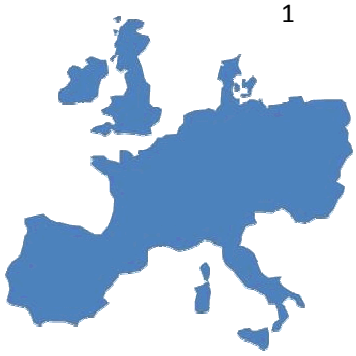
African-European Research Infrastructure Partnerships (PAERIP) Final Conclusions and High Level Recommendations



INTRODUCTION

Optimally exploiting the important role played by research infrastructures as platforms to enrich science and technology output, is receiving increased attention from policymakers, also within the context of international cooperation. Not only do research infrastructures constitute essential mechanisms to support international research cooperation but they also often represent critical investments as part of global efforts to address key sustainable development challenges. Research infrastructures were therefore also recognised in the Second Action Plan of the Joint Africa-EU Strategy as a priority focus for Africa-EU science and technology cooperation. PAERIP was initiated to examine how Africa-EU research infrastructure partnerships could be enhanced as part of the overall Africa-EU science and technology partnership to advance sustainable development. The project focused on creating an understanding of what research infrastructures are available on the two continents and which have existing collaboration and what the potential is for potential collaboration that could lead to partnerships, how access mechanisms could be established and supported, how collaborative planning, development, implementation and use of research infrastrcuture could be facilitated, the socio-economic impact of research infrastructure partnerships and what the funding instruments that are or will become available for such partnerships are.

A few key considerations with regard to the important direct and indirect impact of research infrastructure partnerships as instruments to support international cooperation, advance sustainable development and boost human capital development are highlighted as well as the outcomes of the PAERIP project to highlight specificities for the two continents to collaborate in the respect.

Before proceeding it would, however, be useful to clarify the definition of research infrastructures as those facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields. Research infrastructures, thus, cover major scientific equipment or sets of instruments, e.g. telescopes or accelerators; knowledge-based resources such as collections, archives or structures for scientific information; enabling Information and Communications Technology-based infrastructures such as grid and high-performance computing,

software and high-speed communication networks (known as e-Infrastructures), or any other entity of a unique nature essential to achieve excellence in research. Research infrastructures could be single-sited or distributed as part of a network of resources.

RESEARCH INFRASTRUCTURE PARTNERSHIPS TO SUPPORT INTERNATIONAL COOPERATION

Research infrastructures whether they are single large-scale facilities or instruments, networks, distributed infrastructures or e-infrastructure capacities are essential resources for all knowledge and innovation enterprises. Research infrastructure is at the core of the knowledge triangle (research, education, innovation) and could facilitate a global virtual research community. In order to advance international science and technology endeavour, concerted coordination and cooperation is required in order to ensure the optimal availability of such resources to the global research community. In this context, if appropriately leveraged, research infrastructures also have the potential to act as catalysts to advance international science and technology cooperation in their own right.

Global economic crises impact on the availability of resources for science and technology investment. This will accentuate the need for global partnerships with regard to research infrastructures, including joint financing, reciprocal access and networking, and other cooperation and coordination initiatives. Concomitantly such partnerships will also boost international science and technology cooperation enabling an enhanced policy dialogue between partners and more efficient utilisation and investment of resources. A key principle would be for partner countries' respective comparative advantages, e.g. geographic, knowledge, etc., to inform for example decisions pertaining to the location of infrastructures. These are important dynamics for potential Africa-EU partnerships.

RESEARCH INFRASTRUCTURE PARTNERSHIPS TO ADVANCE SUSTAINABLE DEVELOPMENT

Global sustainable development challenges, including mitigation of, and adaptation to, climate change, protecting biodiversity, fighting poverty-related communicable diseases and ensuring food security, all require a collective and committed international science and technology response. Other than providing critical resources for discipline-specific work (e.g. bioinformatics, bio-imaging, genotyping or bio-bank infrastructures for the life sciences), research infrastructures also contribute to enabling a vital multi-disciplinary approach. An example of the latter is the bettering of the understanding of Earth system dynamics, through coordinated Earth observation capacities coupled with modelling and simulation exercises. Research infrastructures in this manner also play an important role in providing science-based advice to inform policy- and decision-making.

The success of programmes such as the Global Earth Observation System of Systems (GEOSS) of the Group on Earth Observations is an excellent example of what can be achieved through targeted partnerships. GEOSS not only enables improved coordination and integration of national and

regional capacities, as part of an international programme, but also identifies and enables, new investments, which are required to enhance global observation capacities. It is a multi-disciplinary science-driven partnership, focused on harnessing Earth observation to address challenges in different societal benefit areas, including food, health and the environment. The GEOSS example is also mirrored by new infrastructures such as for example the LifeWatch biodiversity data observatory, which integrates through a holistic approach, research capacities related to ecosystems, species information, time/evolution, questions of scale, DNA/proteins/genes, etc.

It is significant that the revised version of the European Strategy Forum on Research Infrastructures (ESFRI) "Roadmap" of priority research infrastructure projects include a greater focus on infrastructures to support health, food and energy research. Investments in projects such as laboratory infrastructure for carbon dioxide capture and storage should indeed be at the heart of the sustainable development agenda. It should also be borne in mind that the development of new research infrastructures can not only serve to boost innovation, but can also serve as procurement instrument for investment in environmentally-friendly technologies.

Effectively fighting poverty, protecting the environment and ensuring sustainable growth is dependent on markedly increased and more efficient knowledge and innovation investment. Research infrastructures should form a central part of these strategies, especially so as they can also serve to strengthen multilateralism, global partnership and stability, as demonstrated by "peace projects" as the Sesame synchrotron light source partnership in the Middle East.

Research infrastructure partnerships can also boost socio-economic development. This is important since funding options for major global research infrastructure development also involve a careful cost-benefit analysis, with the return on investment not only measured in terms of exclusive science and technology orientated criteria, but also with regard to socio-economic development.

Research infrastructure development for example often also includes major services infrastructure development and frequently is a significant boost for employment creation in the area where the infrastructure is created. The interface of research infrastructure funding with for example public procurement, regional development, social cohesion or overseas development assistance is therefore an important policy consideration for Africa-EU cooperation. In appropriate circumstances this interface could even serve a driver for new research infrastructure partnership funding instruments.

TECHNOLOGY CAPACITIES AND HUMAN CAPITAL DEVELOPMENT

Research infrastructures could help to leverage contributions from a broader global community for scientific enterprise. This is valuable since increased international cooperation is essential for global scientific advancement. Whilst most major global research infrastructures involve comprehensive international networks of researchers, these networks could be expanded and significantly enriched by actively promoting the participation of research communities from regions such as Africa, often

excluded from these enterprises, due to historical non-participation or constraints such as limited communications connectivity.

Research communities in developing countries often have unique and rich contributions to offer, for example in dealing with global environmental challenges (climate change, biodiversity protection, etc.) Whilst global research infrastructures will always primarily be advanced by a core group of voluntary partners, concerted efforts to broaden the range of international participants, especially from developing countries, will add significant value to such projects. In this context, ensuring an internationally balanced distribution with regard to the location of major facilities will also play a significant role, and not only symbolically, to promote globally inclusive projects.

Research infrastructure partnerships contribute to human capital development by serving as flagship projects to raise interest of the youth and public in science and by promoting more equitable global brain circulation. Research infrastructure projects play an invaluable role in focusing the attention of not only policy- and decision-makers, but also of the broader public on science and technology. They can therefore also be an excellent vehicle for encouraging the youth's interest in science and technology careers. There is most promising potential to develop exciting science and technology education programmes concurrently with infrastructure projects.

Another important contribution such projects can render is to support raising public awareness and understanding of science and technology and its contribution to society. Global research infrastructure projects enjoy "flagship" status, largely as a result of their scope (e.g. focused on global challenges or frontier research such as astronomy projects) and their large scale, and concurrently also command high levels of public interest.

While international scientific mobility is fundamental to the development and evolution of a global science system and enterprise - and, indeed, of science itself - negative impacts of increased mobility will be more strongly felt by developing nations than developed ones in the form of a long term, net outflow of human resources. This will further deepen the existing dissymmetry in science between developed and developing countries, eroding progress toward a global science enterprise and undermining the growth of science, which would surely be enhanced through full participation of human resources in developing countries, especially over the long-term.

This is the reason why the dissymmetry needs to be actively managed through important means such as the location of international science resources and infrastructures in developing countries. These considerations should play an important part in the global research infrastructure discourse, including measures to facilitate access to international facilities for researchers from developing countries, where such facilities do not exist in their own countries.

ESTABLISHING RESEARCH INFRASTRUCTURE PARTNERSHIPS

The analysis above demonstrates that research infrastructure partnerships can significantly enrich Africa-EU science and technology cooperation, notably by enhancing the bi-regional collaborative efforts to harness research and innovation for sustainable development and to boost human capital development.

The concept of partnerships was considered by PAERIP, on a spectrum ranging from awareness and access, collaboration and cooperation to fully committed partners that are prepared to co-invest in research infrastructure. The European and African research infrastructure landscapes were characterised with the aim of addressing Africa's potential to contribute to the implementation of the ESFRI Roadmap and Africa's potential to host European research infrastructures, also as part of global partnerships.

Partnership formation is influenced by national, regional and continental priority areas for research infrastructure investment, research infrastructure at global and intercontinental scale, better communication and connectivity and the multiplicity of participants. Research infrastructure partnerships are formed against a global environment for the development of new international initiatives, influenced by research challenges, multidisciplinary areas of research and the global nature of research infrastructure. A critical aspect for partnership formation is awareness. PAERIP enabled this awareness and provided guidelines for such partnerships between Europe and Africa that could also become platforms for global research infrastructures.

A research infrastructure partnership can best be described 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 research infrastructure that holds mutual benefit in terms of advancing the frontiers of knowledge, enabling research on intercontinental or global challenges, providing access to science that holds geographic or regional knowledge advantage and contributing directly or indirectly to national competitiveness.

Policy frameworks, when formulated in the right way, support research infrastructure partnerships. The knowledge gained in the PAERIP project is to be applied by policy makers and funding entities to promote, encourage and advocate the formation of research infrastructure partnerships between Africa and Europe, but also to influence global research infrastructure.

Observed criteria for successful research infrastructure partnering were identified and listed:

- A well-defined common need must exist
- There must be a champion that takes ownership for developing and promoting the research infrastructure partnership
- Research infrastructure must be placed at intercontinental scale
- Collective knowledge generation is essential

- Leveraging international funding is critical
- Promoting access and the mobility of researchers to research infrastructure is one of the key success factors
- Partnerships are likely to succeed if the research infrastructure addresses continental or global challenges
- Mutual advantage must be clear to all partners
- Common will to jointly conceptualise, plan, develop, implement, commission, operate, manage, use and phase out research infrastructure must be present
- Co-investment from all stakeholders is key
- Research infrastructures must be linked by advanced communications
- Data sharing, security and curation is integral to a successful partnership
- A research infrastructure partnership must lead to the optimisation of productivity of research outputs and impact
- It must also contribute to the knowledge base of the science
- The partnership must extend the reach and impact of the research infrastructure
- By strengthening the strategic objectives of all partnering entities, a partnership is more likely to succeed
- Building community around research infrastructure is an essential ingredient for a successful partnership
- Clear conditions of access must be communicated
- Excellence in science is non-negotiable
- The research infrastructure established through the partnership must contribute to socio-economic development
- The host country must find funding to implement and operate the research infrastructure

DISTRIBUTION OF PAERIP CONCLUSIONS

The final PAERIP conclusions and policy recommendations highlight the arguments on why research infrastructure partnerships between Africa and Europe should be concertedly promoted as a priority action in bi-regional cooperation. They also present specific recommendations how bi-regional research infrastructure partnerships could be enhanced, ensuring greater impact and mutual benefit for Africa and Europe. The conclusions also confirm several findings made by PAERIP through various workshops and engagements conducted in both Africa and Europe.

The aim is to present these conclusions to the principal bodies entrusted with the governance and advancement of the Science, Information Society and Space Partnership of the JAES, the Co-Chairs of the Bureau of the Africa-EU Science, Technology and Innovation Policy Dialogue, the Co-Chairs of the Joint Expert Group of the 8th Partnership (JEG-8), the European Commission, as well as the African Union Commission and other important actors engaged in the implementation of the Science, Information Society and Space Partnership including Africa's Regional Economic Communities (RECs), the New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency, as well as the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and other United

Nations entities involved in science and technology partnerships with Africa. Dissemination to the broader public will target, among others, research communities (including associations of science and technology professionals or organisations such as the African Network of Scientific and Technological Institutes, as well as policy-makers, representatives of industry and business (including the Africa-EU Business Forum), and diaspora organisations.

PAERIP RECOMMENDATIONS

PAERIP recommendations are structured to interrogate, at policy level, a rationale for bi-regional research infrastructure partnerships; why international science, technology and innovation cooperation needs research infrastructures; why research infrastructures need international cooperation and why, specifically, Africa-EU research infrastructure cooperation? The recommendations serve to enhance Africa-EU research infrastructure partnerships and include *policy objectives* for bi-regional research infrastructure partnerships; *high level recommendations on establishing an enabling environment* and *specific operational recommendations*.

PAERIP POLICY RECOMMENDATION

Research infrastructures should be a priority focus of bi-regional Africa-EU cooperation in science, technology and innovation

After considering evidence from past, current, and planned Africa-EU research infrastructure partnership initiatives related to infrastructures such as bio-banks, phenotyping facilities, radiation sources, clean rooms, observatories, telescopes, databases, supercomputers and high-speed research networks, it became clear that compelling arguments exist why international cooperation is essential in order to optimally exploit the potential of research infrastructures to contribute to societal and scientific advancement. In this context it was found that bi-regional research infrastructure partnerships between Africa and Europe partnerships offered rich potential to deliver significant mutual benefit for both regions. The major policy recommendation following from PAERIP thus is that *research infrastructure cooperation should be a priority focus for Africa-EU cooperation in science, technology and innovation*.

The outcome of PAERIP also highlighted that *global partnerships are essential for research infrastructure*s - regions and countries cannot do it alone.

- Research infrastructures are increasingly complex and costly, requiring the integration of equipment, services and data, and accordingly necessitate extensive international cooperation, with regard to the planning for and funding as well as governance of facilities, including as appropriate with regard to their regulatory aspects.
- Bi-regional research infrastructure cooperation can leverage efficiencies of scale and scope. International cooperation presents opportunities to avoid duplication of effort and investments,

and to better coordinate and rationalise the use of facilities, where for example the small size of a user community do not merit new investments.

This policy recommendation is supported by the fact that Africa and Europe can benefit significantly from cooperating in research infrastructures and that it is fully aligned with the objectives of the Joint Africa-EU Strategy.

- Africa and Europe enjoy a close political, economic and development partnership (as embodied in the JAES) as well as historic ties in cooperation in science, technology and education, which over recent years has grown significantly – for example, Africa's participation in the FP7. Cooperation in research infrastructures can build upon, complement and enrich these partnerships.
- Africa and Europe have comparative advantages to offer each other as partner for international science and technology agreements, which can also be exploited for research infrastructure partnerships. Such advantages could be of a geographic nature, for example, ideal observation conditions for astronomy, or pertain to access to unique resources, such as sample material for clinical trials or relate to specific technical expertise.
- Cooperation in research infrastructures is fully aligned with the overall objectives of the Joint Africa-EU Strategy, including with regard to sustainable development and capacity-building (indeed cooperation in research infrastructures is specifically mentioned in the JAES Second Action Plan for the Science, Information Society and Space Partnership).

This policy recommendation is also supported by the fact that there are persuasive arguments for *research infrastructures to be at the heart of the JAES Science, Information Society and Space Partnership*.

- Research infrastructures are key determinants of competitiveness and development and can further leverage the important role of science and technology investments in stimulating economic growth and sustainable development:
  - Research infrastructures trigger innovation and partnership with industry
  - Significant "non-science" benefits can be leveraged from research infrastructures (for example, employment creation, service delivery, non-research infrastructures, etc.)
- Research infrastructures are essential instruments for collaborative research addressing societal challenges
- Research infrastructures are drivers for international cooperation and science systems
- Research infrastructures encourage multi-disciplinary research
- Research infrastructures foster excellence in research
- Research infrastructures are enablers for researcher training and the international mobility of researchers and ideas

- Research infrastructures are ideal platforms for science communication (public awareness and understanding) and science education programmes, for example, for the youth

High-level objective and goals for Africa-EU research infrastructure partnerships

Harness research infrastructures for scientific advancement and innovation on both continents

PAERIP concluded that the high-level objective for Africa-Europe research infrastructure partnerships should be to optimally leverage such cooperation for *scientific advancement and innovation in Africa and Europe*. Specifically, partnerships should address the following goals:

- Ensuring the availability to African and European researchers of world-class research infrastructures to enable and support their bi-regional cooperation, by:
  - Establishing reciprocal access (to facilities) and research infrastructure networking (between facilities) programmes
  - Building, maintaining and operating research infrastructures required for global and bi-regional partnerships
- Leveraging research infrastructure partnerships as instrument for science, technology and innovation capacity building in both Africa and Europe.

High-level recommendation for Africa-EU research infrastructure partnerships

Cooperation in research infrastructures should be promoted as part of the Africa-EU Science, Information Society and Space Partnership

PAERIP recommends to those bodies entrusted with the stewardship of the Science, Information Society and Space Partnership to take specific attention, as appropriate, to the following considerations with regard bi-regional cooperation in research infrastructures:

- Cooperation between and coordination of national and regional research infrastructure programmes, in Africa and Europe, should be encouraged - specific attention should be paid in both regions to raise mutual awareness of the other's research infrastructure capacities and needs
- Synergy between different international, regional and national funding programmes (for example, research, economic and social development funding instruments) with the potential to support research infrastructure partnerships should be promoted, in order to leverage better returns on investments
- The potential contribution of research infrastructures to innovation and innovation systems should be fostered and exploited
- Human capital needs of research infrastructures (for example, technical and managerial expertise) should be addressed

- Research infrastructures should be leveraged as a tool for human capital development and institutional capacity-building within science and innovation systems

Specific recommendations for Africa-EU research infrastructure partnerships

Actions were identified to promote Africa-EU research infrastructure partnerships that could be implemented as part of the Science, Information Society and Space Partnership in 2013

PAERIP urges bodies such as the Bureau of the Africa-EU Science, Technology and Innovation Policy Dialogue and the Science, Information Society and Space Joint Expert Group (JEG-8) to as appropriate, undertake and encourage specific actions to promote Africa-EU research infrastructure partnerships in 2013. Six specific recommendations are submitted for consideration:

1. A roadmap for Africa-Europe research infrastructure cooperation with regard to large-scale facilities should be developed and approved by relevant stakeholders. The roadmap should notably:
   - Identify global research infrastructure partnership initiatives, which could be supported through Africa-Europe bi-regional cooperation
   - Explore the potential for Africa and Europe to jointly develop new large-scale research infrastructures as required by their user communities
   - Investigate the feasibility of establishing regional partner facilities (in Africa or Europe as appropriate) for existing African or European research infrastructures (including but not limited to those on the roadmap of the European Strategic Forum on Research Infrastructures – ESFRI)
   - Analyse the enabling legal and financial frameworks, which would be required for these partnerships to be pursued.

2. An analysis of available funding instruments to support bi-regional research infrastructure partnerships, both with regard to access to existing and the development of new infrastructures, should be undertaken by a mandated expert group. The analysis should include recommendations how these instruments could best be accessed. Specifically, the analysis should consider:
   - Opportunities for the current and future call for proposals of the FP7 ERA-Net for Africa, ERA-Africa, to support research infrastructure partnerships
   - How the African Union Commission's African Research Grants programme, currently supported by the European Commission, could support research infrastructure partnerships
   - The most appropriate manner to include research infrastructures in the programming phases of the National and Regional Indicative Programmes of the Eleventh European Development and the planned African Partnership Instrument of the new EU Development Cooperation Instrument

- How the EU-Africa Infrastructure Trust Fund and financing agencies such as the African Development Bank and the European Investment Bank could support research infrastructure partnerships
- Opportunities under the future EU Horizon 2020 Framework Programme for Research and Innovation to support bi-regional research infrastructure partnerships with Africa, including, as appropriate, African participation in the successor to the FP7 Integrated Infrastructure Initiative scheme
- The development of indicators with regard to research infrastructure partnerships, which could be used in the monitoring of the implementation of the Second Action Plan of the JAES, to gauge the efficiency of investments

3. Guidelines should be developed by a mandated expert group for the bi-regional integration and opening up, which is to say reciprocal access to, of existing African and European research infrastructure. This analysis should draw on best practices in current cooperation, for example compiled by PAERIP.

4. In the light of the important horizontal impact of e-Infrastructures across all research and innovation areas, the JEG-8 or other appropriated body should develop a framework document with policy guidelines for the advancement of on bi-regional cooperation in e-infrastructures. The framework should address among other issues:
    - Identification of e-infrastructure capacity needs and constraints
    - Best practices in the development, deployment and operation of e- infrastructures
    - Policy frameworks for data management, including the translation of “open access” principles in partnership schemes

5. A specific event should be organised to explore how bi-regional partnerships can foster and leverage the innovation potential of research infrastructures, for example, with regard to:
    - Encouraging research infrastructures to act as early adopters of technology
    - Promoting R&D partnerships between research infrastructures and industry
    - Facilitating industrial use of research infrastructures
    - Stimulating the creation of innovation clusters
    - Creating platforms for technology transfer

6. An Africa-Europe cooperation programme should be developed to ensure the availability of the required human capital for research infrastructures. This programme could comprise training and exchange programmes for staff managing and operating research infrastructures.

CONCLUSION

PAERIP has successfully arrived at high level policy and implementation recommendations that provide compelling support for the facilitation, development and establishment of Africa-Europe partnerships in research infrastructures. While the focus is on research infrastructures, there should be acknowledgement of the need for basic equipment and facilities in Africa. There are a lot of initiatives in progress that represent such research infrastructure partnerships or could lead to them, but better coordination is needed to harness the full potential. The need to communicate the socio-economic aspects of research infrastructure to policy makers in a clear manner without overstating the impact thereof is clear. Acknowledgement has been achieved that PAERIP made a real difference to the understanding and motivation for research infrastructure partnerships between Africa and Europe in many respects such as awareness, networking, partnerships, funding possibilities and future requirements.