RI-VIS D2.2
White Papers: Region-specific recommendations for research infrastructure cooperation

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Executive Summary

Fostering international cooperation of research infrastructures (RIs) promotes the efficiency and quality of research worldwide and is key to tackling global challenges in a concerted manner. To this end, RI-VIS aims to provide tools and strategies to support the initiation and sustainability of international collaboration between research infrastructures.

This deliverable presents three White Papers with region-specific recommendations on how to increase collaboration between European RIs and RIs from Africa, Latin America and Australia, respectively. The papers are targeted at funders, policy makers and research infrastructure managers and collate the insights of experts from RIs and policymakers from the respective regions into sections that cover examples of successful collaboration, lessons learned, and possible bottlenecks.

Recommendations on international cooperation

Research infrastructures (RIs) are organizations that enable scientists to use specific facilities, resources, and services in order to accelerate scientific achievements, break boundaries, and promote sustainable research. International cooperation in science and technology is key to addressing major global challenges including climate change, infectious disease, food security, and natural disasters. Fostering research infrastructure partnerships on a global scale has the potential to improve the efficiency and quality of research to tackle the many challenges faced by society today.

The aim of this deliverable is to provide recommendations to funders, policy makers and research infrastructure managers on how to increase international collaboration among research infrastructures. More specifically, the deliverable presents three White Papers that provide recommendations focused on cooperation between specific regions: (1) African-European, (2) Latin American-European and (3) Australian-European cooperation, respectively.

The three White Papers are structured into sections that cover examples of successful collaboration, lessons learned, and possible challenges as well as a summaries of key recommendations. They collate the insights of a total number of 21 experts from research infrastructures and the political sector from different regions. Initially, we had planned to collect the experts' perspectives as part of the three RI-VIS outreach events that were supposed to take place in Africa, Latin America and Australia, respectively. However, due to the fact that the events had to be postponed and adapted to a virtual format in light of the Covid-19 pandemic, the experts have been interviewed by phone in advance of the outreach events.

Even though the three White Papers highlight region-specific issues and recommendations, common themes emerge. For example, a prominent theme in all three White Papers is the issue of funding. Experts from all regions recommend that policy makers and funders not only consider dedicated funding for collaborative actions but also to ensure sufficient, continued core funding for individual research infrastructures in the first place. This will form the basis for their long-term sustainability, a prerequisite for successful international collaboration. In some regions, this first requires an increase in the awareness of the benefits of research infrastructures.

Independent of the region, a key recommendation is the alignment of scientific priorities and the perception of mutual benefits. Another common recommendation relates to the organisation of outreach events in the respective regions and the use of digital tools of communication.

Further key recommendations cover issues such as collaboration frameworks, global challenges, access, personal relationships and staff recognition.

The three White Papers have been published on the Zenodo platform. To ensure impact, i.e. that the recommendations are translated into action, the next step will now be to disseminate them as widely as possible among decision-makers on policy and research infrastructure management level via various communication channels including dedicated virtual events (Task 2.4).

Appendices

Three white papers:

- Recommendations towards cooperation between African and European research infrastructures: https://zenodo.org/record/4475595
- Recommendations towards cooperation between Latin American and European research infrastructures: https://zenodo.org/record/4544374
- Recommendations towards cooperation between Australian and European research infrastructures: https://zenodo.org/record/4546173

Appendix 1

WHITE PAPER

Recommendations towards cooperation between African and European research infrastructures

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Executive summary

International cooperation in science and technology is an important part of addressing major global issues like climate change, infectious disease, food security and natural disasters. Research infrastructures (RIs) are organizations that enable scientists to use specific facilities, resources and services in order to accelerate scientific achievements, break boundaries and promote sustainable research. Fostering RI partnerships across borders has the potential to improve the efficiency and quality of research to tackle the many challenges faced by society today.

The RI-VIS project is a Horizon 2020-funded project to increase the visibility and raise awareness of European RIs to new communities beyond Europe. This report, as part of RI-VIS, focuses on ways to increase collaboration between African and European RIs. It collates the insights of experts from African RIs, European RIs and policymakers into sections that cover examples of successful collaboration, lessons learned and possible challenges/bottlenecks.

The following key recommendations from experts to facilitate African-European RI partnerships are categorized into actionable items for RI representatives, policy makers and funders:

Key recommendations for RI representatives

RATIONALE/GLOBAL CHALLENGES

- RIs are often involved with global issues and need to include Africa in its research, both in terms of data and solutions.

FRAMEWORK

- Offer different approaches, concepts and other means of participation to countries outside of the continent.
- Provide a formal framework for partnership between countries, such as a memorandum of understanding or a joint grant including expectations and standards for the RI collaboration.
- Recognize that the RI collaboration should have mutual benefit to both parties.

CO-CREATION BASED ON NEEDS

- Patience and tolerance for other cultures as well as different levels of technical competencies.
- Learn new approaches: working in different parts of the world requires simpler and different solutions, based around mobile technology and scarcity of research infrastructure.

- Engagement with the people and institutions on the ground.

ACCESS
- Access for outside researchers to have RI access to specialized equipment or facilities that may not be available in their own country or continent.

OUTREACH
- Organization of outreach activities such as workshops and summer schools for international students.

BEST PRACTICE
- Learn from existing success stories of African-European RI collaborations.

Key recommendations for policy makers & funders

FUNDING
- Assess the value of potential RI projects through the lens of critical mass, affordability and alignment with national priorities.
- Join forces to contribute funding from both the European and African side, with each supporting their own country's researchers to focus on collaborative projects.
- Promote synergies between funding agencies working towards shared objectives.
- Lobbying with key decision-making entities such the African Union for more funding for research.
- Continue to develop and promote European funding programmes that are open to the world or emphasize non-EU partners.

FRAMEWORK
- Co-develop RI roadmap, if the country doesn't already have one.
- Consider signing a low-commitment letter of intent for a year with another country to test the waters of collaboration.

CO-CREATION BASED ON NEEDS
- Listen to the local research community and assist its members in forming proposals that are relevant to local communities, tackling local impact of global issues and devising appropriate solutions
- Listen to the local research community and assist its members in forming proposals that show their project's socioeconomic benefit.
- Support capacity building initiatives on both continents to enable wider use of RIs, including establishing local hubs and sample collections to avoid loss of precious samples and create a resource of international importance.

Contents

Background

In 2015, the United Nations General Assembly outlined a set of 17 Sustainable Development Goals to achieve a better and more sustainable future for all (Sustainable Development Goals, 2015). They aim to address major societal challenges faced by humankind related to disease, climate change, food security, environmental degradation and poverty. Scientific research is an essential part of tackling these issues. The process of gathering information and expanding our knowledge of the world has the power to improve overall health, safety and standard of living.

Research infrastructures (RIs) are crucial to the advancement of science in many fields. The availability of well-maintained RIs facilitates cutting-edge research and training of highly skilled specialists. They include major scientific equipment and infrastructures, cyber- or e-infrastructures, scientific collections, archives and structured information and entities of a unique nature that are used for research (European Strategy Forum on Research Infrastructures, 2018).

A key motivation of RIs is the sharing of knowledge and resources across institutions, countries and continents. Large-scale research facilities are incredibly expensive and challenging to build and maintain by one single nation on its own. Other RIs require data collection from different parts of the world. Thus, a more effective and productive way to conduct research is to pool together resources and share costs.

The RI-VIS project is a Horizon 2020-funded project to increase the visibility and raise awareness of European RIs to new communities beyond Europe. Part of RI-VIS involves identifying routes to maximize the exchange of information and bases for new partnerships, in particular with RIs or communities outside of Europe. Mutually beneficial RI partnerships across borders can harness collective knowledge, assist in meeting global challenges and enhance global science capacity.

This report assembles the insights of several experts from both Europe and Africa who have previous experience with such collaboration. Interviews were conducted from February to April 2020 with five representatives from RIs in Europe and Africa, as well as two individuals from the policy side (see Appendix A). They highlighted examples of African-European RI collaboration, best practices for successful collaboration, challenges/bottlenecks and recommendations to policy makers and funders. The preceding sections will outline the definition of an RI, the importance of RIs to society and the benefits of international research collaboration.

What is a research infrastructure?

The term “research infrastructure” comes with a certain degree of flexibility, since it lacks an established formal definition in scientific and policy literature. The European Commission defines research infrastructures (RIs) as “facilities that provide resources and services for research communities to conduct research and foster innovation” (European Research Infrastructures, 2020). The RI-VIS Communication Toolkit for European Research Infrastructures states that an RI is “an organization that enables the research community to use specific facilities, resources and services in order to accelerate scientific achievements and promote sustainable research” (Abecasis & Pintar, 2020). According to South Africa’s Department of Science and Technology, the concept of RI includes “facilities, resources and services used by the scientific community across all disciplines for conducting cutting-edge research for the generation, exchange and preservation of knowledge” (South African Research Infrastructure Roadmap, 2016).

Despite it being used in different contexts both internationally and even within Europe, the term maintains some common threads across definitions (International Research Infrastructure Landscape 2019: A European Perspective, 2019; Florio, Forte, Pancotti, Sirtori, & Vignetti, 2016):

- RIs are motivated first and foremost by **scientific goals**. The main purpose of RIs is to acquire new knowledge in a scientific field, allow research and innovation to break barriers, and push the frontiers of science. They may be purely **curiosity-driven** without any direct, obvious practical application, or they could have a more application driven, practical **benefit to humanity.**
- All RIs at their heart contain **valuable and unique assets**, whether they be major facilities, instrumentation, knowledge-based collections or collaborative networks.
- RIs often require **substantial capital investment** that typically goes beyond the capacity of an individual faculty, institution or funding programme.
- Access to RIs expands **beyond an institutional level** to a national or international reach. The uniqueness and steep cost of the assets means that the RI's capabilities will be in demand by external researchers in the field.

High-profile examples of RIs include CERN's Large Hadron Collider, the world's largest and most powerful particle accelerator; INSTRUCT, a collection of distributed facilities that promote structural biology research; and the Square Kilometre Array, a radio telescope project partly based in South Africa. Further examples from Europe and Africa are provided in Table 1.

RIs are often placed into three broad categories: single-sited, distributed or virtual. Single-sited RIs are centralized facilities at a single physical location. These include large telescopes, particle accelerators, synchrotrons, nuclear reactor sources or extreme laser sources. Distributed RIs usually have a central hub and interlinked nodes scattered in different regions. They consist of a network of distributed instruments or collections that, taken as a whole, constitute a large-scale facility. An interferometrically linked array of radio telescopes and large genome sequencing projects are two types of distributed RI. Lastly, virtual RIs (also referred to as e-infrastructures) are internet-based systems for scientific research, such as an archive of historical texts or virtual research environments (virtual labs) for data processing and analysis. RIs often offer a mixed category that combines physical and virtual aspects.

Societal impact of research infrastructures

The development, operation and maintenance of RIs require large investments from countries, sometimes encompassing tens or hundreds of millions of Euro per year. Decisions about investment in RIs at a national level often include an assessment of any direct societal benefits in addition to their future scientific impact (Horlings, Gurney, Somers, & van den Besselaar, 2013). However, such benefits tend to be difficult to predict, particularly for curiosity-driven projects.

For example, the overarching goal of CERN's Large Hadron Collider (LHC) was to better understand the fundamental structure of matter. The total cost of the accelerator, detectors and computing was 4.332 billion Swiss francs, making it one of the most complex and most expensive scientific research facility ever constructed. Beyond its obvious contributions to physics, CERN has been responsible for innovations that have improved medical and biomedical technology, space missions, art restoration and energy efficiency (Our Contribution to Society, 2020). The building of LHC has resulted in highly advanced superconducting magnets, exceedingly accurate measurement equipment and breakthroughs in data communication and storage. CERN also sparked the invention of the World Wide Web in 1989 (The birth of the Web, 2020) and the capacitative touch screen in 1972 (Stumpe & Sutton, 2010).

Other RIs have a more direct impact with their observations. For instance, the European Plate Observing System (EPOS) and the European Multidisciplinary Seafloor and water-column Observatory (EMSO) are both distributed RIs that inform society about environmental hazards and allow for more advanced preparation.

On the economic side, jobs are created throughout the RI development process, and revenue is created for businesses contracted to build the facility (Low, 2013). The Square Kilometre Array (SKA) – to be constructed in South Africa and Australia with the help of several partner countries – will be the world's largest radio telescope. Thousands of dishes and up to a million antennas will allow astronomers to monitor the sky in greater detail than ever before, with the hope of answering questions about the origins of the universe. The SKA has already rendered substantial economic benefits to South African communities, including ZAR136 million spent through local suppliers and the creation of 7,284 employment opportunities as of 2016 (Gastrow & Oppelt, 2018). The local hospitality industry has also benefitted, since visitors to the SKA must lately stay off-site. The project is also predicted to have a positive socio-economic impact for the many partner countries that are helping with the development and operation of the telescope.

Aside from such spillover technologies, RIs impact the economy and society in several other ways. RIs serve as key learning environments and hubs where knowledge is exchanged (Horlings, Gurney, Somers, & van den Besselaar, 2013). Researchers, students, industry and government all interact throughout the RI's development, construction and use. In addition, many RIs participate in public outreach to stimulate interest in students and other members of the community. The aim is to inspire curiosity and encourage a new generation of scientists to enter the field.

Taking all of the above points into consideration, the general consensus tends to be that RIs provide a positive return on investment and a substantial net benefit to society, economic development and scientific progress.

Scientific collaboration across borders

The collaborative nature of scientific research is inherent to its success. By sharing skills and data, researchers improve the efficiency and quality of their work while supporting the process of scientific production, knowledge creation and breakthroughs. The whole of a scientific collaboration is undoubtedly greater than the sum of its parts. But what are the benefits of collaborating with researchers based in other countries?

Different motivations exist, depending on the scientific field and country at hand. However, one thing is clear: The number of scientists participating in international collaborations is growing. An analysis of scientific publications and co-authorships found that international scientific collaboration is increasing in volume in all research fields over time (Coccia & Wang, 2016). Research is more global, cross-national, and cross-cultural than ever before.

A metaphor used to describe the importance of international collaborations is a frog deep inside a well, who has an excellent view of a small patch of sky (National Research Council, 2008). If most of the research in a field is done predominantly stuck in one well, such as North America or Europe, it can prove detrimental to scientific discovery. Getting out of the well can provide new research topics and collaborators, which help question underlying assumptions and spark fresh insights.

Many research opportunities can only be found in a specific region of the world. For instance, a study on scientific collaboration between Germany and South Africa found that many publications resulted from uniquely "South-African" topics: observations of the Southern Sky, as well as local geology, ecology and plant science (Schubert & Sooryamoorthy, 2010). Other projects require an international pool in order to attain a research population of sufficient size. Studies on rare diseases or other unusual phenomena require going beyond what a single country can provide.

In addition, international collaborations have the power to mobilize a global network to consider and refine important ideas that affect humanity as a whole. Global issues include environmental protection, energy security, natural disaster mitigation, preventing/curing infectious diseases and food security. RIs bring experts together to form a network where they can openly share knowledge and technology. In the area of food security, for example, researchers from academia and industry across the globe often have similar goals, such an increase in crop productivity and resilience, and RIs are pivotal in this respect (Pieruschka & Schurr, 2019).

Beyond the scientific benefits, international collaboration in large science projects can also save money and support foreign policy (U.S. Congress, Office of Technology Assessment, 1995). The cost of "big science" has gone up, which makes it more difficult for a single nation to undertake such projects alone. Of course, reducing net costs for individual countries also motivates the creation of RIs. Collaboration makes it possible to share both the financial and technical risks of ambitious projects.

Lastly, research can also be a form of diplomacy, leading to alliances and memoranda that support foreign policy objectives. Joint scientific research can strengthen bonds with other countries and establish levels of trust.

African-European research infrastructure collaboration

Bringing together RIs from Europe and Africa with the common goal of scientific advancement and innovation has the potential to breath fresh life into research topics, bring new perspectives and spur on novel developments. In fact, because RIs are already focal points of collaboration within themselves, the mutual advantages of African-European RI partnership are expected to be even greater.

The European Union-funded PAERIP (Promoting African-European Research Infrastructure Partnerships) project was a 2013 initiative aimed at promoting research collaboration between the two continents. PAERIP defined an RI partnership as "an agreement between governments, research societies, research institutions, higher education institutions or individual researchers or groups of researchers to jointly plan, invest, develop, construct, manage, use, and phase out RI that holds mutual benefit in terms of advancing the frontiers of knowledge, enables research on intercontinental or global challenges, provides access to science that holds geographic or regional knowledge advantage, and contributes directly or indirectly to national competitiveness" (PAERIP, 2012).

Broadly, RI partnerships at a global or intercontinental scale are worth developing for the following reasons:

- To harness collective global knowledge and experience
- To support leveraging of new international funding for RIs
- To promote access to and exchanges between RIs
- To facilitate the mobility of researchers
- To assist in meeting global challenges
- To compensate each other's shortcomings with regard to available infrastructures

African-European RI collaboration can take many forms, and the examples that follow represent only a small sampling of partnerships. However, our objective is to learn from these real-world cases for the benefit of future collaborations and to better recognize opportunities for the two continents to work together.

Examples

CHPC & CERN

More than a decade ago, scientists at South African universities had to use facilities based in the United Kingdom and other countries in order to perform large computational analyses. The science community petitioned the Department of Science and Technology (DST) for the creation of a supercomputing RI based in South Africa. The Centre for High Performance Computing (CHPC) was established with funding from the DST in 2007. Today, the CHPC provides much-needed local supercomputing resources for projects on climate change, energy storage, astrophysics, bioinformatics and other disciplines.

In 2015, the CHPC signed a memorandum of understanding with the European Organisation for Nuclear Research (CERN) for provision of a Tier 2 processing facility. The Worldwide LHC Computing Grid is composed of four tiers, with each level being made up of several computing centres that process, store and analyse data from the LHC. As part of Tier 2, made up of 155 sites around the world, the CHPC provides computing power for specific analysis tasks.

"African scientists in general have been participating in experiments at CERN for a very long time. But when I looked at who was contributing computing resources to the LHC, Africa was not contributing at all," said Happy Sithole, Director of the CHPC. "This is why we thought it is important to provide some of our resources, and we pledged them to the overall resource allocation at the LHC."

The CHPC gave its support for two years on a trial basis before becoming an official Tier 2 facility. Understandably, CERN requires that any new partner into the Worldwide LHC Computing Grid demonstrate its capabilities first.

"CERN has got a really high standard and stringent requirements that they need for any facility to be accepted," said Sithole. "You have to really build up your operations and test them. It's not just a walk in the park."

Sithole worked closely with people at the LHC during the trial period, and they helped the CHPC to meet all the necessary requirements. Throughout the process, the CHPC's engineers have learned new skills and become part of the larger computing community at the LHC. The partnership also gives the local high-performance computing community access to CERN, making it easier to attend workshops, schools, and training facilities. He also believes that South Africa's involvement in such a large global project shows the world that African countries have the ability to contribute to international science experiments.

"It's important for African countries to not be just sitting and looking for donations. Collaboration is about putting something on the table," Sithole said. "We might not be able to put an equal contribution as other European countries, but the little contribution that we can put is very significant. That is one thing I would say is very critical for the success of collaboration between Europe and Africa."

ESS & SASAS

The European Social Survey (ESS) is a cross-national survey established in 2001 that measures the attitudes, beliefs, and behaviour patterns of diverse populations in more than thirty countries. Face-to-face interviews are conducted every two years, with the data available online free of charge for non-commercial use. The ESS has completed over 425,000 interviews within a 20-year period.

Sir Roger Jowell, originally born in South Africa, co-founded the ESS to produce a standardized social survey whose results could be reliably compared across countries (The history of the ESS ERIC, 2020). He maintained an interest in his place of birth and became a special advisor to the South African Social Attitudes Survey (SASAS) funded by the Human Sciences Research Council (HSRC). The SASAS has been conducted annually since 2003 with heavy influence from the ESS.

"The methods of survey data collected that Jowell implemented here through the European Social Survey, he enacted on the South African Social Attitudes Survey as well," said Stefan Swift, Media and Communications Officer at the ESS. "So there was always a relationship there."

Beginning in 2010, the two RIs began testing the waters of a formal collaboration when the SASAS fielded identical questions to ones the ESS had already done. The partnership between the ESS and the SASAS became formalized in 2014 with a grant from the UK's Newton Fund, formed to build research and innovation partnerships with 17 partner countries to support their economic development and social welfare (Data from South African survey now available, 2017). This meant that, for the first time, attitudes in South Africa on topics like democracy, health, justice, and trust in the police could be scientifically compared with those in European countries.

To further strengthen ties, the ESS signed a memorandum of understanding with the South African HSRC in 2019, which lasts for four years (Global partnerships revealed, 2019). ESS survey questions will be once again fielded in the SASAS, which will promote the exchange of knowledge and allow for methodological improvements to all three surveys.

"I think we're very lucky with the South African team in that they have a very good survey methods background, and they have the capacity to implement them," said Swift. "You have this opposition of lowering your standards to allow more countries in, and this is the case even within Europe. But the South African team is very experienced in this field, so in many senses, the challenges I would normally expect from cross-national partnerships doesn't exist."

The partnership with South Africa is a first step towards a global social attitudes survey. The ESS also signed a memorandum of understanding with Australia and hopes to expand their global reach further in the next decade. The ability of researchers to compare social science data between countries all over the world will undoubtedly help to advance scientific progress in the field.

IITA within the CASS project

Headquartered in Nigeria, the International Institute of Tropical Agriculture (IITA) offers leading research partnership to facilitate agricultural solutions to hunger, poverty, and natural resource degradation throughout sub-Saharan Africa. This region is home to some of the world's poorest people, and IITA works to improve their livelihoods through the implementation of agricultural research and technology.

"We are involved in translational work – so, taking more basic sciences in Europe and the U.S. and translating that into solutions that benefit people in Africa," said Michael Abberton, Head of the IITA's Genetic Resources Center.

One example is a study on genetically modified cassava within the CASS (Cassava Source-Sink) international project (Sonnewald et al 2020) (IITA commences confined field trials of transgenic cassava, 2017). Cassava's starch-rich roots deteriorate quickly after harvest, which leads to a 40 percent reduction in the postharvest value of the crop and thus has a large negative impact on the income of farmers. Scientists within CASS produced genetically modified cassava plants to try and hinder the process of deterioration.

After testing the plants under controlled condition in greenhouses, the project consortium wanted to take the next step and grow the plants in an African tropical climate. IITA carried out a confined field trial with the highest biosafety standards, which included the protection of test plants to prevent insect access and cross-pollination (Confined field trial of transgenic cassava is completely safe, says IITA scientist, 2018). It also used drone technology in the field to observe cassava growth through the seasons.

"Cassava is an African crop, so it doesn't really make much sense to put it out on the field in Europe. But they have the technology to better understand the genetics of cassava plants," said Abberton. "So the genetically modified plants are coming from Europe, and we have the capacity to run field trials here in Nigeria."

The collaboration produced a scientific publication in 2020 (Obata, et al., 2020), which found the possible basis for the cassava's high rate of photosynthesis and areas to target for genetic improvement of the crop. IITA also has a partnership with the University of Helsinki in Finland, where they send DNA samples for next-generation sequencing. For instance, IITA is involved in a project that uses next-generation sequencing in the diagnosis of viruses in cassava and yam.

SAMRC & Forte

For over fifty years, the South African Medical Research Council (SAMRC) has funded and conducted medical research with a mandate to improve the health of the country's population. It consists of intramural research units, based at the SAMRC campuses, and extramural research units, which are funded by the SAMRC but based at tertiary institutions. The scope of the projects includes tuberculosis, HIV/AIDS, cardiovascular and non-communicable diseases, gender and health, as well as alcohol and other drug abuse.

In 2015, the SAMRC entered into a memorandum of understanding with the Swedish Research Council for Health, Working Life and Welfare (FORTE) to expand collaboration between South African and Swedish scientists. The funding, which comes from both organizations, went to eleven collaborative projects that focused on inequalities of health and health system policies.

“The memorandum of understanding really underpins the relationship in terms of how we fund projects, how we operationalize projects, and so forth,” said Niresh Bhagwandin, Executive Manager of Strategic Research Initiatives at SAMRC. “That has worked very well for us.”

Under the agreement, the two organizations put out a joint call for proposals in South Africa and Sweden. The proposals went through a peer review process in both countries, and the successful projects just completed phase one consisting of a three-year funding period. The SAMRC and Forte are now looking at jointly funding phase two.

They had one co-primary investigator in each country, and the funding from each country went to its respective researchers. One project, for instance, studied the feasibility of the introduction of a Swedish human papillomavirus test (HPV) for the management of cervical disease in the Eastern Cape. Another looked at how to promote institutional collaboration between Sweden and South Africa to improve the accessibility and uptake of sexual health services among men.

The SAMRC believes that these projects will synergize and complement the expertise of scientists from both countries.

“By collaborating with our counterparts in Europe and elsewhere, we build our capacity and skills, which then can be transferred to others in our country,” said Bhagwandin.

INSTRUCT & South Africa

INSTRUCT is a distributed RI that makes high-end technologies and methods in structural biology available to researchers around Europe and increasingly outside of Europe. (Daenke & Owens, 2017)

“In the field of structural biology, we’ve been involved in collaboration with South Africa for some years,” said Susan Daenke, Coordinator of INSTRUCT. “In Cape Town, scientists were interested in using structural techniques for their work on local pathogens, specific to the South African region, and other areas of research as well.”

The researchers had very little technology in South Africa for this purpose, so they began a collaboration with partner sites in the UK to gain access to instrumentation there. When INSTRUCT was formed, they were able to broaden that relationship to include the other sites across Europe.

“That was a way that we were able to increase the value to South Africa, of bringing in more technologies and more access, pathways, training, and support for the structural work they wanted to do but were unable to service themselves with their own national facilities,” said Daenke.

INSTRUCT has also acted as a service provider for further collaborations, including a 2019 project called START (Synchrotron Techniques for African Research and Technology) funded by the UK Science and Technology Facilities Council (Project launched with Africa to develop new energy and healthcare research, 2019). The START grant aims to develop relationships between the UK and Africa in the domain of structural biology. The project is led by the Diamond Light Source synchrotron research facility, which is part of INSTRUCT. The African countries involved include South Africa, Lesotho, Ethiopia, and Egypt.

START held its first workshop at the University of Cape Town in January 2019, followed by a virtual symposium in March 2020 due to the COVID-19 pandemic. The project has already led to a publication on a pathogen found in South Africa (Ebrecht, et al., 2019), and some of the techniques used have become very important for research on the virus that causes COVID-19.

Recommendations & best practices

Many experts noted that a formalized partnership between countries – such as a memorandum of understanding, a joint grant, or RI membership – begins with individual researchers from Africa and Europe working together. Collaboration across regions must start with the science itself as motivation to move forward towards a larger commitment.

For African researchers, working with European partners often stems from a need to access specialized equipment or facilities not available in their own country or continent. According to Abberton, Nigeria lacks the infrastructure for the latest tools in agricultural research, like next-generation DNA sequencing. To gain access to such technology, IITA must work with partners outside of Africa.

"It's about being able to capitalize on those strengths of Europe and the U.S. They can maintain themselves up-to-date in areas like sequencing, where technologies are changing all the time," he said. "But we can apply those tools to our own objectives and needs here in Africa."

"The tried and tested pathway to membership always starts with a scientific collaboration," Daenke said. "So we engage with the scientists first and then rely on them to sort of act as a champion locally to engage the other key stakeholders."

The local scientists are the ones who know who in the ministry they should be talking to, who the local organizers are, and which individuals are the decision-makers. So she recommends relying on the scientists to make the initial broader contacts within their own country, and then representatives from the RI can develop those further.

Several experts mentioned that mutual benefit is a key part of successfully working together. During his Ph.D. work, Sithole realized that African scientists have the ability to bring new research topics to the table. In the field of materials science, Sithole worked on difficult questions related to the mining industry in South Africa. He collaborated with UK universities that had the materials analysis tools he needed to complete his research.

"They had these tools, but they never applied them to the problems that we were presenting," said Sithole. "It made for a very good collaboration in the sense that we were coming up with specific problems for these tools that had never been tested beyond what the people in Europe understand."

Daenke agrees, noting that structural biology research in Africa tends to revolve around local pathogens and diseases in both humans and animals that European scientists don't have any experience with. The unique geographical context of such research brings new and uncharted topics to the table.

When it comes to formalizing African-European RI collaboration, experts stress the importance of laying out expectations and standards in writing. As an example, Bhagwandin brought up a key point about intellectual property. There have been past instances where researchers come from Europe or elsewhere, “parachuted” into an African country, performed the study, and published their findings. But any benefits from the study failed to get back to the local researchers who worked on the project.

“We have had experiences where IP has been taken from the country, and we haven’t been compensated adequately,” he said. “So there is a certain amount of suspicion by researchers here.”

Both parties need to be protected when it comes to intellectual property, and Bhagwandin adds that sound material transfer agreements must be in place. He wants African researchers to avoid the situation of having their unique samples taken by industrialized countries and exploited for their own purposes, such as drug development, with very little credit or monetary return coming back.

Abberton also recommends that European researchers need to engage with people and institutions on the ground in Africa instead of just shipping equipment over and expecting experiments to happen. They need to have boots on the ground, so to speak. In the past, he has seen several instances of equipment sent from Europe or the U.S. either stuck in the port or gathering dust in a building somewhere. Perhaps it broke and no one knows how to fix it, or it requires a reliable source of electricity, which doesn’t always exist in Africa.

“These are projects that have been funded to increase infrastructure in national programmes and have not at all been effectively utilized,” said Abberton. “So I would say very strongly that all those details have to be carefully thought through.”

Even IITA has had issues with procurement in the past. Sometimes chemicals with a finite expiration date, like biological reagents, will get stuck in the port for years. The electricity also fails very regularly, but IITA thankfully has four or five generators in place to rely on as backup.

“European scientists should think about the actual needs of research in Africa. Otherwise, there is a big danger of repeating the research pitfalls of the past,” he said. “Some of it requires things that scientists would not traditionally do, like figuring out supply chain issues or regulations. How will you get the equipment from A to B? Is it going to be something that functions in this heat, dust, etc.? And the training of people and capacity development is very important.”

Lastly, Sithole suggests that patience and tolerance for other cultures, as well as different levels of technical competencies, is critical to a successful international collaboration. The standards put in place by the LHC in order to join its computing grid presented a high bar for the CHPC, but open communication between the two RIs helped it be an enjoyable and fruitful experience. Ultimately, the success of becoming a Tier 2 facility depended on perseverance and enthusiasm from both parties.

Challenges and bottlenecks

When asked about challenges to effective RI collaboration, many experts mentioned the lack of funding for research in Africa. While bi-regional partnerships involve a pooling of resources and sharing of expertise, the majority of funding originates on the EU side (Cherry, Haselip, Ralphs, & Wagner, 2018).

“If you look at the statistics, I think we get more money from external sources outside of South Africa for research rather than from internal sources like the private sector and government,” said Bhagwandin. “Funding is always a major challenge.”

He believes not enough money is allocated to scientific research in South Africa because of problems with translating findings for policy makers. Researchers have trouble publishing their results in a way that people can understand, while those in government don't have the sufficient expertise to look at research outputs and translate them to policy.

In addition, Bhagwandin feels that the low research capacity in Africa is a bottleneck to RI collaboration with Europe. A very small portion of researchers are medically qualified in South Africa because they spend years training to become a doctor and need to earn money afterwards to pay off their student loans. Research doesn't pay very well, so not many choose to go that route.

As a result, differences in capacity and skill level could create an initial rift between African and European researchers. Sithole mentioned that CERN engineers had to help the CHPC meet its standards for becoming a part of the Worldwide LHC Computing Grid. This bottleneck, however, is not exclusive to collaborations with African countries. Swift stated that even some European countries joining the ESS had a lack of quantitative data analysis expertise.

"We have had to put a lot of work into getting the national teams up to our high standard," said Swift. "I suspect the lesson here is that there needs to be a lot of focus on capacity building, but you are still at the behest of local conditions and funding structures."

On a related note, Daenke states that navigating the labyrinth of government and politics in an unfamiliar country can be a barrier to entry. INSTRUCT has tried to broaden its reach into African countries such as Mali, Cameroon, Nigeria and Kenya. But it has proven challenging to wade through the politics and funding capabilities of the different countries.

"In Africa, we have dealt mostly with South Africa, but that's not to say that we aren't aware that there are plenty of other African countries where there is some structural biology. But it's very difficult sometimes to understand the local political scene, which can be very complicated," she said. "We have found it quite difficult to engage with those countries, partly because they tend to have small projects that are rather independently run, and so we haven't so far been able to bring everybody together under a single umbrella."

Typically, it takes five years of work for a non-European country to go from a scientific collaboration to achieving INSTRUCT membership due to all these factors.

Abberton also brings up the point that some Europeans may have a negative perception of traveling to Nigeria and other countries in Africa. He notices that institutions in Europe and the U.S. will organize workshops mostly in places like Nairobi, Kenya or Accra, Ghana.

"I think once people come here, it's fine, but there is that perception, which means there may be a reluctance to collaborate," said Abberton. "There are some countries which just naturally people are more comfortable visiting in Africa compared to others."

Advice for policy makers and funders

Policy makers should start with co-creating an RI roadmap with local partners, if the country doesn't already have one. Such a framework prioritizes the development of national RI needs and provides guidance to government bodies on RIs as necessary tools for research, development, and innovation.

The South African Research Infrastructure Roadmap, for instance, was developed through a joint agreement between South Africa and the EU (South African Research Infrastructure Roadmap, 2016).

“Research infrastructures are very much an important priority for South Africa,” said Pillay. “We should never look at a research infrastructure as just a research infrastructure. It’s about the benefits that accrue from that research infrastructure being in a specific place.”

To convince policy makers to fund a collaborative RI project, the larger socioeconomic benefits must be emphasized. Pillay mentions the SKA as a global RI project that has already had positive effects on the neighbouring community that go beyond the science.

“We’ve set up a new university focused on the skills needed for the SKA like data analytics and computing, which is important for the community because they didn’t have access to a university before,” she said. “It’s about using the research infrastructure to leverage off on some of the socioeconomic development associated with it.”

Adams describes three criteria that influence whether an RI-related project will receive funding from the DST or not: critical mass, affordability, and alignment with national priorities. First, he asks whether there is a critical mass of researchers in the country who need access to the facility. If there are only two or three of them, then the project is unlikely to be funded. Second, the project needs to be affordable – especially given that European RIs require payment in Euro or Swiss francs.

“Lastly, we need to know the objectives of the collaboration, and how they align with the priorities of the country,” said Adams. “There are always competing priorities, because providing money for researchers to go to CERN means less money for building hospitals or HIV/AIDS research. An emerging requirement for our researchers is to demonstrate translation of the research in terms of societal impact.”

He also suggests that countries interested in collaborative research could start with signing a low-commitment letter of intent for a year to test the waters. The letter of intent allows researchers to visit the facilities, attend workshops, and start conversations around potential projects.

“After a year, you learn what that facility is about and what you can offer, if you like what you see and hear, you can go into a formal agreement,” he said.

While research funding is an issue for African countries, European programs that are open to the world or emphasize non-EU partners have worked well to foster collaboration between the two continents. Horizon 2020 is the biggest EU Research and Innovation program to date, with nearly 80 billion Euro worth of funding available over 7 years (2014 to 2020). It is “Open to the World,” meaning that participants from anywhere can apply for most of the calls. In addition, several topics strongly encourage or require cooperation with non-EU partners. The successor to Horizon 2020, Horizon Europe, will cover the period of 2021 to 2027.

As of 2019, the EU has invested a total of 123 million Euro in African Union partners and funded 310 African projects through Horizon 2020 (Horizon 2020: Africa and the EU strengthen their cooperation in research and innovation, 2019). South Africa had 126 projects funded by the program, followed by Morocco with 50 projects and Kenya with 47 projects. The main thematic areas are environment, food, information and communication technology, and health. Horizon Europe, the successor program to Horizon 2020, should provide similar opportunities.

On a smaller scale, the ESS and SASAS tapped into the UK's Newton Fund for their project, which supports research and innovation partnerships with 17 countries including South Africa and wider Africa. Or two nations could work together to contribute funding, such as in the case of the SAMRC and Sweden's Forte. The two organizations each funded their own country's researchers to focus on collaborative projects.

Future opportunities and areas of growth

All experts believed that the opportunities for African-European RI collaboration would only increase in the future. One reason is the growth of e-infrastructures, which involve networked systems in which technologies and social institutions are intertwined. Today, almost all large-scale research activities include or are supported by several e-infrastructure components (e-IRG secretariat, 2017). Resources are shared and used remotely, which allows researchers from Africa and Europe to collaborate without incurring the costs of travel and accommodation.

As an example, some of the structural biology instrumentation at INSTRUCT can be accessed remotely. Researchers ship their samples to the site where the instrument is based and can even watch in real-time as the data are collected live. Some work has to be done to ensure that sample quality is maintained during shipping and handling, but it is a much cheaper option for African scientists who need those particular tools.

In addition, Pillay sees e-infrastructure as an important resource that can benefit a wide range of scientific projects. The CHPC provides computing power for calculations and simulations that cover physics, infectious disease, bioinformatics, energy storage, astronomy, and environmental science to name a few.

“I think digital skills, high-performance computing, and data analytics are things that can be used from a research infrastructure perspective across different domains,” she said. “It isn't necessarily confined to one field like ocean research or agriculture. These resources are cross-cutting.”

Both Pillay and Adams stress the geographical advantages of South Africa for research, which can be extrapolated to the continent as a whole. When it comes to identifying research priorities, the DST has focused on South Africa's unparalleled access to the southern oceans, the Southern Sky, and the Antarctic. For instance, South Africa signed a joint Statement on Atlantic Ocean Research and Innovation Cooperation with the EU and Brazil in 2017 to better understand the ecosystems and climate of the South Atlantic (EU expands its research cooperation with Brazil and South Africa, 2017). The statement specifically describes the sharing of RIs within the partnership in order to increase operational efficiencies.

In medical research, Bhagwandin mentions that South Africa has good expertise – and a plethora of patients – in areas like HIV/AIDS, tuberculosis, and diabetes. Daenke mentions that research conducted with South Africa on local infectious disease pathogens has become very important in light of the COVID-19 pandemic.

Lastly, the experts mentioned outreach activities by RIs as being crucial to increasing the amount of African-European RI collaboration. Summer schools, workshops, and internships based at RIs are all excellent ways to get young people involved at an early stage to build skills and training. INSTRUCT provides internship grants twice a year for students and young researchers to travel to one of its centres to work for three months.

"For scientists from a country where structural biology is perhaps less mature, they really thrive in those conditions because they see first-hand how a busy collaborative laboratory in Europe works," Daenke said. "They get exposed to all the collateral benefits of being in a place like that. The grants are competitive, but if you get one, it could really kickstart your career."

In general, part of INSTRUCT's outreach programme focuses on regions in Africa, Australia and Latin America where structural biology is less established.

Conclusion

African-European RI collaboration has the potential to advance scientific progress in several areas, including astronomy, agriculture, environmental science and medicine. Challenges and bottlenecks do exist – for instance, a lack of funding, low research capacity and political barriers – but the case studies outlined in this report demonstrate that these can be successfully overcome.

Key recommendations from experts to facilitate African-European RI partnerships can be categorized into actionable items for RI representatives, policy makers and funders.

Key recommendations for RI representatives

RATIONALE/GLOBAL CHALLENGES

- RIs are often involved with global issues and need to include Africa in its research, both in terms of data and solutions.

FRAMEWORK

- Offer different approaches, concepts and other means of participation to countries outside of the continent.
- Provide a formal framework for partnership between countries, such as a memorandum of understanding or a joint grant including expectations and standards for the RI collaboration.
- Recognize that the RI collaboration should have mutual benefit to both parties.

CO-CREATION BASED ON NEEDS

- Patience and tolerance for other cultures, as well as different levels of technical competencies.
- Learn new approaches: working in different parts of the world requires simpler and different solutions, based around mobile technology and scarcity of research infrastructure.
- Engagement with the people and institutions on the ground.

ACCESS

- Access for outside researchers to have RI access for specialized equipment or facilities that may not be available in their own country or continent.

OUTREACH

- Organization of outreach activities such as workshops and summer schools for international students.

BEST PRACTICE

- Learn from existing success stories of African-European RI collaborations.

Key recommendations for policy makers & funders

FUNDING

- Assess the value of potential RI projects through the lens of critical mass, affordability, and alignment with national priorities.
- Join forces to contribute funding from both the European and African side, with each supporting their own country's researchers to focus on collaborative projects.
- Promote synergies between funding agencies working towards shared objectives.
- Lobbying with key decision-making entities such the African Union for more funding for research
- Continue to develop and promote European funding programs that are open to the world or emphasize non-EU partners.

FRAMEWORK

- Co-develop RI roadmap, if the country doesn't already have one.
- Consider signing a low-commitment letter of intent for a year with another country to test the waters of collaboration.

CO-CREATION BASED ON NEEDS

- Listen to the local research community and assist its members in forming proposals that are relevant to local communities, tackling local impact of global issues, and devising appropriate solutions.
- Listen to the local research community and assist its members in forming proposals that show their project's socioeconomic benefit.
- Support capacity building initiatives on both continents to enable wider use of RIs, including establishing local hubs and sample collections to avoid loss of precious samples and create a resource of international importance.

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Table 1: Examples of research infrastructures in Europe and Africa

Energy	• European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL) • South African National Energy Development Institute (SANEDI)
Environment	• European Multidisciplinary Seafloor and water column Observatory (EMSO) • BIOdiversity Monitoring Transect Analysis in Africa (BIOTA Africa)
Biomedical Sciences	• European Clinical Research Infrastructure Network (ECRIN) • African Network for Drugs and Diagnostics Innovation (ANDI)
Physics & Engineering	• European X-Ray Free-Electron Laser Facility (European XFEL) • Southern African Large Telescope (SALT)
Social Sciences & Culture	• Survey of Health, Ageing and Retirement in Europe (SHARE) • South African Social Attitudes Survey (SASAS)
Big Data & Computing	• European High-Performance Computing Joint Undertaking (EuroHPC JU) • National Integrated Cyber Infrastructure System (NICIS)

Many more examples of research infrastructures can be found in the RISCAPE International Research Infrastructure Landscape 2019, which can be found online at https://riscape.eu/riscape-report/.

APPENDIX A: List of experts interviewed

Dr. Michael Abberton
Head of the Genetic Resources Center at the International Institute of Tropical Agriculture (IITA)

Abberton is Head of the Genetic Resources Center at the International Institute of Tropical Agriculture (IITA) based in Ibadan, Nigeria. He obtained his B.Sc. in Botany and Ph.D. in plant cytogenetics from the University of Manchester and subsequently undertook postdoctoral research in molecular biology at the University of St. Andrews. Following two years working on coffee germplasm improvement in Malawi, Abberton joined the Institute of Grassland and Environmental Research (IGER) in Aberystwyth, UK. in 1993. For a number of years, he carried out research and breeding in forage legumes and became Head of the Plant Genetics and Breeding Department at IGER. Following merger with Aberystwyth University in 2008, which created the Institute of Biological, Environmental and Rural Sciences (IBERS), he became Professor of Public Good Plant Breeding and Director of International Development.

Dr. Daniel Adams
Chief Director for Basic Sciences and Infrastructure at the Department of Science & Technology (DST) in South Africa

Adams is the Chief Director for Basic Sciences and Infrastructure at the Department of Science and Technology (DST), the South African government department responsible for scientific research. His responsibilities include the development and support of basic science research in fields like mathematics, physics, and chemistry. His portfolio also includes the oversight and management of research infrastructures, both lab-based physical infrastructure as well as e-infrastructure. Adams received his Ph.D. in materials science from Arizona State University in the U.S. He spent almost three decades in the higher education sector as a professor at the University of the Western Cape before joining the DST in 2007.

Dr. Niresh Bhagwandin
Executive Manager of Strategic Research Initiatives at the South African Medical Research Council (SAMRC)

Bhagwandin is the Executive Manager of Strategic Research Initiatives at the South African Medical Research Council (SAMRC), an organization that conducts and funds health research and medical innovation. His portfolio includes collaboration with a number of funding institutions across the world such as the National Institutes of Health (NIH) and the Centers for Disease Control and Prevention (CDC) in the U.S., as well as Forte in Sweden. Bhagwandin received a Ph.D. in biomedical engineering from the University of Cape Town and an M.B.A from Keele University. He has held his position with the SAMRC for almost 23 years.

Dr. Susan Daenke
Coordinator of the Instruct-ERIC Hub

Daenke is the Coordinator of the Instruct-ERIC Hub, a pan-European distributed research infrastructure making high-end technologies and methods in structural biology available to users. She is responsible for the delivery of all access, training, internship, and networking offered through Instruct. She has more than ten years of experience in managing and coordinating large European projects in structural biology. Daenke is a former scientist and group leader who oversaw the implementation of the first European

Commission access program to be run at the structural biology facilities through the I3 project P-CUBE and subsequently through the Biostruct-X project.

Vinny Pillay
Senior Science & Technology Representative at the South African Embassy

Pillay is the Senior Science & Technology Representative to the EU, of South Africa's Department of Science & Innovation. She is currently based at the South African Embassy in Brussels. She holds a Master's Degree in Science, and a Master's Degree in Business Leadership, with experience in international relations, the science and technology sector as well as the environmental sector. In her previous role as Chief Director-Bilateral Cooperation, Pillay managed the science, technology and innovation cooperation between South Africa and strategic partners in Europe, Americas, Asia and the Gulf. In engaging with bilateral partners, she negotiated value addition to the South Africa science system, promoting research, exchanges, human capital development as well as policy dialogues in key science, technology and innovation priority areas.

Dr. Happy Sithole
Director of the Centre for High Performance Computing (CHPC) in South Africa

Sithole is the director of the Centre for High Performance Computing (CHPC) at the Council for Scientific and Industrial Research (CSIR), South Africa's central and premier scientific research and development organization. The CHPC is one of three primary pillars of the national cyber-infrastructure intervention supported by the Department of Science and Technology (DST). The South African National Research Network (SANReN) and the Data Intensive Research Infrastructure of South Africa (DIRISA) complement the CHPC through the provision of high-speed, high-bandwidth connectivity, and the effective curation of a variety of notably large and critical databases. Sithole completed his Ph.D. in materials science, focusing on electronic and atomistic simulation of iron sulphides, at the University of Limpopo. He has led South African participation in the international student cluster competition, hosted by the International Supercomputing Conference – twice walking away with the first prize.

Stefan Swift
Media and Communications Officer at the European Social Survey (ESS)

Swift is the Media and Communications Officer at the European Social Survey (ESS), an academically driven cross-national survey that has been conducted across Europe since its establishment in 2001. Following an application to the European Commission, the ESS was awarded European Research Infrastructure Consortium (ERIC) status in 2013. In the role, he has created -- and is now delivering -- a comprehensive Media, Communications and Public Affairs Strategy to assist the dissemination of results to the European Community in Brussels, European civil society and policy-makers, and the general public in Europe. Swift has developed news material using contemporary and historical survey data accrued and deciphers what can be complicated academic research into more understandable language for the general public. He previously worked for Tower Hamlets Council and London Communications Agency.

APPENDIX B: Further Reading

ESFRI Roadmap 2018: Strategy Report on Research Infrastructures: http://roadmap2018.esfri.eu/media/1066/esfri-roadmap-2018.pdf

RISCAPE International Research Infrastructure Landscape 2019: https://riscape.eu/wp-content/uploads/2019/12/Riscape_report_digi_19122019.pdf

South African Research Infrastructure Roadmap 2016: https://www.gov.za/sites/default/files/gcis_document/201610/sa-research-infrastructure-road-mapa.pdf

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Joint Communication to the European Parliament and the Council - Towards a comprehensive Strategy with Africa: https://ec.europa.eu/international-partnerships/system/files/communication-eu-africa-strategy-join-2020-4-final_en.pdf

Towards an African Light Source by Simon H. Connell, Sekazi K. Mtingwa, Tabbetha Dobbins, Nkem Khumbah, Brian Masara, Edward P. Mitchell, Lawrence Norris, Prosper Ngabonziza, Tshepo Ntsoane, and Herman Winick: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6682199/

Appendix 2

WHITE PAPER

Recommendations towards cooperation between Latin American and European research infrastructures

Author: Meeri Kim

Contributions: Lisa Vincenz-Donnelly (EMPHASIS), Sven Fahrner (EMPHASIS), Golbahar Pahlavan (ECRIN), Paula Garcia (ECRIN), Roland Pieruschka (EMPHASIS), Claudia Alén Amaro (Instruct-ERIC), Bahne Stechmann (EU-OPENSCREEN), Alejandro Buschiazzo (Institut Pasteur de Montevideo), Inmaculada Figueroa (ESFRI, MICINN) with support from the RI-VIS consortium.

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Executive summary

International cooperation in science and technology is an important part of addressing major global issues like climate change, infectious diseases, food security and natural disasters. Research infrastructures (RIs) are organizations that enable scientists to use specific facilities, resources and services in order to accelerate scientific achievements, break boundaries and promote sustainable research. Fostering RI partnerships across borders has the potential to improve the efficiency and quality of research to tackle the many challenges faced by society today.

RI-VIS is a Horizon 2020-funded project to increase the visibility and raise awareness of European RIs to new communities in Europe and beyond. This report, as part of RI-VIS, focuses on ways to increase collaboration between Latin American and European RIs. It collates the insights of experts from Latin American RIs, European RIs and policy makers into sections that cover examples of successful collaboration, lessons learned and possible challenges/bottlenecks.

The following key recommendations from experts (RI representatives and policy makers) to facilitate Latin American-European RI partnerships are categorized into actionable items for RI representatives, policy makers and funders:

Key recommendations for RI representatives

RATIONALE/GLOBAL CHALLENGES

- First and foremost, scientific priorities must align between the two parties for a collaboration to be successful.
- Getting involved with initiatives that promote bi-regional collaboration, such as EU-LAC ResInfra (EU-LAC ResInfra, 2019) or EULAC-PerMed (EULAC PerMed, 2019), have proven effective as a means to connect RIs.
- Build trust and relationships incrementally, as having a few initial connections usually opens the door to many more.

FRAMEWORK

- Take into account that legal, ethical and funding frameworks may differ significantly in the other region.

OUTREACH

- European RIs should place more emphasis on outreach activities in Latin America and make it clear that they want to collaborate.
- Understand that Latin American researchers are not as familiar with the concept of open-access RIs in the European sense.

ACCESS

- Think about ways to collaborate virtually, such as making RI tools available through remote access.

SUSTAINABILITY

- Look into signing official agreements that place a priority on long-term, sustainable collaboration with partners from the other region instead of only working together on informal, one-off projects.

Key recommendations for policy makers & funders:

FUNDING

- The concept and many benefits of research infrastructures (RIs) need to be clearly conveyed to policy makers and funders.
- The example of prominent RIs may be leveraged as a success story to show policy makers and funders the advantages of RIs and RI collaboration across borders.
- Core funding to ensure intrinsic stability over a period of several years is key to take the next step of international RI partnerships.
- Small grants or funding opportunities for bilateral collaborative research projects, practical workshops or staff exchanges are necessary.
- European policy makers and funders could reach out to Latin American governmental organizations to establish RI collaborations.
- Political engagement in RI collaborations is important, and science ministers or heads of funding agencies should get involved for maximum impact.

CO-CREATION BASED ON NEEDS

- Funding calls originating from Europe should promote projects that incorporate Latin American colleagues.
- Co-funding is another option which allows countries from different regions to put money in a common pot for ambitious transnational projects.

Contents

Background

In 2015, the United Nations General Assembly outlined a set of 17 Sustainable Development Goals to achieve a better and more sustainable future for all (Sustainable Development Goals, 2015). They aim to address major societal challenges faced by humankind related to disease, climate change, food security, environmental degradation and poverty. Scientific research is an essential part of tackling these issues. The process of gathering information and expanding our knowledge of the world has the power to improve overall health, safety and standard of living.

Research infrastructures (RIs) are crucial to the advancement of science in many fields. The availability of well-maintained RIs facilitates cutting-edge research and training of highly skilled specialists. They include major scientific equipment; resources such as collections, archives or scientific data; e-infrastructures such as data and computer systems; and networks of communication (Ministro de Ciencia, Tecnología e Innovación, 2020).

A key motivation of RIs is the sharing of knowledge and resources across institutions, countries and continents. Large-scale research facilities are incredibly expensive and challenging to build and maintain by one single nation on its own. Others require data collection from different parts of the world. Thus, a more effective and productive way to conduct research is to pool together resources and share costs. Both single-sited and distributed RIs allow for technological transfer to reduce costs, enable user access across borders, set common standards, help to avoid duplications of effort and strengthen regional integration. The European Strategy Forum for Research Infrastructures (ESFRI) was instrumental in setting up a pan-European ecosystem of research infrastructures, promoting not only integrated services from RIs across several disciplines but also providing a forum for dialogue and the promotion of consensus among countries for the future composition of the RI ecosystem and the adoption of common standards and best practices amongst its constituent RIs.

RI-VIS is a Horizon 2020-funded project to increase the visibility and raise awareness of European RIs to new communities in Europe and beyond (RI-VIS, 2020). Part of RI-VIS involves identifying routes to maximize the exchange of information and bases for new partnerships, in particular with RIs or communities outside of Europe. Mutually beneficial RI partnerships across borders can harness collective knowledge, assist in meeting global challenges and enhance global science capacity.

This report assembles the insights of several experts from both Europe and Latin America who have previous experience with such collaboration. Interviews were conducted from August to November 2020 with five representatives from RIs in Europe and Latin America, as well as three individuals from the policy side (see Appendix A). They highlighted examples of Latin American-European RI collaboration, best practices for successful collaboration, challenges/bottlenecks and recommendations to policy makers and funders. The preceding sections will outline the definition of an RI, the importance of RIs to society and the benefits of international research collaboration.

What is a research infrastructure?

The term “research infrastructure” comes with a certain degree of flexibility, since it lacks an established formal definition in scientific and policy literature. The European Commission defines research infrastructures (RIs) as “facilities that provide resources and services for research communities to conduct research and foster innovation” (European Research Infrastructures, 2020). The RI-VIS Communication Toolkit for European Research Infrastructures states that an RI is “an organization that enables the research community to use specific facilities, resources and services in order to accelerate scientific achievements and promote sustainable research" (Abecasis & Pintar, 2020).

In Latin America as a whole, the concept of research infrastructure is not as well-established and still fairly new. While most European countries have regularly updated national RI roadmaps, only "frontrunner" countries in Latin America such as Argentina and Brazil have undertaken this process (EU-LAC ResInfra, 2020). While the European Strategy Forum on Research Infrastructures (ESFRI) establishes a European Roadmap for research infrastructures across the entire region, no equivalent body or document exists for the Latin American region.

In Argentina, the National Systems of Large Instruments, Facilities and Databases (Los Sistemas Nacionales de Grandes Instrumentos, Facilidades y Bases de Datos) was established in 2008 as an initiative of the Ministry of Science, Technology and Innovation and the Inter-institutional Council of Science and Technology. The programme promotes the efficient use of the country's large-scale equipment and facilities, as well as scientific databases, that exist across different science and technology organizations.

The latest report, published in July 2020, describes RIs as "diverse and heterogeneous" and may include "main scientific equipment, resources such as collections, archives or scientific data, e-infrastructures such as data and computer systems and networks of communication" (Ministro de Ciencia, Tecnología e Innovación, 2020). RIs can register with the National Systems of Large Instruments, Facilities, and Databases by providing information about the host institution and infrastructure, equipment or data. When registered, 20 percent of the available operating time of the infrastructure should be made available to the community.

In 2016, the Brazilian Institute of Applied Economic Research (IPEA) published the first systemized study on the location, quantity and situation of RIs in Brazil (De Negri & de Holanda Schmidt Squeff, 2016). A book that encompassed the methodology and results of the study states that RI is "the set of physical facilities and material support conditions (equipment and resources) used by researchers to carry out R&D activities." It adopted this definition from the Mapping of the European Research Infrastructure Landscape (MERIL), a Horizon 2020-funded project coordinated by the European Science Foundation (ESF) (ESF Member Organisation Forum on Research Infrastructures, 2013).

Despite it being used in different contexts both internationally and even within Europe, the term maintains some common threads across definitions (International Research Infrastructure Landscape 2019: A European Perspective, 2019; Florio, Forte, Pancotti, Sirtori, & Vignetti, 2016):

- RIs are motivated first and foremost by **scientific objectives**. The main purpose of RIs is to generate new knowledge in a scientific field, allow research and innovation to break barriers and push the frontiers of science. They may be **curiosity-driven** without immediate application or application-driven, leading to products or services that directly **benefit humanity.**
- All RIs at their heart contain **valuable and unique assets**, whether they be major facilities, instrumentation, knowledge-based collections or collaborative networks. These networks may be cross-sectoral, multidisciplinary, international or any combination of the above.
- RIs often require **substantial capital investment** that typically goes beyond the capacity of an individual faculty, institution or funding program.

- Access to RIs expands **beyond an institutional level** to a national or international reach. The uniqueness and steep cost of the assets mean that the RI's capabilities will be in demand by external researchers in the field who are based outside the site.

RIs are often placed into three broad categories: single-sited, distributed or virtual. Single-sited RIs are centralized facilities at a single physical location. These include large telescopes, particle accelerators, synchrotrons, nuclear reactor sources or extreme laser sources. Distributed RIs usually integrate research facilities scattered in different regions or countries. They consist of a network of distributed instruments, collections or capacities that, taken as a whole, constitute an RI in order to achieve common goals. An interferometrically linked array of radio telescopes, large genome sequencing facilities or a network of clinical research units are examples of distributed RI. Lastly, virtual RIs are internet/cloud-based systems for scientific research, such as an archive of historical texts or virtual research environments (virtual labs) for data processing and analysis. RIs often offer a mixed category that combines physical and virtual aspects.

High-profile examples of RIs include CERN's Large Hadron Collider, the world's largest and most powerful particle accelerator; INSTRUCT, a collection of distributed facilities that promote structural biology research; Sirius, a Brazilian synchrotron light source that is the largest and most complex research infrastructure ever built in Brazil; and the National Consortium for Scientific and Technological Information Resources (CONRICYT), a digital RI that brings together several Mexican institutions to expand and streamline access to scientific databases and other specialized information. The Mercosur Centre of Structural Biology (CeBEM) is yet another example. While not formally constituted into a distributed RI, CeBEM has been successful in coordinating an array of medium and large facilities located in prestigious research institutions from South America and open to users working in protein science. Further examples from Europe and Latin America are provided in Table 1.

Societal impact of research infrastructures

The development, operation and maintenance of RIs require large investments from countries, sometimes encompassing tens or hundreds of millions of Euro per year. Decisions about investment in RIs at a national level often include an assessment of any direct societal benefits in addition to their future scientific impact (Horlings, Gurney, Somers, & van den Besselaar, 2013). However, such benefits tend to be difficult to predict, particularly for curiosity-driven projects.

For example, the overarching goal of CERN's Large Hadron Collider (LHC) was to better understand the fundamental structure of matter. The total cost of the accelerator, detectors and computing was 4.332 billion Swiss francs, making it one of the most complex and expensive scientific research facilities ever constructed. Beyond its obvious contributions to physics, CERN has been responsible for innovations that have improved medical and biomedical technology, space missions, art restoration and energy efficiency (Our Contribution to Society, 2020). The building of LHC has resulted in highly advanced superconducting magnets, exceedingly accurate measurement equipment and breakthroughs in data communication and storage. CERN also sparked the invention of the World Wide Web in 1989 (The birth of the Web, 2020) and the capacitive touch screen in 1972 (Stumpe & Sutton, 2010).

Other RIs provide direct outputs. For instance, the European Plate Observing System (EPOS) and the European Multidisciplinary Seafloor and water-column Observatory (EMSO) are both distributed RIs that inform society about environmental hazards and allow for more advanced preparation. The Oswaldo Cruz Foundation (FIOCRUZ) in Brazil, a large, distributed organisation composed of 16 scientific and technical units, works on all aspects of the therapeutic development pipeline, from drug discovery to validation and development.

In addition, RIs have the power to mobilize a global network to consider and refine important ideas that affect humanity as a whole. Global issues include environmental protection, energy security, natural disaster mitigation, preventing/curing infectious diseases and food security. In the area of food security, for example, researchers from academia and industry across the globe often have similar goals, such an increase in crop productivity and resilience, and RIs are pivotal in this respect (Pieruschka & Schurr, 2019).

On the economic side, jobs are created during the RI development process and for long-term maintenance. Gemini South is a large telescope in Chile that employs about 200 people, of which just 30 are astronomers and 80 are Chilean (Barandiaran, 2015). The staff who work there develop skills and knowledge that set them apart from their peers and their substantially-higher-than-average wages reflect their unique proficiencies. In addition, parts of the instrumentation are built by local engineering firms. In Chile overall, the number of faculty positions in astronomy almost doubled between 2006 to 2010 (Catanzaro, 2014).

RIs can also be hubs for innovation, as measured by records on the number of patents filed. The Brazilian RI roadmap included an analysis of patent activity during the period from 2007 to 2011 (De Negri & de Holanda Schmidt Squeff, 2016). A total of 548 infrastructures were associated with 591 patent applications during this time. In particular, patents were more concentrated within RIs who cooperate with other institutions, allow access to external researchers or provide services to companies and other organizations.

Aside from jobs and spillover technologies, RIs impact the economy and society in several other ways. RIs serve as key learning environments and hubs where knowledge is exchanged (Horlings, Gurney, Somers, & van den Besselaar, 2013). Researchers, students, industry and government all interact throughout the RI's development, construction and use. In addition, many RIs participate in public outreach to stimulate interest of students and other members of the community. The aim is to inspire curiosity and encourage a new generation of scientists to enter the field.

Taking all of the above points into consideration, the general consensus tends to be that RIs provide a positive return on investment and a substantial net benefit to society, economic development and scientific progress.

Scientific collaboration across borders

The collaborative nature of scientific research is inherent to its success. By sharing skills and data, researchers improve the efficiency and quality of their work while supporting the process of scientific production, knowledge creation and breakthroughs. The whole of a scientific collaboration is undoubtedly greater than the sum of its parts. But what are the benefits of collaborating with researchers based in other countries?

Different motivations exist, depending on the scientific field and country at hand. However, one thing is clear: The number of scientists participating in international collaborations is growing. An analysis of scientific publications and co-authorships found that international scientific collaboration is increasing in volume in all research fields over time (Coccia & Wang, 2016). Research is more global, cross-national and cross-cultural than ever before.

A 2019 study of interregional scientific collaboration from the 28 EU countries and Latin American and Caribbean countries demonstrates a steady rise in scientific publications with at least one author from each region (Belli & Baltà, 2019). From 2005 to 2016, the number of co-authored publications increased roughly 9.9 percent per year, with a total increase of 68.3 percent over the entire time period. The leading countries for bi-regional collaboration were found to be Brazil, Spain, France and Germany. However, small and emerging countries like Ecuador, Peru and Uruguay have more recently taken advantage of international collaborations to enhance their visibility in scientific scenarios.

A metaphor used to describe the importance of international collaborations is a frog deep inside a well, who has an excellent view of a small patch of sky (National Research Council, 2008). If most of the research in a field is done predominantly stuck in one well, such as North America or Europe, it can prove detrimental to scientific discovery. Getting out of the well can provide new research topics and collaborators, which help question underlying assumptions and spark fresh insights.

As an example, a 2010 study of scientific research in Colombia found that partners located overseas collaborate with local scientists and engineers to work mostly on Colombian issues or issues where Colombia is of scientific interest (Ordóñez-Matamoros, Cozzens, & García-Luque, 2010). The knowledge, experience and tools brought about by overseas researchers complement those of Colombian researchers. It also found that co-authoring publications with partners located overseas increased Colombian researcher output by nearly 40 percent.

Healthcare (34 percent) and biology (29 percent) are the biggest and most contributive areas of collaborative research between European and Latin American/Caribbean countries, according to the 2019 scientific publication analysis (Belli & Baltà, 2019). Astronomy, physics and environmental sciences are also productive areas of scientific cooperation between the two regions.

Beyond the scientific benefits, international collaboration in large science projects can also save money and support foreign policy (U.S. Congress, Office of Technology Assessment, 1995). The cost of “big science” has gone up, which makes it more difficult for a single nation to undertake such projects alone. Of course, reducing net costs for individual countries also motivates the creation of RIs. Collaboration makes it possible to share both the financial and technical risks of ambitious projects.

Lastly, research can also be a form of diplomacy, leading to alliances and memoranda that support foreign policy objectives. Joint scientific research can strengthen bonds with other countries and establish levels of trust.

Latin American-European research infrastructure collaboration

The European Union and Latin America (along with the Caribbean) “enjoy privileged relations and are natural partners, linked by strong historical, cultural and economic ties,” according to the European Union External Action Service (European Union External Action Service, 2018). They share a strategic bi-regional partnership, launched in 1999, and co-operate closely at an international level across a broad range of issues. The EU is the second largest trading partner for the Latin American and Caribbean region (European Commission, 2018).

In terms of scientific collaboration, the asymmetry of relations seen in the 1970s and 1980s has given way to a more equal partnership between the two regions (Gaillard & Arvanitis, 2013). Latin America went through an accelerated process of institutionalization and professionalization of research after the 1940s, and for several decades, scientific collaboration with Europe mostly involved European researchers lending technical assistance to Latin American researchers.

Over time, interactions became mutually beneficial to both parties instead of Europe merely supporting Latin America. A bibliometric analysis of co-authorship for the period 1984 to 2007 found that more Latin American and Caribbean papers were co-authored with European partners (98,155) than with the US and Canada (87,540) (Gaillard & Arvanitis, 2013). Under the seventh Framework Programme, Latin American and Caribbean researchers participated 1,143 times in joint projects with European partners (European Commission, 2018).

Regular summits have been held between the EU and the Community of Latin American and Caribbean States (CELAC) since 1999. CELAC, consisting of all 33 Latin American and Caribbean countries in the region, represents a regional political coordination mechanism. The last EU-CELAC Summit took place in June 2015 and highlighted science and research as a priority area for bi-regional cooperation (European Commission, 2018). Leaders suggested moving towards an EU-CELAC Common Research Area based on increased research cooperation, enhanced mobility of researchers, and exchange of knowledge and best practices.

Established in 2010, the Joint Initiative for Research and Innovation (JIRI) aims to enhance EU-CELAC cooperation on science and research by facilitating bi-regional dialogue on common priorities. Senior Officials Meetings are held regularly to discuss progress and future plans for the JIRI. The eighth meeting convened virtually on 30 October 2020, where the senior officials discussed cooperation on COVID-19 to ensure global access to medicines, vaccines and medical equipment. They also created a 2021-2023 Strategic Roadmap that outlines developments in the EU-CELAC Common Research Area (Senior Officials Meeting, October 2020).

The EU-CELAC Common Research Area has four pillars: mobility of researchers, cooperation of research infrastructures, global challenges and innovation. The roadmap states that the participants of the Senior Officials Meeting “acknowledged the multidisciplinary and strategic role of the Research Infrastructures to promote collaboration across borders of scientific domains, contributing to EU-CELAC strategic priorities in response to Global challenges” (Senior Officials Meeting, October 2020).

So clearly, both Latin America and Europe recognize RIs as an essential part of international scientific collaboration. Bringing together RIs from both regions with the common goal of scientific advancement and innovation has the potential to breathe fresh life into research topics, bring new perspectives and spur on novel developments. In fact, because RIs are already focal points of collaboration within themselves, the mutual advantages of Latin American-European RI partnership are expected to be even greater.

Broadly, RI partnerships at a global or intercontinental scale are worth developing for the following reasons:

- To harness collective global knowledge and experience
- To support leveraging of new international funding for RIs
- To promote access to and exchanges between RIs

- To facilitate the mobility of researchers
- To assist in meeting global challenges
- To compensate each other's shortcomings with regard to available infrastructures

Latin American-European RI collaboration can take many forms, and the examples that follow represent only a small sampling of partnerships. However, our objective is to learn from these real-world cases for the benefit of future collaborations and to better recognize opportunities for the two regions to work together.

Examples

LNMA & Global BioImaging

In 2006, Mexico's National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología - CONACYT) put out a call for institutions to apply for status as one of several "National Laboratories of Scientific Infrastructure or Technological Development" (CONACYT, 2006). The purpose was to achieve full national scientific development through the consolidation of physical, analytical, and experimental infrastructure that would allow researchers to produce high quality work. Eleven years and 1.6 million pesos (= about 65 thousand Euros) later, Mexico has established 77 National Laboratories that operate across the country in all areas of knowledge.

The National Laboratory for Advanced Microscopy (Laboratorio Nacional de Microscopía Avanzada – LNMA) provides highly specialized optical microscopy services to academic, industrial, and educational institutions. The RI grew out of a scientific collaboration between two researchers, one originally from Mexico and the other from the United Kingdom.

"Originally, I'm from the UK. I did my doctorate and first postdoc there, and then in 2002, I had the opportunity to come to Mexico and continue some work I'd started in the UK with a Mexican researcher," said Chris Wood, Academic Manager of the LNMA. "After a few years, it was obvious that we really needed to improve the availability of infrastructure."

At that time, the concept of RIs as core facilities and open access centers for researchers from any institution simply wasn't part of the landscape in Mexico. Wood and his colleagues had already put together an application for the Wellcome Trust, which had a fund for establishing infrastructure projects in developing countries, when they saw the call for National Laboratories from CONACYT. They rapidly translated the original application back into Spanish, sent it in, and won National Laboratory status along with financial support.

The LNMA facility opened its doors to offer services to scientific researchers in any discipline or Institution in January 2013. In 2015 a second site for the LNMA opened in the Mexican Health Service's main teaching hospital in Mexico City.

Wood spent the first four years spreading the concept of shared, free RI access to Mexican researchers who had never heard of such a thing.

"I did a lot of miles within Mexico, basically putting a lot of shoe leather into giving seminars explaining the concept. I would still have people at the end of a talk raise their hands and say, 'Would you be so kind as to receive my samples?'" he recalls. "I would reply, 'Absolutely. This is your laboratory, and I am just the custodian.' And they would be amazed."

Once Wood successfully established the LNMA's national reputation, he moved on to increasing the RI's visibility on an international stage. In February 2018, he attended a conference in the US on strategies for bioimaging centres co-organized by Antje Keppler, Head of Imaging Infrastructure Strategy Development at the European Molecular Biology Laboratory (EMBL) and Coordinator of Global BioImaging (HHMI Janelia Research Campus, 2017).

The event was Wood's first introduction to Global BioImaging, a Horizon 2020 project that created an international network of imaging infrastructures and communities in 2015. It brings together imaging facility operators and technical staff, scientists, managers, and science policy officers from around the globe. The network organizes an annual international workshop called Exchange of Experience to discuss common goals, trends, and challenges in running open access imaging facilities.

Keppler, who is also the Interim Section Director of Euro-BioImaging, later reached out to Wood to say that she would love to have more representation from Latin America within Global BioImaging. LNMA is now an active member of Global BioImaging, bringing the unique perspective of a developing country from a different part of the world.

"Even if you work in the best funded science system in the world, you're going to find that there are barriers to development and progress at some point," said Wood. "But the ones that we face in Latin America are not necessarily the same as you would find in Europe, Japan, or the US."

After six years, the LNMA has over 400 registered users from 14 Mexican states, and has delivered over 20,000 hours of services (an average of 14 hours daily). It has received 4.5 million USD in grant awards, and its staff have authorships on 32 – and received over 70 acknowledgements – in published papers. Six students have graduated from the LNMA at undergraduate and postgraduate level.

INSTRUCT

INSTRUCT is a distributed RI in structural biology that makes cutting-edge technologies and methods available to researchers around Europe and increasingly outside of Europe (Daenke & Owens, 2017). It is composed of 14 European Member Countries, one member International Organisation (EMBL), and one Observer Country (Greece). In July 2017, INSTRUCT was awarded European Research Infrastructure Consortium (ERIC) status by the European Commission.

In 2014, the British Council gave INSTRUCT some funding as part of an initiative to create and strengthen links between researchers and institutions in Uruguay and the UK. The RI undertook a small pilot project that allowed for an exchange visit and a structural biology workshop in 2016 organised at the Institut Pasteur de Montevideo in Uruguay. Following the workshop, a memorandum of understanding (MoU) was signed between INSTRUCT and Pasteur Montevideo.

The newly formed relationships with Uruguayan colleagues soon expanded into other connections within Latin America. A key for success in this case nicely illustrates the importance of symmetric work and experiences. The Pasteur Institute in Uruguay had previously joined efforts with several other prestigious research centres in South America, creating CeBEM in 2008. CeBEM is a regional network of

RIs, engaged in consolidating and disseminating Structural Biology methods for Life Sciences, offering medium and large-sized research facilities to Latin American scientists.

Quite similar to INSTRUCT with regards to scientific/strategic aims and values, the fact that CeBEM was already established served to speed up a truly bi-regional association with INSTRUCT, as well as ensured long-term sustainability of such a cooperation. Over the last four years, INSTRUCT has signed eight MoUs with other institutes and networks in Argentina, Brazil, Uruguay, and Venezuela. Members of these institutes were invited to apply for an International Access Call, launched in March 2019, to access the structural biology facilities in INSTRUCT. Such research visits are already delivering concrete results and are leading to much stronger bi-regional collaborations among scientists.

“In the last year, we’ve had another call for research infrastructure access for researchers in Latin America to use our European infrastructure,” said Susan Daenke, Coordinator of INSTRUCT. “That’s been a very successful program over the last several years.”

In addition, INSTRUCT has worked closely with colleagues in Brazil – which already had very sophisticated structural biology infrastructure – to further develop its capability. For example, INSTRUCT RI helped advance the country’s cryogenic electron microscopy (cryo-EM) facility. Brazil is also making a significant upgrade to its synchrotron facility, called Sirius, which should help foster further collaborations with Europe. Sirius will be one of the first 4th-generation synchrotron light sources in the world and designed to be the brightest of all the equipment in its energy class.

“This is very good news for us because they’re very keen to work with us on training programmes but also to establish an exchange programme where they can access our infrastructure and vice versa,” said Daenke. “So we’ve seen a really good expansion on the first relationship with Latin America that we had.”

The INSTRUCT-CeBEM example, with their focus in life sciences, has experienced an unexpected boost with regards to its impact in 2020. Infectious diseases such as COVID-19, while extremely unfortunate for mankind, are utmost pertinent examples of how global research development is very much needed. Pathogens do not respect borders and turn quickly into truly global issues. These cannot be addressed appropriately by building excellent science only in the more developed countries. Only if excellent science becomes a reality everywhere will we be able to tackle the huge challenges that are affecting humanity as a whole.

EULAC PerMed

The term “personalised medicine” generally refers to a medical model that uses the characterisation of individuals’ phenotypes and genotypes (e.g. molecular profiling, medical imaging, lifestyle data) to tailor the right therapeutic strategy or targeted prevention. The field has grown considerably over the last decade with the emergence of new diagnostic and informatic approaches.

Launched in January 2019, the EULAC PerMed project aims to strengthen the cooperation of Europe with Latin America and the Caribbean on research topics within personalised medicine (EULAC PerMed, 2019). It consists of a bi-regional consortium of eleven organisations from ten countries: Spain, Germany, Brazil, Italy, Chile, Uruguay, Panama, Israel, and Argentina. Organisations include the European Clinical Research Infrastructure Network (ECRIN), a distributed RI that was awarded ERIC status in November 2013, and the Oswaldo Cruz Foundation (FIOCRUZ) in Brazil.

Funded by Horizon 2020, EULAC PerMed also aims to engage Latin American countries in the International Consortium on Personalised Medicine (IC PerMed), which supports communication and exchange on personalised medicine research, funding, and implementation. The project has organised major meetings in Madrid, Spain (February 2019) and Montevideo, Uruguay (December 2019) that involved both researchers and stakeholders like policy makers and funders.

"It was amazing how people reacted just to the organization of the meeting. Everybody really came to the meeting from all over Latin America, and this was really great," said Esther Rodríguez, Head of the European Project Office for EULAC PerMed. "So the first thing you see is that they're really interested in establishing more networking and cooperation with Europe."

The technical workshop in Montevideo covered innovative methodologies for data use and management in personalised medicine research, while the stakeholder workshop aimed to build bridges in personalised medicine between Latin America and Europe. Around 60 to 70 participants took part in the stakeholder workshop, while 50 participants were selected for the technical workshop through an application-based process. The meetings highlighted opportunities to work together as well as challenges or barriers to bi-regional cooperation.

"Our priority is to make personalized medicine a reality in Europe and beyond," said Rodríguez. "For Latin America, we wanted to know if we share a common vision and understanding on what personalized medicine is, and what is being done on both sides."

While the COVID-19 pandemic prevented face-to-face meetings among the consortium, the members of EULAC PerMed managed to organise its 3rd summer school (November 2020) as a virtual event on the ethical, legal, and societal aspects of personalised medicine. Also, as part of the project, ECRIN and the Gorgas Memorial Institute for Health Studies in Panama are working together to establish a clinical trial helpdesk to facilitate networking between experts from the two regions.

LifeWatch & LNVCS

In March 2016, the EU-CELAC Senior Officials Meeting on science and technology confirmed "access to research infrastructures" as one of the three pillars for the implementation of the Common Research Area (EU-LAC WORKING GROUP ON RESEARCH INFRASTRUCTURES, 2017). One year later, a bi-regional Working Group on Research Infrastructures was established to support policy making and coordination in the RI dimension. The objectives of the Working Group include the exchange of information on EU-LAC RI policies and the identification of RIs that are priorities for bi-regional cooperation.

Andrés Eduardo Triana Moreno, Director of Research Infrastructures and Research Networks at Mexico's National Council of Science and Technology (CONACYT), serves as a liaison between Mexican and European RIs as a member of this Working Group. At a meeting in Costa Rica, he met representatives from LifeWatch, a European distributed RI that supplies e-Science research facilities for the study of biodiversity and ecosystem which achieved ERIC status in March 2017.

"When we were talking to LifeWatch, we were exploring the possibilities to include different kinds of collaborations with them because they are working on very interesting topics about climate change and environment," said Moreno. "In Mexico, we are very interested in that agenda. So when I came back to

Mexico, I was talking with my partners in my office about the possibilities to explore some collaboration with them."

At the same time, a Horizon 2020 project called EU-LAC ResInfra began in January 2019 as a way to support the dialogue within the Working Group. EU-LAC ResInfra will create a map of national and regional RI policies, with the objective of identifying eligible RIs for European-Latin American collaboration (EU-LAC ResInfra, 2019). It also aims to develop four pilot projects that build on existing European RIs – LifeWatch being one of them – in an area of knowledge identified as a priority for scientific cooperation between the EU and LAC.

Moreno put LifeWatch in touch with the National Laboratory of Housing and Sustainable Communities (Laboratorio Nacional de Vivienda y Comunidades Sustentables - LNVCS), an inter-institutional body with technical and scientific competencies that focuses on the development of sustainable housing and communities. He facilitated meetings between the two RIs that explored areas of interest and potential partnerships.

So far, LifeWatch and LNVCS plan to explore two topics together. The first is studying traditional techniques of making houses in the south of Mexico and the north of Guatemala, where they use natural materials and tools. LifeWatch is interested in learning more about these methods for building European houses. The second topic revolves around urban planning and creating more sustainable smart or green cities, which fits with both LifeWatch's agenda and the European Green Deal.

"The idea of ResInfra, more than the specific issues that the RIs can work on together, is to explore a more sustainable collaboration agenda for the next three, four, or five years," said Moreno. "The goal is really the formalizing of relationships between Mexican and European partners. In this moment, we are interested in another level of this relationship to involve the policy makers, funders, and managers."

MIRRI & Brazil

Biological Resources Centres (BRCs) act as service providers and repositories of living cells, genomes of organisms, and information relating to heredity and functions of biological systems. They ensure the proper maintenance and exchange of biological resources that are necessary parts of scientific investigations in biotechnology.

Since 1998, the Organisation for Economic Co-operation and Development (OECD) has been building international cooperation among BRCs. It aims to establish a global BRC network that will enhance access to biological resources and foster international collaboration. The project was first coordinated in 2008 by two leading European institutions in culture collections, the UK's Commonwealth Agricultural Bureaux International (CABI) and Germany's Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ).

"They started this demonstrative project for the global BRC network, which involved different countries including Brazil," said Manuela da Silva, Director of Biological Collections at FIOCRUZ in Brazil. "So the people from Europe involved with this project were also the people involved with MIRRI, and that's why they invited Brazil to become an observer country."

Launched in 2012, the Microbial Resource Research Infrastructure (MIRRI) spans more than 40 public biorepositories and research institutes from 19 European countries. It facilitates access to a broad range of high quality bioresources and data to support research and development in the field of biotechnology. MIRRI includes both Member States and Observer States, and Brazil was invited to be an Observer State.

First, da Silva and her colleagues wish to organise a stable BRC network within their own country. Eventually, the Brazilian BRC network will link together multiple institutions including FIOCRUZ, the state-owned Brazilian Agricultural Research Corporation (EMBRAPA), the University of Campinas, and a large cell bank in Rio de Janeiro.

Once the network is officially recognised by Brazil's Ministry of Science, Technology and Innovation, da Silva hopes to reconnect with her European colleagues. She also has a more ambitious goal of creating a Latin American or South American BRC network that will become part of a global BRC network made up of several regional BRC networks such as MIRRI.

Despite not joining MIRRI yet, the initial steps to membership and overall discussions between MIRRI and Brazilian BRCs have already produced some fruitful results. Representatives from DSMZ and CABI came to Brazil to evaluate the collections and, in doing so, shared useful information about quality management systems.

"They brought their experience, which was very important because the DSMZ and CABI are two institutions which have their quality systems in place and are accredited. So, we had a lot of discussion about this," said da Silva. "Even today, because of all these exchanges, we have a very good relationship with some European collections."

They also spoke about the complexities of access and benefit-sharing legislation, which aims to share the benefits arising from the utilisation of genetic resources among countries in a fair and equitable way. Currently, DSMZ is helping Brazilian BRCs with some issues related to national legislation. Da Silva has a close relationship with the Belgian culture collection network as well, known as the Belgian Co-ordinated Collections of Micro-organisms (BCCM), and she recently did an exchange visit to evaluate their collections and learn from the other's experiences.

Recommendations and best practices

The successful Latin American-European partnerships outlined above have several similarities that point to recommendations for future RI collaboration.

RATIONALE/GLOBAL CHALLENGES

Getting involved in large, multinational initiatives like ResInfra, the EULAC Working Group on Research Infrastructures, and EULAC PerMed has proven effective as a means to connect RIs from both regions. EULAC PerMed has an overarching global challenge in mind – to better the health of the world populations through personalised medicine – that serves as a common motivator. The EULAC Working Group, on the other hand, explores collaboration within five topics that both regions have expressed interest in, which comprise energy; biodiversity and climate change; food security, health and emerging technologies.

"International collaboration works best by incrementally building trust and relationships, as well as identifying where the needs and interests are of both parties," said Daenke.

INSTRUCT's involvement with ResInfra and other projects focused on European-Latin American cooperation have opened the doors to other countries within the region that the RI previously had no contact with. But Daenke emphasizes that scientific priorities between the two parties much align to produce a successful partnership.

"They're not really interested in working on our problems. They want to solve their own problems," she said. "We as a research infrastructure need to make sure that what we're offering is relevant to the topics that they want to address."

FRAMEWORK

Rodríguez suggests that European RIs take into account the very different frameworks – legal, ethical, funding etc. – present in different Latin American countries. For instance, something like the General Data Protection Regulation in the EU that gives individuals control over their personal data doesn't always exist in other places.

"If you really want to implement something for real, you have to deal with these issues, and they're very different from country to country," she said. "So, you have to deal with these different realities."

This issue can be acutely observed when it comes to the exchange of biological samples from one country to another. The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity, as well as national laws and regulations (especially in Brazil (Dutra, Campos, Santos, & Calixto, 2016)), make it very difficult for scientists to freely exchange samples. For instance, if a chemist wants to make compounds available through EU-OPENSCREEN, there is a risk that the required paperwork would prevent this sort of collaboration.

OUTREACH

RIs in both regions should also place emphasis on outreach activities. In particular, European RIs could initiate communication, since many researchers in Latin America may not be familiar with the concept of research infrastructures.

In order to establish his lab's reputation nationally, Wood spent several years giving seminars around Mexico, explaining what RIs do and how they exist for the purpose of aiding researchers. Having Latin American scientists understand the benefits of their own local RIs may also help them become more receptive to collaboration with European RIs.

"What was probably our biggest hurdle in the early stages, was actually to change the culture and way of thinking," said Wood. "Once that was established, and I could feel that we were accepted as part of the community as a reference point for microscopy, I took the strategic decision to make contact with our international peers."

In addition, Moreno believes that European RIs – even those with legal ERIC status – are not sufficiently visible in Latin America. Initiatives like RI-VIS and ResInfra serve as excellent opportunities to show Latin American researchers that European RIs are eager to work together on collaborative projects.

"When you are inside this world of research infrastructures, you know about ERICs, but when you are just a researcher in your institution, you don't always know. And you don't know that the ERICs are interested to explore other networks outside of Europe," said Moreno. "I think it's very important to have ERICs show what they are doing outside of Europe."

ACCESS
The COVID-19 pandemic has certainly slowed down some bi-regional partnerships, but it has also facilitated the creation of innovative tools that allow for increased virtual collaboration. For instance, INSTRUCT has transformed many of their tools from physical access, where people actually visit their centres to do the work, into remote access. Nearly all their infrastructure now is available from remote access, where researchers can monitor and gather data from their own computers.

"That means that the work can still be done, but you don't have to travel. And that has been a revelation," said Daenke. "It has pushed the development of technologies so that remote access becomes available to more people."

However, virtual access for many RIs is not a permanent solution and does not replace other forms of access. It can serve as a compromise or add-on, but having users present on-site will always be more valuable.

SUSTAINABILITY
One major aim of the ResInfra project is to develop a Sustainability Plan for a long-term bi-regional collaboration rather than short-term, one-off projects. Moreno believes that the key to sustainability lies in the signing of official agreements such as MoUs that involve policy makers and funding agencies. Without a formal partnership that involves other parties, scientific collaboration across borders can become short-lived or fall by the wayside.

"All of us know that we have a lot of years working together but not officially. The researchers and institutions usually have a relationship with partners on other side, they have friends at the other institution, they travel, and they build these relationships in that way," Moreno said. "We have to concrete the agreements and other instruments to the policymakers and the managers of the infrastructures here in Latin America to establish the relationship more formally."

Challenges and bottlenecks

In terms of factors that hinder Latin American-European RI collaboration, most experts mentioned funding as a challenge.

Rodríguez mentioned that RIs must cope with the fact that there are no such funding instruments akin to Europe's framework programmes in Latin America. Many Latin American RIs receive funding as an institution and not for specific collaborations, so they must look for additional funding when it comes to collaborative projects. Even national funding for scientific research in general is not always stable, as Daenke describes, and that usually comes from political volatility.

"These national fluctuations have a big effect on not only funding but also the research environment and the stability of academic salaries and tenure ship in academic posts, and so on," said Daenke. "It's sometimes difficult to navigate through that and to maintain relationships even in spite of the instabilities that might be operating nationally."

Da Silva talked about the difficulties with the change in Brazilian government that has significantly delayed the creation of a Brazilian BRC network – and subsequently, the joining of Brazil as an Observer State within MIRRI. In 2016, an ordinance published by the Ministry of Science, Technology and Innovation outlined all the steps needed for the recognition of the network. But the new government changed everything, and the ordinance lost its purpose. Now, da Silva and her colleagues have to start from scratch.

"We don't know when we are able to get back on track. That's why, in Brazil, we still don't have a recognized BRC," said da Silva. "We have several candidates, and some of them are already accredited by our accreditation body, but we don't have a BRC network yet as we planned it."

Moreno agreed that bureaucracy in Latin America can easily frustrate researchers who are eager to work together. Even when two parties are ready to formalize a scientific collaboration with a written agreement and dedicated funding, extreme delays introduced by legal reviews and other issues can get in the way.

"As a very specific example, when the lawyers review the documents to sign agreements on both sides, they have very different ways to make the assessment. It can take months and months," said Moreno. "The researchers may feel confused and sad because they say, 'I'm ready to start to work with my partner in the other region, but you, the bureaucracy, you never help us.' This is the principal problem."

In addition, the fragmentation of the regulatory framework in Latin America – with no overarching guidelines like in the EU – can serve as an obstacle to successful research collaboration. This can prove challenging from both sides, as some EU policy makers and investigators are less knowledgeable about this fact and believe that Latin America operates as a multi-country block. On the other hand, Latin American policy makers and investigators sometimes have a simplistic vision of what it takes to navigate the EU system, assuming that there are single policies and frameworks for every aspect.

Another challenge is the language barrier that can arise between certain countries from Europe and Latin America. Natalie Haley, Project Manager at INSTRUCT, notes that language is a key point when engaging with different regions. It can be far more productive and meaningful to have someone on the RI side who speaks the local language fluently when engaging with representatives from Latin American governments.

"Particularly, the funders speak in their local language and feel more comfortable interacting in that language," said Haley. "Although the scientists may speak English, the policy makers and funders may not, so it makes things difficult sometimes."

Advice for policy makers and funders

The expert interviews revealed recommendations for policy makers and funders coming from the government side, both in Latin America and Europe, that would increase RI partnerships between the two regions.

FUNDING

First and foremost, more policy makers and funders in Latin America need to understand the concept and many benefits of RIs. Wood's colleagues based in other Latin American developing countries have asked him to talk to their science ministers about the importance of establishing and funding RIs. Once

RIs are built up at a national level, they can then raise their profile to the international level and begin to collaborate more widely with regions like Europe.

“The argument has to be made for the benefits of organizing facilities or infrastructures into networks and centralizing them,” said Wood. “That argument doesn’t have to be made to scientists, but I do think that argument has to be promoted still to the funders.”

While policy makers and funders in the EU seem to intrinsically recognise the advantages of RIs, their Latin American counterparts need to be introduced to the idea first, perhaps by presenting European RIs as a success story. Many European RIs receive a degree of core funding to give them sufficient continuity and stability over a window of five to ten years – enough time to initiate and foster a long-term international scientific partnership.

“That kind of core funding just releases your shackles and enables you to think big. That is something I would dream about having in this region,” he said.

While larger, more complex projects like EU-LAC ResInfra have been successful, one should not ignore the importance of small grants and other funding opportunities for bilateral collaborative research projects, practical workshops, and staff exchanges. They can complement higher-impact projects while serving to bring scientists together and initiating collaborative research projects. For instance, Latin American funders can start small by providing funds to their own scientists to access European RIs.

European policy makers and funders could also reach out to Latin American governmental organisations to establish concrete collaborations with the region through RIs. Wood recommends having some kind of political engagement included in those initiatives by inviting science ministers or heads of funding agencies.

European programmes that are open to the world or emphasize non-EU partners have worked well to foster collaboration between the two regions. Horizon 2020 was the biggest EU Research and Innovation programme to date, with nearly 80 billion Euro worth of funding available over seven years (2014 to 2020). It was “Open to the World,” meaning that participants from anywhere could apply for most of the calls. In addition, several topics strongly encouraged or required cooperation with non-EU partners.

Up to October 2018, CELAC entities participated 524 times in 265 signed grants of collaborative, Marie Skłodowska-Curie, and European Research Council (ERC) actions of Horizon 2020, receiving a total of 26.3 million euros from the EU. The successor to Horizon 2020, Horizon Europe, will allocate an even more ambitious 95.5 billion Euro and cover the period of 2021 to 2027.

CO-CREATION BASED ON NEEDS

In addition, experts support having more funding calls originating from both European and Latin American sides that promote bi-regional projects. For example, Horizon 2020 had a call that funded several research projects in collaboration with Latin America including EULAC PerMed. Rodríguez also recommends more opportunities for “common pot”-style funding where countries collectively put money together for research.

“You each put a little bit of money, decide on the topics you want to fund, and then each party saves money on the management,” said Rodríguez. “Also, you can fund wider and more impactful projects because they're transnational. So if you believe you really can share some priorities, I think it's worth it for the funders to go for these transnational programs."

She describes the success of ERA PerMed, a funding instrument under Horizon 2020 to support collaborative research projects in personalised medicine. The co-fund is supported by 32 partners from 23 countries and co-funded by the European Commission. EULAC PerMed aims to bring Latin American countries into the ERA PerMed funding scheme so they can work on transnational projects together. Panama already joined the 2020 funding call, and Brazil and Chile are due to join the 2021 funding call.

Future opportunities and areas for growth

Overall, experts believed that Latin American-European RI collaboration would only increase in the future and highlighted several potential avenues for cooperation.

Daenke remarks that INSTRUCT's various collaborations with Latin America have been very rewarding, and the RIs participation in projects like ResInfra continue to open up contacts with more countries. Countries like Brazil already have sophisticated structural biology technology, but even the smaller countries have great science and new areas of knowledge to offer.

"It's important for them to not only be in receipt of some of the work and infrastructure access that we can provide for them, but they also want to provide something themselves as well," she said. "So the collaboration goes both ways. We can provide some of the technology and infrastructure, but they provide great science and the support for doing that."

For instance, experts at INSTRUCT have worked with Latin American colleagues on pathogenic diseases that are endemic to the region but not in Europe. These are areas of interest that European researchers wouldn't otherwise have an opportunity to be involved in.

The European Green Deal, an action plan to make the EU's economy sustainable, could also provide incentive for collaboration with Latin America. The EU aims to become climate neutral by 2050, and it plans to work with international partners to improve global environmental standards.

Every country in Latin America represents a different set of opportunities for scientific collaboration with Europe. Ana Vasquez and Nancy Ghan, representatives from the National Research and Innovation Agency of Uruguay (ANII), describe the country as small but very capable in terms of scientific research. Their strengths include agriculture, information technology, biomedical research, and clean energy. Andres Lopez Lara, a representative from the National Research and Development Agency in Chile (ANID), mentions that Chile is abundant in "natural laboratories" like the Atacama Desert, the Pacific Ocean, and access to Antarctica.

"We have a really strange geography in Chile. We have the driest desert in the north, and we have Antarctica in the south," said Lara. "For example, the rovers that went to Mars came here first to know how they can work. We also have a lot of volcanoes."

Lara hopes that Chilean researchers will increase collaboration with Europe in the future for access to better technology, as well as the chance to tackle problems of a global scale. To face looming issues like climate change, the regions of the world need to work together. Chile, in particular, has several research institutes dedicated to studying Antarctica. Of course, the COVID-19 pandemic has also highlighted the advantages of sharing information and working together to get results more quickly. Latin America has the strength of a huge population and incredible diversity, which are optimal when studying genomic medicine.

“One strength that is very clear, apart from their own capabilities in research at different places in Latin America, is the size of population,” said Rodríguez. “Diversity is a key strength when dealing with personalized medicine because then you have rich information.”

Conclusion

Latin American-European RI collaboration has the potential to advance scientific progress in several areas, including genomics, agriculture, arts and humanities, and medicine. Challenges and bottlenecks do exist – for instance, large time differences and the lack of European funding available to Latin America – but the case studies outlined in this report demonstrate that these can be successfully overcome.

Key recommendations from experts to facilitate Latin American-European RI partnerships can be categorized into actionable items for RI representatives, policy makers and funders.

Key recommendations for RI representatives

RATIONALE/GLOBAL CHALLENGES

- First and foremost, scientific priorities must align between the two parties for a collaboration to be successful.
- Getting involved with initiatives that promote bi-regional collaboration, such as EU-LAC ResInfra (EU-LAC ResInfra, 2019) or EULAC-PerMed (EULAC PerMed, 2019), have proven effective as a means to connect RIs.
- Build trust and relationships incrementally, as having a few initial connections usually opens the door to many more.

FRAMEWORK

- Take into account that legal, ethical and funding frameworks may differ significantly in the other region.

OUTREACH

- European RIs should place more emphasis on outreach activities in Latin America and make it clear that they want to collaborate.
- Understand that Latin American researchers are not as familiar with the concept of open-access RIs in the European sense.

ACCESS

- Think about ways to collaborate virtually, such as making RI tools available through remote access.

SUSTAINABILITY

- Look into signing official agreements that place a priority on long-term, sustainable collaboration with partners from the other region instead of only working together on informal, one-off projects.

Key recommendations for policy makers & funders:

FUNDING

- Policy makers and funders should understand the concept and many benefits of RIs.
- The example of prominent RIs may be leveraged as a success story to show policy makers and funders the advantages of RIs and RI collaboration across borders.
- Core funding to ensure intrinsic stability over a period of several years is key to take the next step of international RI partnerships.
- Small grants or funding opportunities for bilateral collaborative research projects, practical workshops or staff exchanges are necessary.
- European policy makers and funders could reach out to Latin American governmental organizations to establish RI collaborations.
- Political engagement in RI collaborations is important, and science ministers or heads of funding agencies should get involved for maximum impact.

CO-CREATION BASED ON NEEDS

- Funding calls originating from Europe should promote projects that incorporate Latin American colleagues.
- Co-funding is another option which allows countries from different regions to put money in a common pot for ambitious transnational projects.

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Table 1: Examples of Research Infrastructures in Europe and Latin America

Energy	• European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL) • Brazilian Centre for Research in Energy and Materials (CNPEM)
Environment	• European Multidisciplinary Seafloor and water column Observatory (EMSO) • Centro de Referência em Informação Ambiental (CRIA)
Biomedical Sciences	• European Clinical Research Infrastructure Network (ECRIN) • The Oswaldo Cruz Foundation (FIOCRUZ) • The Mercosur Centre for Structural Biology (Centro de Biologia Estructural del Mercosur – CeBEM)
Physics & Engineering	• European X-Ray Free-Electron Laser Facility (European XFEL) • Labratorio Argentino de Haces de Neutrones (LAHN)
Social Sciences & Culture	• Survey of Health, Ageing and Retirement in Europe (SHARE) • Instituto Nacional de Estadística y Censos (INDEC)
Big Data & Computing	• European High-Performance Computing Joint Undertaking (EuroHPC JU) • High-Performance Computing Latin America Community (HPCLatAm)

Many more examples of research infrastructures can be found in the RISCAPE International Research Infrastructure Landscape 2019, which can be found online at https://riscape.eu/riscape-report/.

APPENDIX A: List of experts interviewed

Dr. Susan Daenke, Coordinator of the Instruct-ERIC Hub

Daenke is the Coordinator of the Instruct-ERIC Hub, a pan-European distributed research infrastructure making high-end technologies and methods in structural biology available to users. She is responsible for the delivery of all access, training, internship, and networking offered through Instruct. She has more than ten years of experience in managing and coordinating large European projects in structural biology. Daenke is a former scientist and group leader who oversaw the implementation of the first European Commission access program to be run at the structural biology facilities through the I3 project P-CUBE and subsequently through the Biostruct-X project.

Dr. Manuela da Silva, Director of Biological Collections at FIOCRUZ

Since August 2002, da Silva has worked as a Federal Government Specialist at the Instituto Nacional de Controle de Qualidade em Saúde of Fundação Oswaldo Cruz (INCQS/FIOCRUZ) in Rio de Janeiro, Brazil. She focuses on the identification and preservation of fungi from environmental and clinical samples. Her work also consists of research on fungal degradation of pollutants, fungal diversity, fungal deterioration, and their elimination by gamma radiation. da Silva graduated in Biological Science from the São Paulo State University (UNESP) in 1991 and then started her career at the International Mycological Institute (now CABI) from 1992 to 1993, compiling the list of fungi from Brazil.

Andrés Eduardo Triana Moreno, Director of Networks and Scientific Infrastructure at the National Council for Science and Technology (CONACYT) in Mexico

Triana is the Director of Networks and Scientific Infrastructure and Deputy Directorate for Scientific Development at the National Council for Science and Technology (CONACYT) in Mexico. He participates in the EU-CELAC Working Group on Research Infrastructures (WG RI), which was officially created in March 2017, highlighting the importance of research infrastructures as one of three strategic pillars of the EU-CELAC Common Research Area (CRA). Triana also has a role as a coordinator of Work Package 4 for the Horizon 2020-funded ResInfra project, which pursues the construction of a bi-regional collaboration between the EU and LAC countries.

Nancy Ghan, Cooperation Officer at the National Research and Innovation Agency of Uruguay (ANII)

Ghan is a professional with a scientific background and experience in molecular biology applied to diagnosis in human health. At present, she is working in the field of Science, Technology, and Innovation Management as a Cooperation Officer at the National Research and Innovation Agency of Uruguay (ANII). Ghan also has a role as a teacher and mentor for biotechnology entrepreneurs. She is trained in Quality Management, Intellectual Property, and Marketing. She received her degree in biochemistry and molecular biology from Universidad de la República in 2005.

Andrés López Lara, National Contact Point for Research Infrastructures at the National Research and Development Agency of Chile (ANID)

López currently works as the Fondequip Program Officer in the Scientific and Technological Equipment Program and the National Contact Point for Research Infrastructures at the National Research and Development Agency (ANID) in Chile. He also serves as a representative of Chile in the CELAC-EU initiative of research infrastructures. He received his degree in Industrial Civil Engineering from the Pontificia Universidad Católica de Valparaíso in 2006 and his Diploma in Management Skills from the Universidad Adolfo Ibáñez in 2013. In total, López has more than 11 years of experience and more than 7 years in management and leadership positions in various organizational areas.

Dr. Esther Rodríguez, Head of European Project Office at the Instituto de Salud Carlos III

Rodríguez is the European Project Office Director at the Instituto de Salud Carlos III based in Madrid, Spain. She has a role as the National Contact Point and expert for the European Research Council and Research Infrastructures. In terms of science policy, she has experience in reporting for policy makers such as performing follow-up of Competitive Councils and Horizon 2020 preparation. Rodríguez received her doctoral degree in physics from the Université Denis Diderot (Paris VII) in 2005 and a postgraduate degree in International Management of RTD projects from the Universidad Politécnica de Madrid in 2007.

Ana Vasquez Herrera, Cooperation Officer at the National Research and Innovation Agency of Uruguay (ANII)

Vasquez is a Cooperation Officer at the National Research and Innovation Agency of Uruguay (ANII). Her professional interest is focused on the design and management of projects that aim to bring together the fields of science, technology and innovation, and society. From this axis, Vasquez has participated in scientific communication projects, public participation in science and technology, and promotion of science and scientific careers. More recently, she has expanded her experience and training in the field of organizational communication. Vasquez received her degree in biology and life sciences from Universidad de la República in 2013.

Christopher Wood, Director of the National Laboratory for Advanced Microscopy (LNMA)

Wood is an optical microscopist and cell biologist, and Director of the Laboratorio Nacional de Microscopía Avanzada (National Laboratory for Advanced Microscopy or LNMA), incorporated into the Instituto de Biotecnología, UNAM. He graduated with Honours from the University of Oxford with a Bachelor’s degree in Biochemistry and gained his Ph. D in 2000. Wood arrived in Mexico in 2002 to continue studies with Dr Alberto Darszon of the Instituto de Biotecnología, UNAM. He subsequently became an Associate Researcher in the laboratory of Dr Luis Covarrubias. Since 2008 he has worked to establish Mexico’s first open-access microscopy core facility, and after receiving funding from Conacyt and UNAM in 2011, the Laboratorio Nacional de Microscopía Avanzada opened its doors to offer services to scientific researchers in any discipline or Institution in January 2013. In 2015 a second site for the LNMA opened in the Mexican Health Service’s main teaching hospital in Mexico City. After six years the LNMA has over 400 registered users from 14 Mexican states, and has delivered over 20,000 hours of services (an average of 14 hours daily). It has received 4.5 million USD in grant awards and its staff have authorships on 32, and received >70 acknowledgements, in published papers, and six students have graduated from the LNMA at undergraduate and postgraduate level.

APPENDIX B: Further reading

ESFRI Roadmap 2018: Strategy Report on Research Infrastructures:
http://roadmap2018.esfri.eu/media/1066/esfri-roadmap-2018.pdf

RISCAPE International Research Infrastructure Landscape 2019:
https://riscape.eu/wp-content/uploads/2019/12/Riscape_report_digi_19122019.pdf

Grandes instalaciones científicas en Iberoamérica:
http://tux.iar.unlp.edu.ar/boletin/bol-mar10/2010-01revistacts.pdf

INFORME SOBRE INFRAESTRUCTURAS DE INVESTIGACIÓN EN ARGENTINA (Argentina RI Roadmap):
https://www.argentina.gob.ar/sites/default/files/catalogo_-_sistemas_nacionales_2707.pdf

SISTEMAS SETORIAIS DE INOVAÇÃO E INFRAESTRUTURA DE PESQUISA NO BRASIL (Brazil RI Roadmap):
https://ipea.gov.br/portal/index.php?option=com_content&id=27203:sistemas-setoriais-de-inovacao-e-infraestrutura-de-pesquisa-no-brasil

EU-LAC ResInfra D2.1 Report on the criteria, scientific areas and methodology to develop the LAC RI landscape: https://resinfra-eulac.eu/resinfra-deliverables/

Appendix 3

WHITE PAPER

Recommendations towards cooperation between Australian and European research infrastructures

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Contributions: Lisa Vincenz-Donnelly (EMPHASIS), Sven Fahrner (EMPHASIS), Golbahar Pahlavan (ECRIN), Roland Pieruschka (EMPHASIS), Bahne Stechmann (EU-OPENSCREEN), Adelino Vicente Mendonça Canario (CCMAR) with support from the RI-VIS consortium.

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EXECUTIVE SUMMARY

International cooperation in science and technology is an important part of addressing major global issues like climate change, infectious disease, food security and natural disasters. Research infrastructures (RIs) are organizations that enable scientists to use specific facilities, resources and services in order to accelerate scientific achievements, break boundaries and promote sustainable research. Fostering RI partnerships across borders has the potential to improve the efficiency and quality of research to tackle the many challenges faced by society today.

RI-VIS is a Horizon 2020-funded project to increase the visibility and raise awareness of European RIs to new communities in Europe and beyond. This report, as part of RI-VIS, focuses on ways to increase collaboration between Australian and European RIs. It collates the insights of experts from Australian RIs, European RIs and policymakers into sections that cover examples of successful collaboration, lessons learned and possible challenges/bottlenecks.

The following key recommendations from experts to facilitate Australian-European RI partnerships are categorized into actionable items for RI representatives, policy makers and funders:

Key recommendations for RI representatives

RATIONALE/GLOBAL CHALLENGES:
- RI partnerships should start with common interest and perception of mutual benefit on both sides.

FUNDING:
- RIs should budget for international collaboration.

ACCESS:
- Take advantage of technology that enables virtual meetings and collaborative documents.

CO-CREATION BASED ON NEEDS:
- Overseas events should be customized to the host country's needs.

OUTREACH:

- Connecting on a personal level with others from abroad can lead to successful joint projects down the line.

BEST PRACTICE:

- Value RI staff members and give them a rewarding career pathway.

Key recommendations for policy makers & funders

BEST PRACTICE:

- RIs need the bare minimum amount of national contributions to sustain operations in order to take the next step of international collaboration.

OUTREACH:

- Policy makers and funders should recognize that RIs may take several years to produce significant scientific results.

SUSTAINABILITY:

- Multi-year funding schemes give Australian RIs the security to plan ahead and develop fruitful international partnerships.

FUNDING:

- Europe should find ways to open up funding access to Australian organizations by including RIs in the work programmes.

Contents

Background

In 2015, the United Nations General Assembly outlined a set of 17 Sustainable Development Goals to achieve a better and more sustainable future for all (Sustainable Development Goals, 2015). They aim to address major societal challenges faced by humankind related to disease, climate change, food security, environmental degradation and poverty. Scientific research is an essential part of tackling these issues. The process of gathering information and expanding our knowledge of the world has the power to improve overall health, safety and standard of living.

Research infrastructures (RIs) are crucial to the advancement of science in many fields. The availability of well-maintained RIs facilitates cutting-edge research and training of highly skilled specialists. They include major scientific equipment and infrastructures, cyber- or e-infrastructures, scientific collections, archives and structured information and entities of a unique nature that are used for research (European Strategy Forum on Research Infrastructures, 2018).

A key motivation of RIs is the sharing of knowledge and resources across institutions, countries and continents. Large-scale research facilities are generally expensive and challenging to build and maintain by one single nation on its own. Other RIs require data collection from different parts of the world. Thus, a more effective and productive way to conduct research is to pool together resources and share costs.

RI-VIS is a Horizon 2020-funded project to increase the visibility and raise awareness of European RIs to new communities in Europe and beyond (RI-VIS, 2020). Part of RI-VIS involves identifying routes to maximize the exchange of information and bases for new partnerships, in particular with RIs or communities outside of Europe. Mutually beneficial RI partnerships across borders can harness collective knowledge, assist in meeting global challenges and enhance global science capacity.

This report assembles the insights of several experts from both Europe and Australia who have previous experience with such collaboration. Interviews were conducted from August to October 2020 with seven representatives from RIs in Europe and Australia (see Appendix A). They highlighted examples of Australian-European RI collaboration, best practices for successful collaboration, challenges/bottlenecks and recommendations to policy makers and funders. The preceding sections will outline the definition of an RI, the importance of RIs to society and the benefits of international research collaboration.

What is a research infrastructure?

The term “research infrastructure” comes with a certain degree of flexibility, since it lacks an established formal definition in scientific and policy literature. The European Commission defines research infrastructures (RIs) as “facilities that provide resources and services for research communities to conduct research and foster innovation” (European Research Infrastructures, 2020). The RI-VIS Communication Toolkit for European Research Infrastructures states that an RI is “an organization that enables the research community to use specific facilities, resources, and services in order to accelerate scientific achievements and promote sustainable research” (Abecasis & Pintar, 2020).

As part of the Australian Government’s National Innovation and Science Agenda (NISA), an Expert Working Group led by Australia’s Chief Scientist, Alan Finkel, developed the 2016 National Research Infrastructure Roadmap (Expert Working Group, 2016). The document interprets RIs as “the nationally significant assets, facilities and services to support leading-edge research and innovation… accessible to publicly and privately funded users across Australia, and internationally.”

Despite it being used in different contexts both internationally and even within Europe, the term maintains some common threads across definitions (International Research Infrastructure Landscape 2019: A European Perspective, 2019; Florio, Forte, Pancotti, Sirtori, & Vignetti, 2016):

- RIs are motivated first and foremost by **scientific goals**. The main purpose of RIs is to acquire new knowledge in a scientific field, allow research and innovation to break barriers and push the frontiers of science. They may be purely **curiosity-driven** without any direct, obvious practical application, or they could have a more application driven, practical **benefit to humanity.**
- All RIs at their heart contain **valuable and unique assets**, whether they be major facilities, instrumentation, knowledge-based collections or collaborative networks.
- RIs often require **substantial capital investment** that typically goes beyond the capacity of an individual faculty, institution or funding programme.
- Access to RIs expands **beyond an institutional level** to a national or international reach. The uniqueness and steep cost of the assets means that the RI's capabilities will be in demand by external researchers in the field.

RIs are often placed into three broad categories: single-sited, distributed or virtual. Single-sited RIs are centralized facilities at a single physical location. These include large telescopes, particle accelerators, synchrotrons, nuclear reactor sources or extreme laser sources. Distributed RIs usually have a central hub and interlinked nodes scattered in different regions. They consist of a network of distributed instruments or collections that, taken as a whole, constitute a large-scale facility. An interferometrically linked array of radio telescopes and large genome sequencing projects are two types of distributed RI. Lastly, virtual RIs are internet-based systems for scientific research, such as an archive of historical texts or virtual research environments (virtual labs) for data processing and analysis. RIs often offer a mixed category that combines physical and virtual aspects.

High-profile examples of RIs include CERN's Large Hadron Collider, the world's largest and most powerful particle accelerator; INSTRUCT, a collection of distributed facilities that promote structural biology research; the Australian Synchrotron, the largest particle accelerator in the Southern Hemisphere; and the National Imaging Facility, a grid of imaging facilities spread across Australia. Further examples from Europe and Australia are provided in Table 1.

Societal impact of research infrastructures

The development, operation and maintenance of RIs require large investments from countries, sometimes encompassing tens or hundreds of millions of Euro per year. Decisions about investment in RIs at a national level often include an assessment of any direct societal benefits in addition to their future scientific impact (Horlings, Gurney, Somers, & van den Besselaar, 2013). However, such benefits tend to be difficult to predict, particularly for curiosity-driven projects.

For example, the overarching goal of CERN's Large Hadron Collider (LHC) was to better understand the fundamental structure of matter. The total cost of the accelerator, detectors and computing was 4.332 billion Swiss francs, making it the most complex and most expensive scientific research facility ever constructed. Beyond its obvious contributions to physics, CERN has been responsible for innovations that have improved medical and biomedical technology, space missions, art restoration and energy efficiency (Our Contribution to Society, 2020). The building of LHC has resulted in highly advanced superconducting magnets, exceedingly accurate measurement equipment and breakthroughs in data communication and storage. CERN also sparked the invention of the World Wide Web in 1989 (The birth of the Web, 2020) and the capacitative touch screen in 1972 (Stumpe & Sutton, 2010).

Other RIs have a more direct impact with their observations. For instance, the European Plate Observing System (EPOS) and the European Multidisciplinary Seafloor and water-column Observatory (EMSO) are both distributed RIs that inform society about environmental hazards and allow for more advanced preparation. Similarly, the AuScope Infrastructure Program (AuScope) allows for better coastal management informed by improved sea level estimates, reduced resource exploration cost through more efficient acquisition of Earth structure data and disaster planning and management for extreme weather events with enhanced meteorological analysis.

The Australian Government recently published a report on the scope, scale and reach of its National Collaborative Research Infrastructure Strategy (NCRIS) projects (NCRIS, 2019). NCRIS is a national network of 24 active RI projects that have been awarded government grants for operating and capital expenses, supplemented by co-investment from other parties. According to the 2016 National Research Infrastructure Roadmap, funding decisions consider the RI's ability to "maximise the capability of the research and innovation system to improve productivity, foster economic development and serve the national interest" (Expert Working Group, 2016).

The census report covered the academic and commercial impact of NCRIS projects in 2017-18. The network of RIs enabled a total of 8,371 publications in fields like engineering, chemistry, physics, biology and medicine. Over 70 percent of projects provided critical or operational/functionality to enable federal government policies and program delivery. For instance, Bioplatforms Australia – a distributed RI that manages research facilities for genomics and other life sciences – worked with the federal government on risk assessment mechanisms for the importation of plants, the environmental impact of breeding threatened species and genomic developments for use in pathology.

RIs in Australia also provide services to key sectors of industry. The census revealed that 62 percent of NCRIS facilities are utilized by companies in the agriculture, forestry and fishing industries and 57 percent are used by the mining industry. In terms of commercialization outputs, NCRIS projects had 72 patents granted and 1,112 pieces of copyrighted material produced in 2017-18 alone. They initiated 240 clinical trials during this time period and from 2015 to 2018, the network introduced 15 products to market.

The European Strategy Forum on Research Infrastructures (ESFRI), which plays a key role in policy making on RIs in Europe, also places high priority on socioeconomic impact when it comes to supporting projects. Socioeconomic impact is an element of the ESFRI Roadmap assessment procedures and is central in the networking activities of ESFRI RIs. It is used to evaluate the effective use of public resources, to inform future decision and policy making and to secure funding for the continuous operation of RIs. For instance, assessment of health and food RIs takes into account drug discovery and production, new diagnostics and therapies, new models of human rare diseases and the emergence of new biomedical applications.

Aside from such spillover technologies, RIs impact the economy and society in several other ways. RIs serve as key learning environments and hubs where knowledge is exchanged (Horlings, Gurney, Somers, & van den Besselaar, 2013). Researchers, students, industry and government all interact throughout the RI's development, construction and use. In addition, many RIs participate in public outreach to stimulate interest in students and other members of the community. The aim is to inspire curiosity and encourage a new generation of scientists to enter the field.

Taking all of the above points into consideration, the general consensus tends to be that RIs provide a positive return on investment and a substantial net benefit to society, economic development and scientific progress (European Strategy Forum on Research Infrastructures, 2018).

Scientific collaboration across borders

The collaborative nature of scientific research is inherent to its success. By sharing skills and data, researchers improve the efficiency and quality of their work while supporting the process of scientific production, knowledge creation and breakthroughs. The whole of a scientific collaboration is undoubtedly greater than the sum of its parts. But what are the benefits of collaborating with researchers based in other countries?

Different motivations exist, depending on the scientific field and country at hand. However, one thing is clear: The number of scientists participating in international collaborations is growing. An analysis of scientific publications and co-authorships found that international scientific collaboration is increasing in volume in all research fields over time (Coccia & Wang, 2016). Research is more global, cross-national and cross-cultural than ever before.

A metaphor used to describe the importance of international collaborations is a frog deep inside a well, who has an excellent view of a small patch of sky (National Research Council, 2008). If most of the research in a field is done predominantly stuck in one well, such as North America or Europe, it can prove detrimental to scientific discovery. Getting out of the well can provide new research topics and collaborators, which help question underlying assumptions and spark fresh insights.

Scientific cooperation beyond borders can take many different forms, in particular for RIs. In 2019, the National Research Infrastructure Census surveyed NCRIS projects regarding their activities with entities outside of Australia (NCRIS, 2019). The 21 RIs included in the study reported having 41 active memoranda of understanding (MOUs) with international entities in 2017-18. Outside of MOUs, the group also declared 57 informal and 43 formal collaborative arrangements with RI providers. Other activities included invitations to speak at international conferences, representation on working groups or key committees and collaborative arrangements with research organizations.

In addition, international collaborations have the power to mobilize a global network to consider and refine important ideas that affect humanity as a whole. Global issues include environmental protection, energy security, natural disaster mitigation, preventing/curing infectious diseases and food security. RIs bring experts together to form a network where they can openly share knowledge and technology. In the area of food security, for example, researchers from academia and industry across the globe often have similar goals, such an increase in crop productivity and resilience, and RIs are pivotal in this respect (Pieruschka & Schurr, 2019).

According to the National Research Infrastructure Census, 86 percent of NCRIS RIs were a member of, partnered with or were a participant in global RI in 2017-18 (NCRIS, 2019). More than 60 percent plan to join some or more global RI networks in the future. The RIs find that participation in global or international RI enables them to adopt best practice as well as international standards.

Beyond the scientific benefits, international collaboration in large science projects can also save money and support foreign policy (U.S. Congress, Office of Technology Assessment, 1995). The cost of "big science" has gone up, which makes it more difficult for a single nation to undertake such projects alone. Of course, reducing net costs for individual countries also motivates the creation of RIs. Collaboration makes it possible to share both the financial and technical risks of ambitious projects.

Lastly, research can also be a form of diplomacy, leading to alliances and memoranda that support foreign policy objectives. Joint scientific research can strengthen bonds with other countries and establish levels of trust.

Australian-European research infrastructure collaboration

Australia is already an important economic and trading partner for the European Union (EU), and the two regions have a long history of productive research collaboration. Australia collaborates more with the EU than any other single country in the world, averaging over 13,000 co-publications per year over the period 2011-15 (Researching innovative opportunities with Australia, 2020). Australia ranks as the EU's fifth highest international collaborator over the same time period.

The EU signed a treaty-level science and technology agreement with Australia in 1994, which represented the first time it had done so with an industrialized country (European Commission, 2018). The agreement established the Australia-EU Joint Science and Technology Cooperation Committee (JSTCC), which meets every two years to set bilateral research collaboration priorities and monitor cooperation activities. Most recently, the JSTCC gathered in Canberra for their 15th meeting in July 2019, which included a discussion of ongoing and future cooperation in RI, possibilities to host major international conferences on RI and using global RIs as a forum to foster international cooperation.

Australia and the EU also share a common approach to investing in and prioritizing RIs. Bringing together RIs from both regions with the common goal of scientific advancement and innovation has the potential to breathe fresh life into research topics, bring new perspectives and spur on novel developments. In fact, because RIs are already focal points of collaboration within themselves, the mutual advantages of Australian-European RI partnership are expected to be even greater.

Broadly, RI partnerships at a global or intercontinental scale are worth developing for the following reasons:

- To harness collective global knowledge and experience
- To support leveraging of new international funding for RIs
- To promote access to and exchanges between RIs
- To facilitate the mobility of researchers
- To assist in meeting global challenges
- To compensate each other's shortcomings with regard to available infrastructures

Australian-European RI collaboration can take many forms, and the examples that follow represent only a small sampling of partnerships. However, our objective is to learn from these real-world cases for the benefit of future collaborations and to better recognize opportunities for the two regions to work together.

Examples

NIF & Euro-BioImaging

Founded in 2007, the Australian National Imaging Facility (NIF) provides state-of-the-art imaging facilities and services of animals, plants, and materials for the research community. The NCRIS-funded distributed RI has ten nodes based at universities and medical research institutes across the country, with each node offering its own specialized instrumentation and experts. Research performed at NIF includes visualizing human brain structure with magnetic resonance imaging (MRI), scanning native animal species to better understand their anatomy and even computed tomography (CT) imaging of an Egyptian mummy.

NIF signed an MoU with Euro-BioImaging, a European RI that offers much of the same services, in 2014. Euro-BioImaging gives life scientists access to biological and biomedical imaging infrastructure through 21 nodes spread across eight countries. The RI was granted the legal status of an ERIC (European Research Infrastructure Consortium) in 2019.

The Australian-European RI collaboration kicked off with a signing ceremony and two-day symposium in Brussels to celebrate the MoU. Other RIs, including Therapeutic Innovation Australia and the European Clinical Research Infrastructure Network (ECRIN), joined the festivities as well.

“It was about sharing the experience and challenges of a research infrastructure around things like staff recognition, promotion prospects and what’s the career pathway for an infrastructure scientist,” said Graham Galloway, NIF’s Chief Executive Officer. “The other theme of the event was around building better data practices.”

At the symposium and during the period of time that followed, NIF and Euro-BioImaging discussed the development of systems that promote best practice data curation and the promotion of fair data in imaging research. As a result of this initial connection, Euro-BioImaging invited NIF to become a partner on a Horizon 2020 project that aimed to create an international network of imaging infrastructures and communities.

The project culminated in the creation of Global BioImaging in 2015, which brings together imaging facility operators and technical staff, scientists, managers and science policy officers from around the globe. The network organizes an annual international workshop called Exchange of Experience to discuss common goals, trends and challenges in running open access imaging facilities. In September 2020, Global BioImaging held its fifth Exchange of Experience workshop virtually with a record turnout of 158 participants across 16 time zones.

“By demonstrating that we are partnering with researchers through Euro-BioImaging and Global BioImaging, we are able to say to the Australian government that we are developing international best practices,” said Galloway. “We’re not doing it alone – we’re doing it with the rest of the world.”

APPF & EPPN

Australia has long emphasized innovation in agriculture, with farmers historically achieving strong productivity growth driven by improvements in technology and structural change. As one example, the country pioneered significant aspects of plant phenomics research, which uses automated image analysis to characterize the complex traits of living plants.

The Australian Plant Phenomics Facility (APPF) is an NCRIS-funded distributed RI that aims to accelerate the development of new and improved crops, healthier food and more sustainable agriculture practice. Established in 2007, APPF operated across three nodes at the University of Adelaide, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Canberra and the Australian National University. Each node has unique, specialized facilities that interlink to offer open access to plant phenomics technologies and expertise.

"Australia was probably one of the earliest adopters in the area of plant phenotyping, and to some degree, we were ahead of the game at that point," said Bettina Berger, Scientific Director of the APPF node at the University of Adelaide. "Since then, others have caught up. Europe is the next area to really invest quite heavily into plant phenotyping."

The RI has closely interacted with three European centres: Forschungszentrum Jülich and the Leibniz Institute of Plant Genetics and Crop Plant Research in Germany, as well as the French National Institute for Agricultural Research. Cooperative efforts arose either through personal connections among researchers or because they used similar pieces of equipment.

Since then, APPF has been a partner in two EU-funded RI projects that link multiple facilities together into a single transnational network in order to integrate plant phenotyping efforts. The European Plant Phenotyping Network (EPPN) ran from 2012-15 with a total of 14 participants, including APPF, enabling 66 experiments and various joint research activities. The follow-up project to EPPN is the Horizon 2020-funded EPPN2020, which runs from 2017-21 with 21 partners across 12 countries.

The benefits of such a network go beyond simply increasing facility access for researchers. Because plant phenotyping is still a fairly young discipline – only about a decade or so old – such partnerships are needed to quickly overcome challenges being faced by the field as a whole. While the initial limiting factor for performing efficient research was having the right cameras and sensors to acquire data, now the bottleneck has shifted towards questions around data storage and analysis.

"How do we share, annotate and analyze the data? How do we best extract knowledge out of it? This is nothing that a single institution can solve. It really requires a community effort and also community funding," said Berger. "Having those links is absolutely critical because there's no point in any individual country or institution working in isolation if what they're developing will then be adopted by the rest of the community across the world."

APPF was also a founding member of the International Plant Phenotyping Network (IPPN), an association representing the major plant phenotyping centres around the world. IPPN enables cooperation by fostering communication among members through workshops and symposia. The inaugural International Plant Phenotyping Symposium – the first-ever international meeting that brought together plant biologists under a phenomics banner – was held at the Canberra node of APPF in 2009.

PHRN

The Population Health Research Network (PHRN) aims to link existing health and services data from around Australia for the purpose of action-oriented research. National data collections include hospital admissions, emergency department attendance, births, deaths, cancer registries, doctor's visits and various other information. Research projects based on PHRN's data may aim for a better understanding of disease, the development of new treatments or improvements in services.

The RI has a programme office in Perth, along with a network of project participants and data linkage units located in each Australian state/territory. Merran Smith, Chief Executive of the PHRN, also serves as the current director of the International Population Data Linkage Network (IPDLN), which connects over 1,000 members that specialize in data linkage. The IPDLN Executive Committee, chaired by Smith, includes two members from the UK and one from Germany.

"There is a strong international collaboration existing now around big data that's been going on for about ten years," said Smith. "Through the IPDLN, we have connections to many European groups, including colleagues in the Netherlands and France."

The network organizes a biennial conference to create more opportunities for interdisciplinary collaboration, cross-jurisdictional studies, and robust, accessible international data. The 2008 inaugural meeting of the IPDLN was held in London and included over 30 participants from the UK, Australia, New Zealand and Canada. The event was hosted by the Research and Development Directorate of the UK's National Health Service.

The IPDLN now includes over 1,000 members with 234 from Australia and 92 from Europe. The 2020 conference was supposed to be held in Adelaide but transformed into a virtual event due to the COVID-19 pandemic. The agenda included researchers from Australia and the UK sharing their work on population health data and the response to COVID-19 in their respective countries.

Cooperative efforts across borders most often focus on methodologies to link data on a large scale, ways to ensure data privacy and improving the infrastructure itself. Researchers at the University of Swansea in Wales created a platform that secures information very well, and it has now been adopted at two Australian universities. Such an example highlights how the expertise from Europe is being exported and shared with Australia in a collaborative way.

Insights flow the other way as well, with active information exchange from Australia to the UK happening related to methodology. For instance, some elements of the linkage system developed by the PHRN have been incorporated into UK platforms.

"People are generally relatively altruistic. Researchers around the world have a passion for the research they do and are keen to progress, particularly in the health and human services area," Smith said. "To the extent that those infrastructures become better through international collaboration, then we see that as a win-win for everybody."

DARIAH beyond Europe

While the majority of RIs remain STEM-focused, others fall into a category that the European Strategy Forum on Research Infrastructures (ESFRI) calls "Social and Cultural Innovation" (European Strategy

Forum on Research Infrastructures, 2018). In fact, ESFRI notes that RIs in this domain are among the first known infrastructures, with libraries, museums, and archives as the most obvious examples.

The Digital Research Infrastructure for the Arts and Humanities (DARIAH) is a European RI aimed at enhancing and supporting digitally enabled research and teaching across the arts and humanities. Established as an ERIC in 2014, DARIAH includes 19 countries as members and has several cooperating partners – basically, participating institutions in countries who aren't yet members – in eight non-member countries.

In 2017, the RI began a Horizon 2020-funded project called DARIAH ERIC Sustainability Refined (DESIR) that explored ways to strengthen its position as a long-term leader and partner within the arts and humanities communities (DESIR, 2017). One goal of DESIR involved the dissemination of DARIAH's tools and services to researchers outside of Europe.

"We had been doing so much work on bringing the countries within Europe together, and we wanted to explore how we could work with similar initiatives overseas," said Sally Chambers, the National Coordinator of DARIAH for Belgium. "So we had this series of workshops in the U.S. and Australia, and we chose those countries because they are doing a lot of work already in the digital arts and humanities."

The 3rd DARIAH Beyond Europe workshop took place in Canberra at the end of March 2019 (DARIAH Beyond Europe, 2019). The three-day conference highlighted how ongoing work in DARIAH could intersect with initiatives in the Australian academic community. The first day involved a series of "big idea" panels, where speakers explored new horizons for humanities, arts and culture within the context of policy, research and infrastructure. The second and third days were billed as an Australia-DARIAH knowledge exchange, looking at areas to build fruitful, long-term collaborations.

A report written by Chambers and her colleagues in 2019 provided an overview of the three workshops and highlighted key outcomes (Chambers, Daems, & Raciti, 2019). Overall, the DARIAH Beyond Europe initiative "not only increased DARIAH's visibility internationally, but has led DARIAH to reflect on its long-term approach to its international activities much more deeply." The Australian workshop specifically sparked a number of ideas for further follow-up, including concrete areas of shared interest between Australian and European colleagues.

Since the workshop, the European and Australian researchers have kept the discussions going by developing collaborative research proposals and scientific advisory boards. In addition, they have continued to connect by attending the same events.

"The humanities have such a small voice in the research community in general, so the more people that we collaborate with, the stronger that voice becomes," said Chambers. "Also, because of sustainability issues, if we can collaborate on activities rather than reinventing the wheel, that is also very helpful."

Bioplatforms Australia & EMBL-EBI

Bioplatforms Australia supports researchers in the life sciences with 15 node facilities across the country that cover genomics, proteomics, metabolomics and bioinformatics. Notable research projects include the first-ever sequencing of the Australian koala genome, wine yeast systems biology, wheat pathogenomics, and the world's largest coral genome sequencing project on the Great Barrier Reef.

Established in 2007, the NCRIS-funded RI has strong ties to Europe through multiple organization-level collaborations. It has a long-standing relationship with the European Molecular Biology Laboratory (EMBL), Europe's flagship laboratory for basic research in molecular biology. EMBL operates from six laboratory sites throughout Europe, providing both physical and digital experimental services for researchers. Australia became the first associate member of EMBL in early 2008.

"We cooperate both at a scientific level through our partner laboratory network that is reasonably analogous to how EMBL operates in Europe, and also at an organizational level with EMBL itself," said Andrew Gilbert, Chief Executive of Bioplatforms Australia. "We try to find points of difference and harmony where we can share value on both sides."

The EMBL partnership has been extended to an extensive and meaningful collaboration with the European Bioinformatics Institute (EBI), a part of EMBL that provides freely available data and bioinformatics services to the scientific community. A high-profile example of their collaboration is the sequencing and analysis of the koala genome, which made the cover of *Nature Genetics* in 2018 (Rebecca N. Johnson, 2018). While Bioplatforms Australia provided most of the infrastructure for the project, EBI contributed by performing annotation of the genome.

The EBI relationship subsequently led Bioplatforms Australia to sign an MOU with ELIXIR, a European distributed RI for biological data, in April 2020 (ELIXIR, 2020). EBI is an ELIXIR node, an RI that manages bioinformatics resources across 22 member states and one observer. Gilbert and his colleagues noticed that ELIXIR was trying to address many of the same challenges faced by Bioplatforms Australia, and the RIs could both benefit from open knowledge exchange.

"We have a lot to learn, but we have something to contribute back to ELIXIR as a first-class scientific contributor too," he said. "We've been so appreciative of them contributing to our program in terms of standard protocols, collaborative framework, and other things that would have taken us years to catch up. In time, our relationship will lead to actual scientific collaboration."

The COVID-19 pandemic has slowed down international collaborations for Bioplatforms Australia at the moment, as the RI is trying to suss out its own operations first during these trying times. But Gilbert and his team hope to restart projects involving their European colleagues very soon.

Recommendations and best practices

The successful Australian-European partnerships outlined above have several similarities that point to recommendations for future RI collaboration.

RATIONALE/GLOBAL CHALLENGES

Gilbert notes that any RI partnership should start with personal interest on both sides, since without that driving motivation, it's very difficult to transact on either a strategic or structural level. Signing the MOU is only the first step to broker the future activity, and parties must keep up the energy around the activity in the months or years that follow. Projects should benefit both communities locally, with each side aiming to contribute something, whether that be finances, data or know-how.

“There are collaborations that, on paper, sound really easy. But without a science driver or clear need as to why you’re collaborating, people kind of lose that enthusiasm and energy, and it’s really hard to get things off the ground,” said Sarah Nisbet, Platforms and Engagement Manager at Bioplatforms Australia.

FUNDING

While funding isn’t an issue for NCRIS projects, Gilbert strongly recommends that RIs budget for international collaboration. Without having dedicated funds, it can easily become an afterthought. RIs need to be proactive rather than reactive, and international partnerships should be a focus from the outset.

ACCESS

When organizing an overseas workshop such as DARIAH Beyond Europe, Chambers suggests using technology that enables virtual collaboration. For a whole year before the meeting, the team at DARIAH had monthly Zoom calls with its partners in Australia and used Google Documents to work on key aspects of the workshop together. Today, such technology has become much more commonplace due to the COVID-19 pandemic. The widespread familiarity with organising and attending virtual meetings, workshops, and conferences could largely benefit future overseas collaboration.

CO-CREATION BASED ON NEEDS

She also emphasizes the importance of tailoring an event to the host country. For instance, the Australian Government had recently given a larger proportion of funding to STEM-focused RIs, and DARIAH’s partners wanted to make the workshop more strategic. The whole first day became dedicated to policy, research and infrastructure for this reason.

“We decided to move the workshop to Canberra because that’s where the Australian Government is,” said Chambers. “We wanted to raise the profile of the importance of research infrastructures for the arts and humanities as well.”

OUTREACH

Many experts emphasized the importance of personal relationships in terms of sparking scientific or organizational collaboration between Australia and Europe. People getting to know one another through conferences, workshops, committees, and exchanges can lead to successful joint projects down the line.

“Collaborations happen in an organic way, and underpinning that are good relationships and good communication,” said Smith, who cites in-person meetings as more conducive to relationship creation than virtual meetings. But she does note that virtual meetings, with their much lower cost and time commitment, allow a much greater number of people to attend.

BEST PRACTICE

Galloway believes that the best thing RIs can do to facilitate partnerships across borders is knowing how much their staff is worth and nurturing their careers. Sometimes RIs and their experts fail to receive adequate recognition for their work. Often times, they aren’t getting first author on papers or high-profile mentions in the press.

“The number one recommendation to increase collaboration is to ensure that we employ the best expertise that we can, value that expertise, and give them a career pathway. Because collaboration is only ever going to be driven by people, not equipment,” Galloway said. “If you’ve got a unique piece of equipment, researchers will come use it, but collaboration is around interactions of people and sharing expertise as well as opportunities."

CHALLENGES AND BOTTLENECKS

In terms of factors that hinder Australian-European RI collaboration, several experts mentioned the difficulty in getting funding out of Europe and into Australia. While Australian RIs may be accepted as members or official partners of European RIs, they are expected to fund any work themselves. Berger brings up the example of EPPN and EPPN2020, noting that APPF was an official partner in both European RIs but could not receive any funding.

"A lot of European projects are like that: as someone from the outside, you can't necessarily tap into that funding. While we have a seat at the table, everything we do or contribute has to be on top of what we already do," said Berger. "There are often good intentions, but unless there is funding and time allocation that goes with it, the collaboration can sometimes stop there."

Stewart Newman, Chief Executive Officer of Therapeutic Innovation Australia, believes that the lack of access to European funding is a major roadblock to intercontinental collaboration. He suggests Europe could take the path of the United States, which opened up National Institutes of Health (NIH) funding for foreign organizations years earlier. Enabling countries like Australia to have access to EU funding could offer a unique opportunity to become more competitive with the US in terms of research output and innovation.

"I think it's all about the money. European money needs to leave Europe and enable Australian researchers to go over there or do work here that has applicability," said Newman. "It used to be hell trying to get money out of the US, but now it's very possible. Ten years ago, when somebody was writing an NIH grant here, you'd think, 'Why?' But now, it's quite common."

Lastly, most experts mentioned the time difference between the two regions as a challenge. For instance, Sydney can be ahead of London by up to 11 hours, depending on the time of year. While setting up one-on-one virtual meetings isn't an issue, Australian experts cited larger online gatherings, workshops and conferences as being harder to manage.

"It sounds ridiculous that you get stuck by such a physical problem, but it really is the time zone being difficult," said Nisbet. "ELIXIR working groups have meetings, and we want to attend the meetings so that we can benefit and contribute, but it's just really hard when they're in the middle of the night."

While it makes sense for a European RI to set a meeting time that prioritizes its member countries, some collaborators in Australia may feel left out of the discussion or regarded as an afterthought. Nisbet recommends speaking up and making European partners aware if meetings are set at times that are less than ideal for those in Australia. She's had previous success with such open communication, and in her experience, European partners will happily accommodate.

Despite the significant effort and cost of long-distance travel, Australian experts seemed to have no qualms about taking trips to Europe to attend events. They realize the importance of reaching out to the rest of the world when living in such a physically isolated country.

"Australia is far away from everywhere, but as an Australian researcher, you learn fairly quickly that if you want to be connected to the research community, you have to travel and put up with being jetlagged at every single conference that you go to," said Berger. "Thankfully, a lot of the Australian research funding has fairly generous travel budgets because it is essential to stay connected."

Smith remarked that travel and time differences are just part of the way Australians do business, while Europeans may find them more of a barrier. Exchanges do occur, where a European delegation will fly over to Australia, but from speaking to the experts, it certainly seems less common than Australians going to Europe.

ADVICE FOR POLICY MAKERS AND FUNDERS

The expert interviews revealed recommendations for policy makers and funders coming from the government side, both in Australia and Europe, that would increase RI partnerships between the two regions.

BEST PRACTICE

Newman described that the difficulty in Australia is that there's a fairly limited pool for funding to either maintain or upgrade infrastructure, whether it's a benchtop device or large instrument like a synchrotron. Without this bare minimum amount of funding, international collaboration could appear to RIs as a further stretching of resources that just isn't possible.

One issue that his RI ran into was the difficulty in hiring an operator or technician who specializes in keeping equipment running. NCRIS-funded projects certainly have the means to hire such experts, but the majority of Australian RIs are not NCRIS capabilities. There is ample project funding for pure research, which gives institutions the ability to hire postdocs and research assistants, but that money doesn't go to long-term RI maintenance.

"The challenge has been to argue with universities and governments and other public funded research organizations to say that we need this ongoing operational funding to keep this knowledge from walking out the door when the grant finishes," said Newman.

Policy makers should consider that RI-specific expertise is necessary to keep equipment and other resources optimized for the benefit of the research scientists who use them – and funding schemes should reflect this point. Many RIs must reach the point of being operationally stable and secure within themselves in order to take the next step of international collaboration.

OUTREACH

Galloway believes that policy makers should understand that RIs can take many years to have a commercial, societal or even scientific impact. It could even take a decade or more to see significant results, but that's just the nature of the beast. He suggests that RIs should remain committed to various marketing and communications efforts in order to raise the RI's profile in the eyes of both the government and the public.

"Sharing the success stories that we can identify is important so that we can make these cases to governments on both sides of the world," said Galloway. "But policy makers need to realize that you're not going to see impact within the three- to four-year political cycle. This is long-term research."

SUSTAINABILITY

Newman also brings up the fact that NCRIS funding used to be a year-to-year proposition, and this 12-month cycle made it very hard to manage budgets and infrastructure. In 2018, Therapeutic Innovation

Australia received 10 additional years of funding through NCRIS, a scheme that allowed for more breathing room and the ability to consider long-term international partnerships.

“The first thing we did with our funding security was to reorganize ourselves to make sure we made sense internally,” he said. “We have to take care of our own community first before we look outside, but now that things are sorted for us, I think we’re in a position to increase collaborations with Europe and others.”

FUNDING
European programmes that are open to the world or emphasize non-EU partners have worked well to foster collaboration between the two continents. Horizon 2020 is the biggest EU Research and Innovation program to date, with nearly 80 billion Euro worth of funding available over seven years (2014 to 2020). It is “Open to the World,” meaning that participants from anywhere can apply for most of the calls. In addition, several topics strongly encourage or require cooperation with non-EU partners. The successor to Horizon 2020, Horizon Europe, will allocate an even more ambitious 100 billion Euro and cover the period of 2021 to 2027.

However, Australian participants in Horizon 2020 are only eligible for funding when their participation is deemed essential for the project (European Commission, 2017). For example, they must have outstanding competence or expertise, access to particular geographical environments or access to RI/data. In the majority of cases, because they reside in an industrialized country, Australian participants must themselves determine the sources of funding for the Australian part of the project. Based on recently proposed regulation from the European Council, Horizon Europe will likely have the same funding scheme with regards to eligible countries (European Council, 2020).

Newman recommends that either Europe open up its funding to Australian organizations, or the Australian Government could adopt a funding match for those who have won a Horizon 2020-like grant from Europe. Another option is for European partners to make funding for the Australian partner part of their proposal, which is how DARIAH Beyond Europe happened.

“I think DARIAH Beyond Europe went really well. We had good collaborations, and we’ve made a lot of personal contacts,” said Chambers. “Yet it’s about keeping up the momentum when the project is finished, and I think the biggest thing is that we need funding opportunities from both sides to continue to collaborate.”

FUTURE OPPORTUNITIES AND AREAS FOR GROWTH
Overall, experts believed that Australian-European RI collaboration would only increase in the future and highlighted several potential avenues for cooperation.

Regardless of the country or region of origin, RIs within the same field often face the same scientific challenges. All experts mentioned that a key motivation for collaboration is the need to solve mutual problems in a better and more efficient way. In some cases, a European RI had already established methodology or platforms that an Australian RI could adopt, or vice versa. In other instances, both RIs were starting from square one, and cooperation helped to accelerate the process of learning something new.

Berger described a situation where APPF and Wageningen University & Research in the Netherlands had both purchased a new kind of field phenotyping vehicle, a complex piece of equipment that drives over plots to capture plant data with various sensors. Because they received the first two systems made by the company, the groups agreed to work together to figure out the best ways to use it.

“A lot of the success in collaboration is learning from each other: optimizing workflows and efficiencies, sharing ways to capture and analyze data, etc. There are plenty of the same issues that many are grappling with,” said Berger. “Having that open conversation and making sure that people are able to contribute or become partners in projects is really critical.”

Also, it is important to note that Australia and Europe have different strengths, scientifically and organizationally. RIs in each region could leverage the other’s strengths by reaching out and establishing a partnership for joint research projects.

Gilbert cited Australia’s biodiversity as a contributor to the country’s collaborative science efforts, as in the koala genome study or experiments involving the Great Barrier Reef. The unique flora and fauna offers something distinct from what is available in Europe. Chambers recalled being impressed with Australia’s linguistics research, given that there are 200 to 300 indigenous languages spoken there. Newman also lists marine biology, astronomy, clinical trials, and genetic/population studies as strong areas.

The European Green Deal, an action plan to make the EU’s economy sustainable, could also provide incentive for collaboration with Australia. The EU aims to become climate neutral by 2050, and it plans to work with international partners to improve global environmental standards.

Organizationally, Australian and European RIs have accelerated at different paces and within different areas, opening up opportunities for RIs to lift one another up. Galloway offered an example of Euro-BioImaging needing guidance to grow their biomedical and human imaging components. They brought him on to chair a working group and help review initial calls for nodes to join Euro-BioImaging, which has mostly focused on microscopy up to this point.

“At that stage, we had more experience in human imaging at a collaborative level. Of course, there’s a huge amount of human imaging in Europe, but the idea of a national or pan-national collaboration was in very early stages,” said Galloway. “So from that, there was a natural interest in us coming together to share those opportunities.”

Lastly, several of the experts mentioned training exchange as an excellent avenue for intercontinental RI partnership. Bioplatforms Australia signed an MOU with EBI focused on training in bioinformatics and the digital workforce more than a decade ago. Australian practitioners go to Europe to get trained in best practices while finding ways to apply them back home, and a European delegation heads to Australia as well.

“That transfer of knowledge by training is low-hanging fruit for global collaboration, particularly over research infrastructures that by their definition are capital-intensive, and there are very few people who can operate them,” he said.

Conclusion

Australian-European RI collaboration has the potential to advance scientific progress in several areas, including genomics, agriculture, arts and humanities, and medicine. Challenges and bottlenecks do exist

– for instance, large time differences and the lack of European funding available to Australia – but the case studies outlined in this report demonstrate that these can be successfully overcome.

Key recommendations from experts to facilitate Australian-European RI partnerships can be categorized into actionable items for RI representatives, policy makers, and funders.

Key recommendations for RI representatives:

RATIONALE/GLOBAL CHALLENGES:
- RI partnerships should start with common interest and perception of mutual benefit on both sides.

FUNDING:
- RIs should budget for international collaboration.

ACCESS:
- Take advantage of technology that enables virtual meetings and collaborative documents.

CO-CREATION BASED ON NEEDS:
- Overseas events should be customized to the host country's needs.

OUTREACH:
- Connecting on a personal level with others from abroad can lead to successful joint projects down the line.

BEST PRACTICE:
- Value RI staff members and give them a rewarding career pathway.

Key recommendations for policy makers & funders:

BEST PRACTICE:
- RIs need the bare minimum amount of national contributions to sustain operations in order to take the next step of international collaboration.

OUTREACH:
- Policy makers and funders should recognize that RIs may take several years to produce significant scientific results.

SUSTAINABILITY:
- Multi-year funding schemes give Australian RIs the security to plan ahead and develop fruitful international partnerships.

FUNDING:
- Europe should find ways to open up funding access to Australian organizations by including RIs in the work programmes.

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Table 1: Examples of Research Infrastructures in Europe and Australia

Energy	• European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL) • Brazilian Centre for Research in Energy and Materials (CNPEM) Australian Nuclear Science and Technology Organization (ANSTO)
Environment	• European Multidisciplinary Seafloor and water column Observatory (EMSO) • Integrated Marine Observing System (IMOS)
Biomedical Sciences	• European Clinical Research Infrastructure Network (ECRIN) • Therapeutic Innovation Australia (TIA)
Physics & Engineering	• European X-Ray Free-Electron Laser Facility (European XFEL) • Australian Synchroton
Social Sciences & Culture	• Survey of Health, Ageing and Retirement in Europe (SHARE) • Australian Data Archive (ADA)
Big Data & Computing	• European High-Performance Computing Joint Undertaking (EuroHPC JU) • Australian Research Data Commons (ARDC)

Many more examples of research infrastructures can be found in the RISCAPE International Research Infrastructure Landscape 2019, which can be found online at https://riscape.eu/riscape-report/.

APPENDIX A: List of experts interviewed

Dr. Bettina Berger, Scientific Director of The Plant Accelerator

Berger joined The Plant Accelerator when it opened in 2010 as Senior Scientist and became Scientific Director in 2015. The Plant Accelerator is one of the nodes of the Australian Plant Phenomics Facility (APPF) funded under the National Collaborative Infrastructure Strategy (NCRIS) and provides critical infrastructure and services to the plant science community in Australia and abroad. In her roles, she has set up novel screening techniques to study plant growth and performance using automated, non-destructive imaging. Users of The Plant Accelerator include Australian researchers, as well as overseas customers from Europe, North America, and Saudi Arabia. Berger has a degree in biotechnology and a PhD in molecular biology of plants.

Sally Chambers, Digital Humanities Research Coordinator at Ghent University

Chambers is the Digital Humanities Research Coordinator at Ghent University, where she coordinates the day-to-day activities of the Ghent Centre for Digital Humanities and Belgian participation in DARIAH, the Digital Research Infrastructure for the Arts and Humanities. From 2011-2015, Chambers was Secretary-General for DARIAH-EU, based in the Göttingen Centre for Digital Humanities, Germany. Before joining DARIAH-EU, she worked for The European Library, focusing on interoperability, metadata and technical project coordination. She initially started working in libraries in the mid-1990s, where she coordinated a digital enquiry service for UK public libraries and the development of an online library for distance learning students at the University of London. Chambers has a first degree in Literature with Psychology and postgraduate qualifications in Cultural Studies and Information Services Management.

Dr. Graham Galloway, Chief Executive Officer of the National Imaging Facility (NIF)

Professor Galloway is the Chief Executive Officer of the National Imaging Facility (NIF). He has been instrumental in establishing Imaging collaborative research infrastructure in Australia. In 2006, he led the collaborative team that developed the Investment plan for Imaging, within NCRIS (National Collaborative Research Infrastructure Strategy). This plan was accepted by Department of Industry, Innovation and Science, with $7M Commonwealth funding, plus $10M state and institutional funding, and Galloway was nominated by the Imaging Community as the Inaugural Chief Executive Officer of the National Imaging Facility. In this role, he provides leadership to the NIF as it develops a strategic vision for imaging in Australia. Under his leadership, NIF has expanded through the Education Investment Fund and further capital investment through NCRIS. With state and institutional funding, this is a $130M project. He is passionate about providing open access to the imaging resources and enabling effective use of those resources.

Andrew Gilbert, Chief Executive of Bioplatforms Australia

Gilbert has been Bioplatforms Australia’s general manager since its inception in 2007. He is a graduate of the Australian Institute of Company Directors. He oversees the investment of $300 million in Commonwealth Government research infrastructure funding in the discovery sciences of genomics, proteomics and metabolomics. He has an extensive network of contacts from Commonwealth and State Governments, along with prominent universities, medical research institutes, agricultural research institutes and commercial entities. The Bioplatforms Australia network now supports 4500 users per annum across the spectrum of pure research to commercial production. In addition to managing the national infrastructure network, Gilbert has also catalysed the formation of a series of strategic national scientific collaborations. Each of these projects is by design multi-disciplinary, multi-institutional and contain both discovery implications and pathways to end use.

Dr. Stewart Newman, Chief Executive Officer of Therapeutic Innovation Australia (TIA)

Newman is the Chief Executive Officer of Therapeutic Innovation Australia (TIA), which supports translational research infrastructure to develop new therapeutics for human health. Since completing a PhD in Antarctic Biology from the University of Tasmania, he has built up considerable experience of science policy, pharmaceutical R&D, grant funding, IP management, business development and commercialization. Newman previously worked with TIA as Queensland Development Manager, where he assisted the development of TIA's Queensland Node, and assisted in establishing the iQDOCs resource and the ATRAX database.

Sarah Nisbet, Platforms and Engagement Manager at Bioplatforms Australia

Nisbet is responsible for overseeing Bioplatforms Australia’s investment in its Genomics, Proteomics, Metabolomics, and Bioinformatics platforms. She is also responsible for enhancing and extending cooperation and collaboration across Bioplatforms networks and capabilities. Nisbet works closely with the CEO to execute the organization’s vision and strategy to deliver research infrastructure to the life sciences in Australia. Nisbet was previously COO at eResearch South Australia, a state based eResearch infrastructure provider, delivering HPC, Cloud and Storage solutions to researchers in SA. She began her career delivering communications solutions in the health care sector where she mastered the art of working across institutions, departments, and organizational silos. Nisbet has a Bachelor of Media from the University of Adelaide and an Industry Certificate (Festival & Event Design & Management).

Dr. Merran Smith, Chief Executive Officer of the Population Health Research Network (PHRN)

Smith commenced as the inaugural Chief Executive of Australia's Population Health Research Network (PHRN) in 2009. The PHRN is a national research infrastructure capability focused on the provision of high quality linked data in privacy preserving ways. It receives core funding from the Australian Government’s National Collaborative Research Infrastructure Strategy (NCRIS). Prior to joining the PHRN, Smith was a Director in the Western Australian Department of Health. She was in charge of the Department's Health Information Centre for more than 10 years and was responsible for establishing data linkage as a core Department of Health service during this period. She also participated in a number of significant nationally funded population health research projects. Smith has served as Chair or Member of a number of Australia's peak national health information committees.

APPENDIX B: Further reading

ESFRI Roadmap 2018: Strategy Report on Research Infrastructures
http://roadmap2018.esfri.eu/media/1066/esfri-roadmap-2018.pdf

RISCAPE International Research Infrastructure Landscape 2019
https://riscape.eu/wp-content/uploads/2019/12/Riscape_report_digi_19122019.pdf

Australia’s 2016 National Research Infrastructure Roadmap
https://www.education.gov.au/2016-national-research-infrastructure-roadmap

Australia’s National Research Infrastructure Census (NRI Census)
https://www.education.gov.au/national-research-infrastructure-census-nri-census