recent survey conducted in March 2015 by NRF showed that there are 27 repositories mostly hosted by universities in South Africa. The NRF has also developed a National ETD Portal, which harvest South African theses and dissertations for 17 out of 26 public universities. It is also assisting some local universities to develop their own repositories and three repositories were handed over to the recipient institutions in the past 2 years.

### 3.2 China

In China, both the Natural Science Foundation of China (NSFC) and Chinese Academy of Sciences (CAS) have issued policies on open access that mandate the deposit of peer-reviewed drafts of papers funded by them, with an embargo of 12 months into a repository. To support this, CAS has built a Repository Grid that harvests records from 96 CAS affiliated institutional repositories.[11] The grid currently indexes over 625,000 records from these repositories, which include 477,378 full text articles. The CAS network is

[9] Repositories by Continent: http://www.opendoar.org/find.php?format=charts
[10] http://ir.nrf.ac.za/bitstream/10907/103/1/oastatement_2015.pdf
[11] http://www.irgrid.ac.cn/

extremely well used outside of CAS, with the collective content being downloaded over 11 million times and close to 5 million times from users outside China.

The Chinese academic library consortium, CALIS, has also been promoting the development of IRs at academic institutions in China.[12] Most recent data shows about 40 Chinese university outside the CAS network have substantial repository operations. In addition, the Chinese Academy of Agricultural Sciences (CAAS) and Chinese Academy of Medical Sciences (CAMS) each have an institutional repository to provide access to articles and other research materials produced by their affiliated researchers.

### 3.3 Europe

Europe has a very robust repository landscape with about 44 percent (1275) of the world's repositories located on that continent.[13] These repositories support a growing number of open access policies being adopted in various countries as well as the European Commission (EC). Since 2008, all EC grant agreements signed after August 2008 contained a clause requiring beneficiaries to deposit articles resulting from FP7 projects into a repository, and in the current funding program, Horizon 2020, the EC stipulates that all publications must be made open access.

Along with several very well developed national repository systems in countries like the United Kingdom, Portugal and Spain, the EC has been investing in a European-wide network, called OpenAIRE. OpenAIRE aggregates the research output of EC-funded projects and makes them available through a centralized portal. All member states are participating in OpenAIRE, as well as five associate countries, making a total of 33 countries involved in the project. OpenAIRE currently aggregates the metadata from over 590 repositories across Europe.

Although OpenAIRE's infrastructure is based on OA repositories, it has moved beyond a traditional publication aggregator. It currently aggregates 12.5 million publications and 7,000 datasets from 590 validated literature and data repositories.[14] OpenAIRE links these records with funding information from the EC and other European Union national funders. On top of the validated, cleaned, and enriched metadata aggregated by OpenAIRE, they are also developing value-added services for a range of stakeholders, in particular research managers to help them monitoring their research output. In doing so, it is becoming a true research Information system that demonstrates the value of open access and how this can be best implemented through community participation.

[12] http://ir.calis.edu.cn/
[13] OpenDOAR Repositories by Continent: http://www.opendoar.org/find.php?format=charts
[14] https://www.openaire.eu/

### 3.4 Japan

Japan has an extremely well developed repository network even in the absence of substantial funder open access policies. After some pioneering deployment of institutional repositories beginning in 2002, the Digital Repository Federation was formed by a group of interested universities in 2006 to lead efforts and bring together the Japanese institutional repository communities. Japan now has over 420 institutional repositories and is one of the countries with the greatest repository coverage. To support this repository network and ensure it is scalable, the National Institute of Informatics (NII) recently adopted the repository cloud service named JAIRO Cloud.[15]

In 2013, Japan Science and Technology Agency, one of the national funding agencies, adopted an open access policy, making use of the system of repositories or open access journals.[16] In 2014, Institutional Repository Promotion Committee was established for further cooperation with universities and NII and it is likely that open access activities will accelerate in Japan, with a recently published report, "Promoting Open Science in Japan" which strongly promotes open access.[17]

### 3.5 Latin America

Traditionally, Latin America has been an open access continent, with an early and strong presence of regional Open Access journal repositories (SciELO and Redalyc), and in the past decade the development of institutional repositories and numerous open access policies by funders. Going beyond the adoption of policies, the governments of Argentina, Mexico and Peru have implemented laws that require all research output coming from government-funded research to be made freely available via a repository and discussions for new legislation in Venezuela and Brazil.

In order to support improved visibility of local scientific production through an affordable infrastructure, several Latin American governments formed LA Referencia in 2012. LA Referencia began as a project funded by the Inter-American Development Bank (IDB) between 2010 and 2013 and is now operated by RedCLARA, the organization that runs the high-speed network in Latin America. LA Referencia maintains a centralized harvester, promotes common standards across Latin America and works at the strategic level to further promote open access. These services reflect the public policy agreements of the science and technology authorities in all 9 countries (Argentina, Brazil, El Salvador, Colombia, Chile, Ecuador, México, Perú, Venezuela) that were signed in November 2012 in Buenos Aires.

[15] https://library.stanford.edu/projects/stanford-prize-innovation-research-libraries-spirl/2014-prizes
[16] http://www.jst.go.jp/EN/about/pdf/OpenAccessPolicy.pdf
[17] http://www8.cao.go.jp/cstp/sonota/openscience/150330_openscience_summary_en.pdf

LA Referencia currently harvests metadata from 8 national nodes aggregating from about 200 repositories, and representing over 800,000 full-text documents, which include journal articles, theses and dissertations, and research reports.[18]

### 3.6 North America

With a growing number of open access policies being passed by Canadian and US funding agencies, repositories have gained in importance and momentum in North America over the last several years. According to OpenDOAR, there are over 500 repositories in US and Canada, representing a very well developed repository landscape.[19] In 2013, The US federal government directed each US Federal agency with over $100 million in annual conduct of research and development expenditures to develop a plan to support increased public access to the results of research funded by the Federal Government. The three Canadian research councils along with numerous private funder have also adopted open access policies, making the vast majority of researchers in this region regulated by open access requirements. As with most other regions, these policies are either neutral in terms of how researchers can adhere to the policy, or require specifically that researchers deposit into a repository.

In 2013, the SHARE project was launched to bring together information about publication output in this region. SHARE (SHared Access Research Ecosystem) is a joint effort supported by the Association of Research Libraries (ARL), the Association of American Universities (AAU), and the Association of Public and Land-grant Universities (APLU) to strengthen efforts in North America to identify, discover, and track research outputs. The Center for Open Science has been SHARE's technical partner since 2014.

SHARE is creating an openly available data set about research activities across their life cycle.[20] Similar to OpenAIRE in Europe, SHARE aims to collect, connect, and enhance scholarly metadata for the purposes of better understanding and tracking research outputs. By creating an open data set, SHARE will provide opportunities for further innovation and analysis about research impact. SHARE's first service is called SHARE Notify. Now in beta release, SHARE Notify takes metadata from a variety of digital repositories and generates a normalized feed of notifications.

[18] http://lareferencia.redclara.net/rfr/
[19] OpenDOAR Repositories by Country: http://www.opendoar.org/find.php?format=charts
[20] http://www.share-research.org/

# 4. Challenges and Opportunities

## 4.1 Alignment and Interoperability

It is clear that many regions around the world are investing in the development of repository networks. However, these networks have evolved in their own local contexts and differ in a number of ways. For example, there is significant diversity across regions in terms of implementation speed and availability of resources. Networks do not all share a common directive and have been deployed to support differing mandates and requirements. In addition, differences in language and geographic location present challenges to working together and identifying common approaches.

One of the major principles and aims reported in the Global Research Council's 2013 Action Plan is to create and interconnect repositories.[21] The repository community, through COAR and other regional and national initiatives, has already made important strides towards this interconnection. While it would be impossible, and undesirable, to align networks across all areas, there are some important components where we should invest our efforts. Particularly urgent is to adopt standard practices for tracking and linking research publications with project, funders, and institutions. In addition, common approaches to measuring use of content, will allow us to reliably compare impact of research.

Open access repositories already adhere to the a minimum standard of interoperability through the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). However as repositories evolve, the community will need to adopt other agreed upon standards and practices that supports unified access to content across national borders. For example, if repositories use similar methods for recording funding information, measuring impact, and adhere to standard vocabularies, this will enable governments and funding agencies to better monitor the research outputs in which they invest.

In order to work towards greater alignment of repositories, COAR launched an initiative in March 2014 to bring together the major repository networks from around the world. The aim of this activity is to provide a mechanism whereby repository networks can promote interoperability and adopt common approaches to policies, practices and technologies. Through this initiative, repository networks are working in three areas to better align their activities: technical and semantic interoperability, policies and advocacy, and service.[22]

There are other benefits for the repository community in doing this. It enables networks to learn from each other, progressing the global community more quickly and leading to cost synergies by preventing duplication of work across networks. It is also a mechanism for

[21] www.globalresearchcouncil.org/sites/default/files/pdfs/grc_action_plan_open_access%20FINAL.pdf
[22] www.coar-repositories.org/activities/advocacy-leadership/aligning-repository-networks-across-regions

repository initiatives to collectively express their perspectives to the international community.

In addition to aligning repository networks, repositories must be integrated and/or interoperable with other systems with which they overlap, including research administrative systems (CRIS), research data repositories, journal publishing platforms, indexing and abstracting services and search engines. This kind of integration is also happening via various forums including pilot projects at the institutional and network level, as well as increasing dialogue between the repository community and other important stakeholders. COAR has recently published a report, The "COAR Roadmap for Future Directions for Repository Interoperability"[23] outlining priority areas for repository interoperability.

### 4.2 Balancing Global and Local Requirements

Many of the world's greatest challenges such as climate change, poverty, and health are global in nature and must be addressed in collaborative ways by researchers across regional and disciplinary boundaries. Conversely, there are important research problems, technical needs, and political and social environments in different regional/national and disciplinary contexts. As the distributed global network of repositories continues to evolve, we must find ways to support these two fundamental requirements.

Repositories are already well positioned to support local management of and access to research outcomes. By depositing articles and other content into local repositories in their own country, authors, who may have published their articles in international journals that are not accessible to individuals in their local environment, can ensure their work is accessible and used by important constituents.

On the other hand, as research becomes increasingly global, distributed and cross-disciplinary, repository infrastructures also aim to belong to a global network whereby researchers, regardless of location or disciplinary practice, to access research outputs worldwide. Striking the right balance between local needs and developing a truly global interconnection of repositories will be important.

### 4.3 Sustainability

The current publishing system, and consequently the flow of knowledge, remains under the control of the major publishers. This has created numerous disparities in the nature of scientific inquiry and the way findings are communicated, including barriers to access and newly emerging barriers to publishing that being introduced by the author or institution-pays model.

[23] www.coar-repositories.org/activities/repository-interoperability/coar-interoperability-project/coar-interoperability-roadmap/

Openness is about more than gaining access to knowledge. It is also about the being able to participate in the knowledge production process. As noted by the Global Research Council in the 2013 Action Plan towards Open Access to Publications, "in transitioning to open access, undue publication barriers must be avoided. It will be necessary to look for solutions that assist those authors in openly sharing their research results and thus making impact."[24] While open access has made tremendous gains in terms of improving access to research publications, publishers are beginning to shift their business models from subscription to article processing charges (APCs). The consequence of this is to further marginalizing researchers at institutions in the developing world and smaller institutions who cannot pay the often large fees attached to them.

Investments in repositories allow the research community to take back some ownership of the scholarly communication system and manage it as a commons. They represent a distributed and participatory model whereby institutions manage content locally, but contribute to the global knowledgebase through adoption of common open standards. Distributed systems, such as a global network of repositories, have an inherent sustainability. They increase the resilience of infrastructure and foster social and institutional flexibility and innovation. These systems are managed by long-lived institutions such as universities, research centres, libraries, archives, and cultural institutions that have knowledge dissemination and stewardship at the core of their mandate.

### 4.4 Visibility

Open access repositories significantly raise the visibility, use, and citation of deposited articles. Numerous studies over the last 15 years have reported on the citation advantage of open access content in general.[25] In terms of open access repositories, this also is true. For example, both arXiv and PubMed Central (PMC) are extremely well used. arXiv, which now provides access to over 1 million e-prints in Physics, Mathematics, Computer Science, Quantitative Biology, Quantitative Finance and Statistics reported about 1.5 million downloads per week in 2014.[26] PMC is a free full-text archive of biomedical and life sciences journal literature that now contains over 3.4 million articles.[27] While no public statistics are available, anecdotal evidence tells us that PMC is one of the most well used repositories in the world.

Usage of institutional repositories is also significant. The repository at MIT in the US (called DSpace@MIT) is one of the largest institutional repositories in the world, with a

[24] www.globalresearchcouncil.org/sites/default/files/pdfs/grc_action_plan_open_access%20FINAL.pdf
[25] http://opcit.eprints.org/oacitation-biblio.html
[26] https://confluence.cornell.edu/display/culpublic/arXiv+Update+-+January+2015
[27] http://www.ncbi.nlm.nih.gov/pmc/

collection of more than 60,000 items.[28] The repository receives, on average, more than 1 million downloads per month. Smaller repositories, such as the Nülan Repository from Universidad Nacional de Mar del Plata in Argentina, containing predominantly Spanish language articles, are very well used. In 2015, the repository which has just over 2,000 items, has had downloads of approximately 50,000 per month.[29] Perhaps even more impressive are the individual download numbers for some of the articles in repositories. For example, the most downloaded item at the University of the West of England, Bristol has been downloaded over 65,000 times. Further technological and service developments in repositories, such as those described in the next section, will further increase the use and value of repositories in the scholarly community.

### 4.5 Value Added Services

In order to maintain their relevance, repositories must continue to evolve and expand their service offerings. Repository networks are increasingly used by governments, funders and institutions to monitor their investments in research. Networks, such as OpenAIRE in Europe, generate information for research administrators and funders to help them better understand and track their funded research outputs. Indeed, With over 5000 registered users, mainly research administrators, policy officers and principal investigators who use their services to analyse the impact of the research they fund, OpenAIRE has become a reliable and trusted service for the EC and other policy makers.

Another emerging service for libraries is measuring usage. The repository community has already begun to incorporate usage statistics and other measures into their platforms. While the most widely recognized measures of impact are citation data and journal impact factors, new complementary measures are being introduced that may better reflect the real impact of research articles (and other research outputs). Many repository platforms are building in this type of functionality, which is highly valued by the authors who deposit into repositories.

The aggregation of repository content can offer the foundation for a whole host of text mining activities to be developed on top of the content. Text and data mining are becoming valuable analytical methods that allow researcher to discover interesting patterns and extract new knowledge from a corpus of content. Repository collections contain all kinds contain rich information, which could be further used, combined and analyzed through text mining techniques. A growing number of services are being developed to support these types of service.[30] As text and data mining techniques in research are more widely adopted, repositories and the broader community will need to

[28] http://libguides.mit.edu/dspace
[29] http://nulan.mdp.edu.ar/stats_12m.html
[30] http://thehaguedeclaration.com/cases/

address some of the existing limitations that exist, including restrictive licenses imposed by publishers, copyright regimes, and technical limitations.

As we move from open access to journal articles, to a broader vision of open science, repositories are also expanding the scope of their services to support the collection and management of other content types. Research data, in particular is a growing concern for the research community. The current data centres around the world do not have the capacity to collect and provide access (where appropriate) to the huge volumes of research data produced by researchers around the world. Our investments in open access repository infrastructures should be extended to include all valuable research outputs including research data.

Repositories have not yet been incorporated into promotion and tenure system and, for the most part, do not yet contribute to a researcher's prestige. As such, they remain an afterthought in order to fulfill open access policy requirements or to give visibility and access to research output. In order to become more relevant and actively used by the research community, repositories can begin to develop quality assurance and peer review services that will bring the kind of value offered by journals. Some repositories are already adopting overlay services that support peer review on top of their collections. Episcience, for example, offers a technical platform for peer-review of content. It promotes the emergence of "epijournals", or journals that take their contents from preprints deposited in open archives such as arXiv or HAL, that have not been published elsewhere.[31] This kind of approach could be also generalized to regional, or even a global networks of repositories, eventually generating further value to the contents within the repositories.

## 5. Conclusions

Research is an international activity whereby progress builds on the reported results of colleagues from around the world. An unimpeded flow of knowledge is a critical factor for creating a strong research environment. The expanding distributed network of open access repositories collectively supported by long-lived institutions around the world represent a sustainable, equitable and cost effective way for the global research community to support the dissemination, sharing and reuse of research knowledge.

In the future, we envision a global network of repositories that will act as the foundation for access, certification, quality assessment and further re-use of research outputs. As we move from open access to open science, repositories will become even more important components of the research landscape by supporting the dissemination and preservation of a wide range of outputs including research data. Furthermore, repositories are well

[31] http://www.episciences.org/

positioned to support a new model of scholarly communication that reflects the continuous flow of knowledge as it evolves over time, rather than the static one currently in place.

With a growing number of funding agencies adopting open access and open science policies that rely on repository infrastructure for adherence, it is critical that the repository and funder communities forge closer ties and find mechanisms to engage in regular dialogue. In addition, given that there are different approaches across regions in terms of both policies and infrastructure, it is important that the diversity perspectives are considered as we collectively move forward. COAR, and its members and partners, welcome further discussion with the Global Research Council as we chart a course for a sustainable and dynamic future for scholarly communication.