AFRICA EUROPE
INNOVATION PARTNERSHIP

AEIP – Activity 2 Technology exchange – learning activity

Technology & knowledge exchange in H2020 projects

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Author

Karine Kouassi Lou – Kouacou

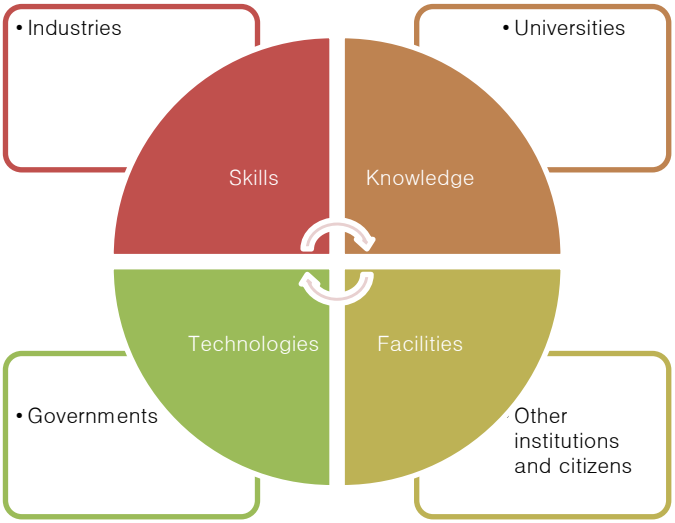
Table of Contents

1 Introduction

Technology transfer is a complex and multifaceted process of disseminating and transferring technology from its originating environment to a wider group of stakeholders. It refers to the process of conveying results stemming from scientific and technological research to the market place and to wider society, along with associated skills and procedures, and is as such an intrinsic part of the technological innovation process.

Technology transfer starts with the results of the research. Observations and experiments during research activities lead to discoveries and inventions. When an invention (process, technology) is made, the next step is to find the best way to disseminate and effectively exploit the research result with a view to reaching the market.

Figure 1 Technology and Knowledge transfer process



Source: EC JRC

The process of disseminating technology occurs along various potential axes, from research and knowledge organisations (RTOs) to the private sector, from large companies to SMEs, and within or between countries. Technology transfer can involve various stages of technological sophistication, related to operating technology, maintenance or repairs, implementing innovations or eventually, designing and developing new products and (manufacturing) processes (Agola N. , 2016).

Technology transfer deals with issues of demand-side uptake capacities, the supply-side market, and competition considerations, as well as a lack of intermediary pathways and brokers for such transfer. These issues and their framework conditions such as legal frameworks, business environment, and enforcement all play important roles in technology transfer.

In the framework of the Sustainable Development Goals (SDGs), **technology transfer has been recognized as a priority for supporting economic development in developing countries**. When used effectively, technologies can be applied to overcome development challenges. The ambition to provide developing countries with the tools and capacity to enable or accelerate their trajectories towards inclusive and sustainable growth is mentioned in particular in SDG 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation) and SDG 17 (strengthen the means of implementation and revitalize the global partnership for sustainable development). SDG 17 devotes particular attention to the need for enhanced cooperation, both North–South, South–South, and triangular regional and international cooperation, including access to science, technology, and innovation through improved coordination and through a global technology facilitation mechanism. SDG 9 supports, amongst others, domestic technology development, research and innovation in developing countries, as well as the access to information and communications technology (United Nations, 2015).

In this study, we enlarge the strict definition of technology transfer to "**knowledge and innovation transfer**", which means **it encompasses several possible activities** (Technopolis Group, 2019): publications, exploitation of intellectual property, formal contract with a company to conduct novel research to create new knowledge, formal collaboration/ partnerships, informal /personal exchanges, training, etc. See Figure 2. The technologies, knowledge and innovations under consideration will come not only from Europe to Africa: we also consider technology, knowledge and innovation (TKI) from Europe to Africa but also from Africa to Africa and from Africa to Europe although not the core of the project. This open definition also caters for the fact that a) not all innovations are technology–driven and b) where there is technology involved, the transfer is usually not just about the intellectual property (IP), but about a combination of IP rights and (often not codified) know–how, without which the IP can hardly be used.

Figure 2 Technology and Knowledge exchange mechanisms

	Description
Publicati ons	Publications in referred journals / books Other reports /publications Open source publication Presentations at conferences Patent specifications
Exploiting intellectual property	Disclosure of PRO generated IP and its commercialisation through: Selling IP Licensing IP (particularly patents) to companies for commercialization Creating spin–outs based on PRO IP (typically licensed to the spin–out) and Involving PRO personnel/ faculty Furthermore: Establishing the role of IP in different forms of collaboration / partnerships (e.g., contracts / IP terms in consortia agreements, etc.) Furthermore: Establishing the needs to secure and deal with trade secrets (particularly also in the context of traditional knowledge (TK) and traditional cultural expressions (TCEs)
Contract R&D and consultancy	Contract R&D: formal contract between a company and a PRO, for the PRO to conduct novel research to create new knowledge on behalf of a business Consultancy: formal contract between a company and a PRO for PRO personnel to apply existing knowledge to company's business (e.g. advice, written reports, technical adaptation) Technical services: e.g. testing / characterisation services etc. using PRO facilities to provide data /information
Formal collaboration/ partnerships	University–industry collaborative research partnerships typically encouraged and supported (in part) with public funds Joint (research) ventures between PRO and a company Groups of companies and universities /PROs engaged in longer–term research partnerships of common interest such as competence centres

Informal interactions	Informal /personal exchanges with links made through a variety of means: Personal contacts Alumni organisations Professional organisations Participation in conferences /seminars
Accessing research skills	Hiring higher-level graduates (Masters/ PhD) Financing of PhD projects Student internships in business Temporary staff exchanges / visits Staff holding joint positions in PRO and industry
Other mechanism(s)	For example: Training / continuing professional development; Sharing facilities; Exchange of research materials; Public events / open days

Source Technopolis Group, Africa-Europe Innovation Partnership Activity 2 strategy report (2019)

According to academic literature, Africa is the continent with the lowest adoption of technologies in the economic sphere. In production, such as agriculture or manufacturing there is "limited deployment of productive technology or capital equipment" (Agola N. O., 2016). Some authors have suggested that **effective adoption of technology has the capacity to unlock the potential of industries, especially in Africa, and foster entrepreneurial development** (Danquah, 2017).

Various multilateral initiatives have been set up to facilitate technology transfer from developed to developing countries, including specifically between EU and Africa, as well as within developing countries.

Collaboration between Africa and the EU for research and innovation activities is mainly shaped by the Joint Africa-EU Strategy (JAES), which puts emphasis on the use of technology to achieve Millennium Development Goals and Sustainable Development Goals. The AU-EU High-Level Policy Dialogue (HLPD) on Science, Technology and Innovation serves as a platform for exchange regarding R&I and is key in developing and implementing these strategic priorities. In this framework, the EU and AU have engaged in both a Research & Innovation Partnership on Climate Change and Sustainable Energy and on Food Nutrition Security and Sustainable Agriculture. Both partnerships aim to increase scientific and technological cooperation or technology transfer (African Union) (The Africa-EU Partnership, 2017). Initiatives under the partnerships are funded by Horizon 2020 (H2020), the current Framework Programme for Research and Technological Development of the European Commission.

Besides the flagship initiatives specifically aiming to increase cooperation between Africa and the EU, organisations from Africa (any legal entity) are able to join the **Horizon 2020** consortiums. The Open to the World strategy of Horizon 2020 implies that many of the research calls are open to researchers from outside the EU, and in fact are often encouraged to apply in consortiums which should include at least 3 participants from 3 different EU Member States or Associated countries.

The Directorate-General for Research and Innovation (DG RTD) of the European Commission has launched an initiative entitled **'Africa-Europe Innovation Partnership' (AEIP)** with the aim to support Africa – Europe cooperation in the area of Innovation. Specifically, in this initiative, we aim at producing a body of knowledge on Technology Transfer.

This study explores Technology and Knowledge exchange in selected H2020 projects. It answers the following key questions:

- How technology and knowledge exchange is effective in H2020 projects?

- How technology and knowledge exchanges happen in H2020 projects? How was it organized? How IP is dealt with?
- How African partners benefit from H2020 research results?
- What are the key success/failure factors? What are the best practices?
- What lessons can be learnt for enhanced Technology & Knowledge exchange in H2020 projects?

The investigation methodology rests on the triangulation of information sourced through literature review and interviews with coordinators and partners of **selected H2020 projects** in the **health**, **food security**, **climate change,** and **ICT** sectors. The study also benefits from the review and comments of the AEIP Technology Transfer Community of Practice (CoP).

The following sections are organised as follows. First, we summarise the general framework of technology and knowledge exchange in H2020 projects (section 0). We then present three H2020 funded projects cases of technology and knowledge exchange (section 4) and conclude on the strengths and weaknesses of the models/examples presented (section 4). Finally, we elaborate on recommendations for enhanced Technology and Knowledge exchange in H2020 projects (section 5).

2 General framework of Technology and Knowledge exchange in H2020 projects

In line with the EU innovation policy, H2020 projects have to mainstream Technology and Knowledge exchange. Under Horizon 2020, beneficiaries engage in dissemination and exploitation activities. The rationale for this engagement lies in the fact that as Horizon 2020 is financed by EU citizens, it should benefit to the largest number and the fruits of the research should reach society as a whole.

Dissemination means sharing research results with potential users – peers in the research field, industry, other commercial players and policymakers. By sharing research results with the rest of the scientific community, H2020 beneficiaries contribute to the progress of science in general. Whereas **exploitation** (**commercialisation**) is the use of results for commercial purposes or in public policymaking[1].

Research results could be:

- **direct** – like a manual, test, model, new therapy, better product or process, or improved understanding of mechanisms
- **indirect** – like reduced material or energy usage, improved safety, or better-trained staff.

H2020 participants must take steps to make sure the research results are used:

- in further research activities other than those covered by the project concerned, or
- in developing, creating and marketing products or processes, or

[1] https://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/grant-management/dissemination-of-results_en.htm

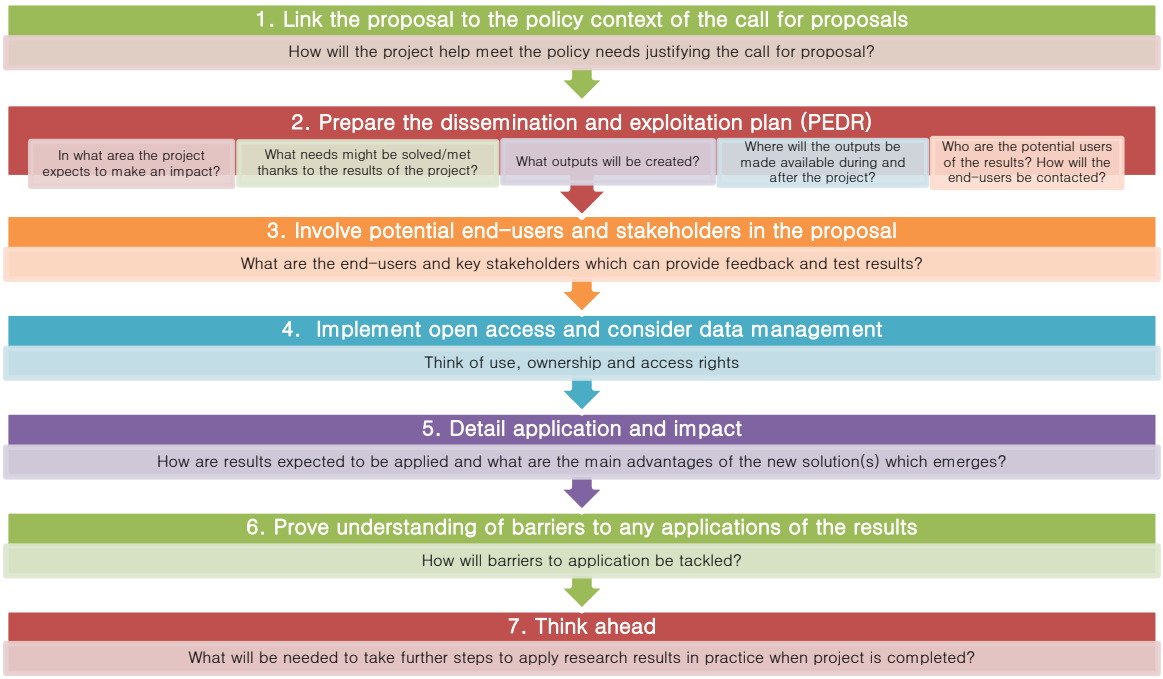
- in creating and providing a service, or
- in standardisation activities.

Technology and knowledge exchange should be highlighted at every stage of the project, from the proposal writing to the implementation phase of the project.

2.1 Guidelines for exploitation and dissemination activities in H2020 projects

The Horizon 2020 online Manual (EC, 2020) provides guidelines for dissemination and exploitation activities in H2020 projects. These guidelines consist of a step-by-step approach which is summarised in the figure below.

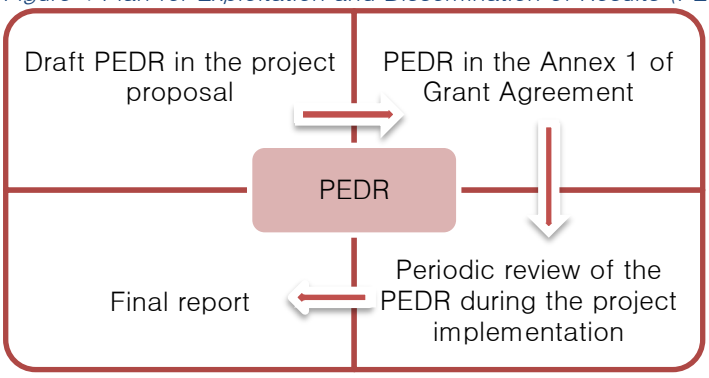
Figure 3 Guidelines for dissemination and exploitation activities in H2020 projects



Source: Horizon 2020 Online Manual (consulted 03 June 2020)

H2020 projects include a **Plan for the Exploitation and Dissemination of Results (PEDR)** which summarises the beneficiaries' strategy and concrete actions related to the protection, dissemination, and exploitation of the project results (European IPR Helpdesk, Fact sheet The Plan for the Exploitation and Dissemination of Results in Horizon 2020, 2015). The PEDR follows the evolution of the project from the proposal until the submission of the final project report. Thus, a preliminary or draft plan for the exploitation and dissemination of results is part of the project proposal itself. It is updated during the implementation of the project and beneficiaries are required to report periodically to the European Commission the concrete dissemination and exploitation activities carried out.

Figure 4 Plan for Exploitation and Dissemination of Results (PEDR)



Source: European IPR Helpdesk (2015)

All projects receiving Horizon 2020 funding are required to **make sure that any peer-reviewed journal article they publish is openly accessible**, free of charge (Article 29.2. Model Grant Agreement). Thus, when publishing results in scientific publications, open access to the publication must be ensured by participants.

As for **open access to research data**, the European Commission is running a flexible pilot on open access to research data[2], which covers all thematic areas of Horizon 2020. The pilot applies to research data underlying publications but beneficiaries can also voluntarily make other datasets open. The EC is committed to "open research data per default", but it is allowed to opt-outs for some datasets, for instance in cases of intellectual property rights (IPR) protection, personal data or national security issues. Projects that do not opt-out must develop a **data management plan** outlining how data is generated, curated and made accessible.

To be successful, dissemination activities should be fed by an ongoing dialogue with potential users during project. If users are committed from early on, the can provide valuable insight to guide the research results towards applications. The end-users may be found among fellow researchers, companies, investors, standardisation bodies, regulatory bodies, patent organisations, sectoral organisations, NGOs, the education sector, the public sector, etc. They can be involved as partners in the project, or throughout its duration, as members of an advisory board or user group tasked with testing the results and providing feedback.

The exception to the obligation to disseminate results only applies to protect intellectual property rights (IPR), security or legitimate interests.

2.2 How to manage IP in Horizon 2020?

The EC provides guidelines on how to manage IP in Horizon 2020 projects (European IPR Helpdesk, 2015). At the implementation stage, project partners need to give **access rights** to their background and results being created for other partners to carry out their work on the project and/or exploit their results.

According to the Horizon 2020 Rules for Participation and models grant agreement, **the results of the project belong to the participant generating them**. Given the collaborative nature of most

[2] https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm#OA_Rdata

projects, some results can be jointly developed by several participants. Hence, **situations of joint ownership might arise**. In Horizon 2020, results are jointly owned if:

- they have been jointly generated by two or more participants and
- it is not possible to:
  - establish the respective contribution of each beneficiary, or
  - separate them to apply for, obtain or maintain their protection.

In most cases **joint ownership will occur in very specific situations**, mainly for results of a technological nature.

It is best practice to regulate in the consortium agreement the rules on joint ownership of results or later on in a separate **joint ownership agreement**, defining in concrete terms the allocation and terms of exercising their ownership.

Transferring the ownership of their results to other parties is a possibility for those participating in Horizon 2020. However, it is fundamental that, whenever transferring the ownership of their results, participants follow the requirements established in their grant agreement.

Protection of results is essential in Horizon 2020, since an effective exploitation depends on it. Thus, participants must assess the possibility of protecting their results once these are generated. Should the results be reasonably expected to be commercially or industrially exploited and their protection possible, reasonable and justified, then participants must provide for adequate protection of the results during an appropriate period and in a suitable territory. Thus, although **IP protection is vital for a prospective commercial or industrial exploitation, on the other hand it is not always mandatory.**

The protection of results is not limited only to industrial and intellectual property rights (e.g. patents, trade marks, design rights, copyright). Indeed, results generated under the project could be any tangible or intangible output, more particularly data, knowledge or information whatever its form or nature, whether it can be protected or not. Also business information or valuable know-how can be protected via **contractual mechanisms**, like non-disclosure agreements or as trade secret.

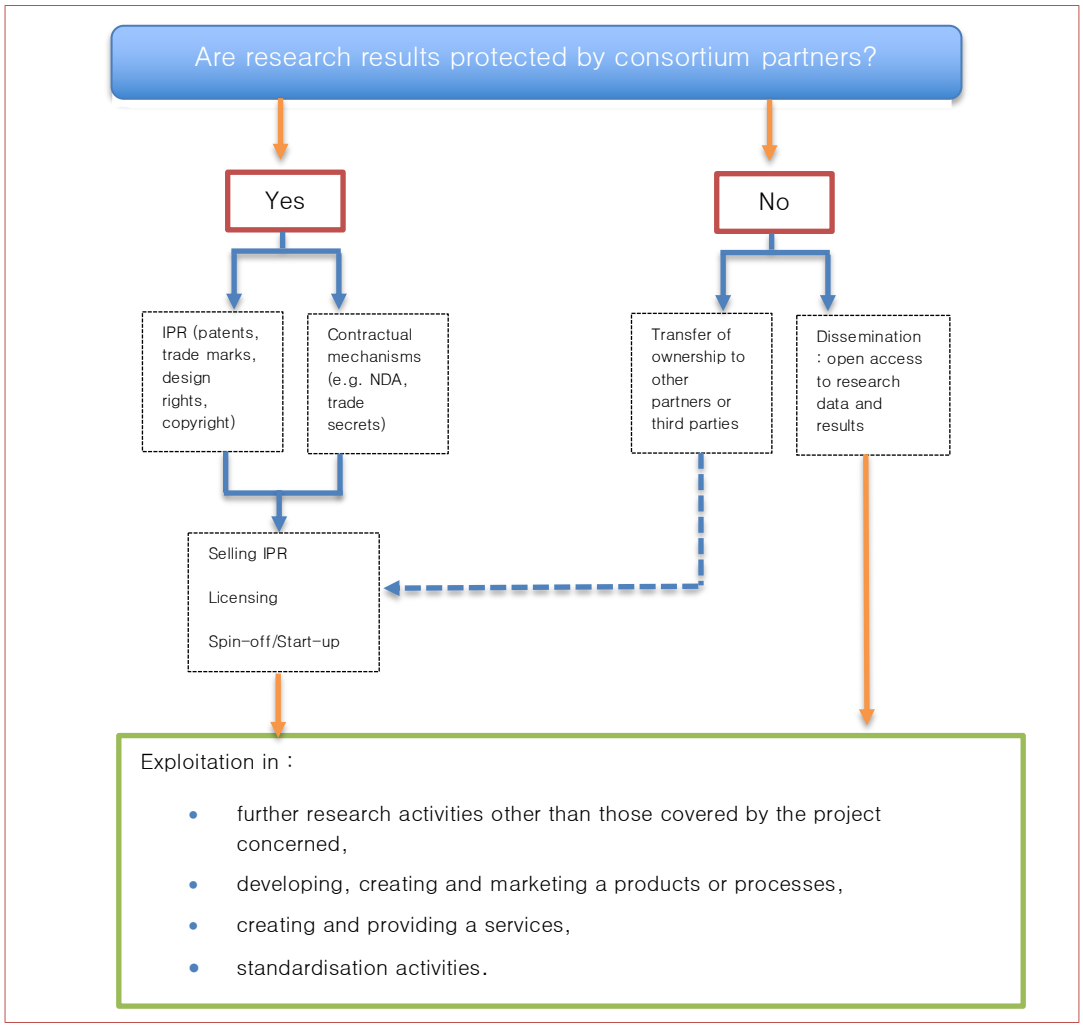
The choice of the most suitable form of IP protection, as well as the duration and geographical coverage depends on the results at stake, but also the business plans for their exploitation and legitimate interests of consortium partners. Protecting results before any public disclosure is crucial, since such disclosure can destroy the participants' chances of being granted intellectual property rights, in particular patents and utility models that require novelty.

Where a participant does not intend to protect a result, it is also best practice to consider offering to transfer it to other consortium partners or third parties, better positioned for the exploitation of the results and willing to seek their protection.

2.3 Commercialisation in H2020 projects

In conclusion, when trying to reach the market in H2020 projects, consortium partners cans explore different options. There are summarised in the figure below.

Figure 5 Commercialisation in H2020 projects



3 Examples of Technology and Knowledge exchange cases in H2020 projects

In order to illustrate how technology and knowledge exchange happens in H2020 projects, we studied three projects which we studied in detail. For that, we reviewed the projects documents and interviewed consortium partners from both Europe and Africa.

3.1 EBODAC project

3.1.1 Summary of project

Research on the Ebola vaccine faces several issues. Researchers are not always trusted by the community and finding volunteers for vaccine trials can be difficult. When they do participate, volunteers do not always carry an ID, so it is hard to tell if researchers are dealing with the same person on return visits. And with weeks or sometimes months between visits, not every volunteer remembers all their appointment.

The Ebola Vaccine Deployment, Acceptance, and Compliance (EBODAC) project uses communications, engagement strategies, and technological tools to support Ebola vaccine trials. It is currently used by researchers in a trial in Sierra Leone. First, the local community engagement officer builds trust and addresses misconceptions by using plain language and simple images to explain about Ebola and clinical research. When volunteers join the study, they sign the informed consent. They are then registered using the iris scan and finally give their phone numbers, so they can receive a voice or text reminder for each return visit.

The EBODAC consortium consists of four (4) partners: Janssen, London School of Hygiene and Tropical Medicine (LSHTM) which is the project coordinator, World Vision and Grameen Foundation. These partners have experience and expertise in:

- Ebola vaccine development and vaccine acceptance; m-health deployments for disease management in resource limited settings (Janssen)
- Vaccine acceptance; risk management in health programs (LSHTM)
- Mobile health deployments for emergency assistance; communication and training delivery in emergency settings (World Vision)
- Mobile health software development and deployment in resource-limited settings (Grameen).

The project started in December 2014 and will be completed by November 2020.

A detailed factsheet of the project is presented in Appendix B1.

3.1.2 Technology and knowledge exchange outcomes

The EBODAC project is building capacity in Sierra Leone to use communication, engagement strategies, and technological tools in the future. EBODAC is delivering a series of projects to build local knowledge and capacity and strengthen health systems, in preparation for the potential future use of a licensed Ebola vaccine in several potential deployment scenarios:

- Piloting a Mobile Training and Support Service (MOTS) to deliver training to remotely-located Community Health Workers, to increase their preparedness to support future Ebola vaccination campaigns and respond to outbreaks.
- Developing an evidence-based Gap Analysis Tool (3C gap analysis tool) to enable governments to assess their readiness, from a demand-side perspective, to deploy a licensed Ebola vaccine. This tool is currently being translated into a digital tool that will be piloted in Uganda.

The MOTS was developed in collaboration with the Sierra Leone Ministry of Health & Sanitation in line with the National Digital Health Strategy. Investing in digital platforms for the education of community health workers (CHWs), who are mostly remotely-located in Sierra Leone is a critical strategic approach to strengthening the country's readiness for future Ebola outbreaks. Training content was customized in line with the national training curriculum and case reporting requirements. Local ethical approval was achieved and a pilot involving recruitment of 125 consenting CHWs was implemented in Bo district of Sierra Leone. Two training modules—one covering vaccination and one covering outbreak response and disease surveillance were delivered to the mobile phones of participants as audio messages in the preferred local language. Knowledge change was assessed largely through pre- and post-quiz assessments also implemented through interactive voice response (IVR). The consortium members are in the process

of transferring ownership of the MOTS platform to the Sierra Leonian Ministry of Health. An MoU has been signed in this regard with the financial contribution of the Sierra Leonian Ministry of Health to ensure the transfer of technology (equipment and capacity building).

The EBODAC consortium is committed to sharing the expertise and lessons learned from using community engagement, communication, and technology tools through publications and participation to events. In February 2017 EBODAC organised a symposium on this theme in Dakar, Senegal, which brought together experts from across Africa and beyond. The learnings from the symposium have contributed to a training resource which is now available as an open-access tool (London School of Hygiene & Tropical Medicine & Johnson & Johnson Global Public Health, 2018) for anybody interested in community engagement, communications and enabling technologies for clinical trials in outbreak settings. Consortium members have published several papers that are openly accessible. They have participated in conferences and given presentations to share what they have learnt from their experience to international audiences in Africa and beyond. Finally, the LSHTM is integrating what has been learnt into their courses at the university.

The community engagement, communication, and technology tools developed by EBODAC are also being used in Rwanda to support the country Ebola vaccination programme Umurinzi which started late 2019.

World Vision is also using the learnings and results of the project within their organisation in other activities they are carrying out in other countries.

As part of the grant of the consortium agreement, the research results are co-shared among consortium members. All results are being made publicly available. The project has not generated any IPR.

The EBODAC project has been successful in transferring knowledge. Key factors of success have been:

- The selection of consortium members: the consortium members have complementary skills and know-how that contributing to enhancing the research results and transfer of knowledge.
- Local presence: One of the consortium members (World Vision) is present on the ground and played an instrumental role in ensuring that key messages and training are communicated by using the right languages and channels that local stakeholders can understand.
- Dissemination as a key focus of the project: From the start, consortium members were obliged to disseminate the learnings and research results of the project. They were committed to completely transfer results to local partners for them to manage and take forward.
- Adapting to the local context: The collaboration between consortium members has helped to proposed more adequate technologies to the local context. For example, the first prototype for biometrical identification equipment was big (+300 kgs), required electricity and internet. Now, the biometrical kit is a tablet that works offline and helps circumvent the electricity and internet issues, especially in remote areas.

The EBODAC project has developed communication, community engagement strategies, and technological tools for vaccine research which have been adopted and in the process of being

completely transferred to local public authorities in Sierra Leone. The tools and learnings are also being used beyond the projects in other countries (Rwanda namely). The major learnings have been documented and disseminated through openly accessible publications. All components of the EBODAC platform are designed and developed to allow rapid and efficient scale-up, especially when working in resource-limited settings. They can be used by Africa governments to face, for example, the current COVID-19 outbreak and in other contexts. One of the major constraints to this will be the capacity to afford the equipment and subsequent costs.

3.2 WAZIUP project

3.2.1 Summary of the project

WAZIUP has addressed economic challenges in Africa in agriculture, aquaculture and cattle rustling:

- poor soil fertility management which leads to low-crop yield, severe erosion, and loss of income
- Lack of water quality monitoring, which induced fish loss in aquaculture production and low yield
- The problem of cattle rustling (the income of breeders is directly threatened when the cows are stolen) and numerous conflicts among breeders.

Besides, lack of infrastructures, such as internet access or electricity, is a problem across rural Africa and presents a challenge for digital transformation.

The Open Innovation platform for the Internet of Things (IoT)-Big Data in Sub-Saharan Africa – WAZIUP is a collaborative research project using cutting edge technology applying IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa, for example in agriculture, aquaculture and cattle rustling.

The WAZIUP project developed an open-access IoT Cloud platform that allows to create and deploy IoT applications both in the Cloud and on the IoT gateway. WAZIUP offers "out-of-box" complete solutions from sensors nodes to applications. WAZIUP is particularly adapted to tough conditions, for example, low power and long-distance applications. It is a "do-it-yourself" technology.

The WAZIUP consortium consisted of 5 European Union partners and 7 partners from 4 sub-Saharan African countries. It had support from multiple African stakeholders to define an innovation space to advance the African rural economy. It did so by involving end-users communities, namely rural African communities on selected pilots, and by involving relevant public bodies in the project development as well as African Tech Hubs. WAZIUP aimed at accelerating innovation in Africa by using EU innovation in the sector of IoT and Big Data. This technology was adapted to generate African cost-effective technologies to prepare the playground for future technological waves by solving concrete needs. Collaboration between European and African partners was at the centre of the project which started in February 2016 and ended in January 2019.

A detailed factsheet of the project is presented in Appendix B2.

3.2.2 Technology and knowledge exchange outcomes

The WAZIUP project dedicated a work package to dissemination, exploitation and commercialisation activities ((WAZIUP Consortium Partners, 2019). From the beginning, the project consortium wanted to ensure the creation of a WAZIUP community and ecosystem as well as maximum awareness of the project's activities and achievements through community building.

The WAZIUP project succeeded in building an **innovation ecosystem** around IoT and Big Data and its application in African Rural Economy by using WAZIUP platform. The project engaged with actors in the IoT and Big data ecosystem through workshops on the applications of the IoT for **Government officials**, **researchers** in the field of IoT, **higher education institutions** in IoT across the continent, and **tech hubs**. The project also contributed to the creation of **IoT Clubs** in African countries (Togo, Benin for instance) to train people at using the WAZIUP platform.

The project also organised **hackathons** (WAZIHacks) in several African countries (Togo, Ghana, Senegal) as well as **bootcamps**.The goal was to involve developers and organisations interested in IoT in sub-Saharan countries and source interesting IoT projects, using WAZIUP platform, which can be supported as **business spin-offs**. The business spin-offs were provided support by local incubators and WAZIUP offered small financial support to validate the idea and application. These activities were organised in close collaboration with the African Partners involved in the project (Université Gaston Berger of Senegal, ISPACE Ghana, …). The WAZIUP also community interacted via social media platforms which shared documentaries on the economic impact of WAZIUP platform and attracted many viewers around the world.

WAZIUP is an Open Source project and uses Github as its community platform for software development. The project has not generated any IPR. All WAZIUP source code is hosted on Github WAZIUP uses an Open Source approach and methodology for its development. All new features are first discussed in a Github issue. Complex features are designed in a separate Google document that is publicly accessible. WAZIUP had several external contributors, that developed applications based on WAZIUP technology.

General dissemination and communication activities included newsletters and online articles to inform about results and project activities. Several open access scientific publications were also issued by consortium partners. WAZIUP participated in many of events in Africa and presented the project to a wide audience in each event (ITU, higher education institutions events, IoT forums, Afrilabs annual gatherings, etc.).

The WAZIUP project **developed three devices to address key challenges** that are faced in agriculture, aquaculture and cattle rustling in Africa.

- WAZIUP soil moisture sensor which helps farmers to manage better their fertilisers and see the impact on the water retention mechanism
- WAZIUP water measurement device which helps monitor water quality in real-time
- WAZIUP cattle collar developed which helps breeders to control the position of their cow.

The prototypes were developed following the **minimum viable product (MVP) concept** consists of a product with a minimum of features to satisfy end-users, and to provide feedback for future product development. During the MVPs implementation process, a learning mechanism is set up based on the lessons learnt from different deployments. Feedbacks and issues are collected regularly and shared with MVP leaders to improve the proper functioning of devices. MVP leaders

developed low-cost products under the low-power constraints, that have been shared to pilot partners for experimentation in several countries (Senegal, Ghana, Burkina Faso and Togo).

The three MVPs developed by WAZIUP have shown interest both in term of technical features and potential prices by end-users, even if some adjustments must be made on the price for some devices. WAZIUP has proven the feasibility of building such devices and can provide full documentation to industrialize such devices. This is an opportunity for African companies to develop relevant businesses thanks to WAZIUP (WAZIUP Consortium Partners, Impact analysis report, 2019).

Another important element in the exploitation of WAZIUP project results is the WAZIHUB accelerator programme, which also received support from the EC under Horizon 2020. The WAZIHUB programme mobilizes the WAZIUP Open source technologies for start-up and business creation. The WAZIHUB phase (2018 – 2021) is based on the Open Source IoT hardware, cloud and software technologies developed by WAZIUP. Under WAZIHUB, an IoT technical accelerator programme was launched for 20 countries in Africa with different partners. The main vision of the programme is to create a network of IoT hubs in Africa, based on the open-source IoT platform. The core component of this accelerator programme is the bootcamp, hackathon, MVP prototyping and testing, IoT technical capacity building. So far WAZIHUB supports 100 different tech start-ups in Africa. WAZIHUB programme will donate 500 IoT development kits to African young entrepreneurs. The programme main target is to create IoT job opportunities for young people in Africa.

WAZIUP is now registered as a non-profit association and has established several cooperations with are an important relay of exploitation. Each partner has taken on board WAZIUP potential both with WAZIUP MVP results but more broadly with the overall potential of developing products and applications with IoT and big data approaches. Partners include international organisations, private companies, higher education institutions and tech hubs.

The WAZIUP project has been successful especially in exchanging technical knowledge between European and African partners, even if the larger adoption by end-users (farmers) is still limited. Key factors of success have been:

- Sourcing of partners: most consortium members have been sourced using personal network. Identifying the right partners is key. Still, it remains challenging to coordinate a cross-continental project.
- Adaptation of the technology to the local context: the WAZIUP platform has been designed with the view of infrastructure limitation and solving concrete challenges. Yet, the adoption of this technology by end-users is slow. This is mainly due to the fact the market is not ready to absorb this technology. However, the supply side (technical actors, entrepreneurs, companies) responded better. This category appears to be the immediate beneficiaries of the project.
- Open science approach: from the beginning, consortium partners were clear on the fact that, if they wanted the technology to be adapted in Africa, it has to be open source. End-users are young people and entrepreneurs who cannot afford to pay royalty fees.
- Joint research approach: Technical partners from Africa (universities) and Europe worked together to develop the WAZIUP platform. For example, the cattle collar MVP has been completely developed by students from Université Gaston Berger of Senegal, namely

PhDs. African Tech hubs were involved in the organisations of events to ensure the engagement of their entrepreneurs.

- Contribution of end-users: The end-users (farmers) have been involved in the testing of prototypes through the MVP approach.
- Building a community: the WAZIUP community is instrumental in ensuring long-term impact and sustainability.

The passage from WAZIUP to WAZIHUB was more of continuity. The sustainability issue will be more acute at the end of the WAZIHUB project. Therefore, consortium members are approaching funding agencies and potential donors to mobilise complementary resources. This appears to be one of the most effective ways to proceed since the market is not yet mature enough for such technologies.

3.3 SafeWaterAfrica project

3.3.1 Summary of the project

In the Southern African Development Community (SADC), more than 100 million people have limited or even no access to clean water. The overall goal of the SafeWaterAfrica project was to research and develop an autonomous and decentralized "Made in Africa" water treatment system for rural and peri-urban areas which is highly efficient in the degradation of harmful pollutants, and which is accepted by the members of rural communities. The system was to be designed to provide 300 people in rural areas with safe water.

The project was implemented by a consortium of European partners from Germany, Italy and Spain, providing European knowledge on new technologies for water purification. Academic and industrial partners from South Africa and Mozambique completed the project consortium by adding knowledge on additional technologies and system integration.

As research outputs, the project developed a new water treatment technology based on the energy-efficient production of strong oxidants, produced electrochemically from the water, called “CabECO”. It does not need additional chemicals for the effective degradation of persistent organic pollutants as well as for killing pathogens. The research resulted in a prototype and the project ran demonstrators in South Africa (Waterval, Klip River) and Mozambique (Ressano Garcia, Incomati River).

The developed demonstrator systems are successfully producing water according to WHO and SANS 241 standards. The construction, installation and operation, completed by South African partners, has great benefits against imported solutions. These benefits are:

- adaption to local needs and markets,
- involvement into and deep understanding of the solution (no black box),
- increased acceptance, responsibility and ownership,
- local business and job opportunities.

A detailed factsheet of the project is presented in Appendix B3.

3.3.2 Technology and knowledge exchange outcomes

In order to disseminate the results and to identify potential partners for exploitation (SafeWaterAfrica Consortium members, 2019), the consortium contributed to ten **conferences** and one **industrial fair**, published nine **scientific peer-reviewed papers**, organised eleven **workshops** and published various press releases, news and videos.

The SafeWaterAfrica solutions are integrated into undergraduate courses, postgraduate projects, and project developments at the academic partners. For **capacity building**, students from South Africa and Mozambique universities were involved in the installation and operation of prototype and demonstrators.

Following the successful demonstration trials, **the consortium is now actively developing appropriate implementation and commercialisation strategies** for the SafeWaterAfrica solution ((SafeWaterAfrica Consortium Members, 2019). The commercialisation activities are being deployed by **Tshawne University of Technology Enterprise Holdings (TUTE), the business arm of Tshawne University of Technology (TUT) which was a consortium partner.**

A key determinant of economic sustainability of the SafeWaterAfrica solution is the **ability and willingness of end-users to pay for the water**. This is particularly challenging in rural and indigent areas. **Extensive work has been done on market research and product design for marketable SafeWaterAfrica systems**. These activities resulted in cost calculations for the systems and business models for the roll-out of the technology.

Market and economic analyses conducted during the course of the project proved that rural communities are willing to pay for water services, but the level of potential payment is about 50% less than the lower production cost estimate for SafeWaterAfrica. This suggests that the **potential market and adoption of the SafeWaterAfrica solution could be increased substantially if the capital cost could be funded through grant funding or low interest financing. Different business models have been considered as a path to commercialisation.** They are above presented.

The first one consists of a direct implementation through municipalities. This business model suggests the manufacture of the SafeWaterAfrica systems by SafeWaterAfrica NEWCO and their sale to relevant municipalities and water authorities. Secondly, municipalities would contract SafeWaterAfrica NEWCO for the operation and maintenance of the systems in the field.

The second model lies in Public-Private Partnership. In this case, the operational model would entail the establishment of a public-private partnership between SafeWaterAfrica NEWCO and municipalities, whereby the private sector (in this case SafeWaterAfrica NEWCO) would assume more financial and operational risk than in the previous model.

The third envisioned model is licensing / social franchising. In this business model, the SafeWaterAfrica consortium could license third parties to manufacture the SafeWaterAfrica systems and roll out the solution, with royalties paid to the consortium on an agreed basis.

Another strategy is to develop a model for the creation of new Black owned business that can be capacitated to commercialize the solution in manufacturing components for and assembling the SafeWaterAfrica treatment units, installation and training, as well as support and maintenance.

SafeWaterAfrica NEWCO is envisaged to be a legal entity which will manufactured and market the solution. Start-up financing will be required for company initiation, market development, and the

manufacture and deployment of the first commercial field units. Such funding could be accessed through development finance institutions. In addition, equity or commercial loan financing would be required. Since the consortium members are not in a position to contribute such financing, an outside (commercial) investor will need to be sought.

Different interested parties from public and private sector from the partner countries as well as third countries have been identified. Negotiations with interested parties are ongoing.

The SafeWaterAfrica project has been successful especially in exchanging technical knowledge between European and African partners. One consortium partner (TUTE) is now taking the lead to find sustainable ways to commercialise the solution. Key factors of success have been:

- The quality of consortiums partners: the consortium gathered the best water scientists from Europe and Africa. They comptences were complementarity. They all learn from the project, especially what is feasible with their individual technology in a new environment.
- The importance of know-how: the project relied on existing technologies, merged this to know-how of consortium partners to develop a unique solution which works and is adapted to the rural African context. In this regard, the project focus on searching a "Made in Africa" was instrumental.
- Securing demonstrators: the consortium partners have been able to secure testing site with municipalities which allowed to anchor the project in a real world scenario and prove its effectiveness

The COVID-19 pandemic is an opportunity to scale-up the project since there is currently a need to provide clean water to population so that they can follow the hygiene measures.

4 Conclusion on strengths and weaknesses of Technology & Knowledge transfer models

An examination of the above examples reveals they have been successful in technology and knowledge exchange mainly for the following reasons: the selection of the consortium partners and their complementarities, the particular focus on dissemination, and the contribution of end-users.

The choice of consortium members is critical and yet is difficult. Networking plays a pivotal role in sourcing the right partners. This emphasises the role of the Africa-Europe Innovation Partnership as a way to develop a network of technology transfer and innovation actors where H2020 partners can be easily sourced.

Furthermore, the focus on dissemination and exploitation which is expected from H2020 projects allows commercialisation activities to be better structured since the project inception, yielding to more audible results in this domain. In addition, all the projects studied privileged an open science approach to ensure that research results are easily accessible. As an extension of this research, it might be interesting to study the case of H2020 projects which dealt with IPR issues.

Moreover, the contribution of end-users as consortium partners, stakeholders allows the testing of demonstrators and the development of products/services which are adapted to the local context and which meet specific needs.

Different exploitation commercialisation models emerge from the studied H2020 projects: from exploitation in public policies to business spin-offs. At the heart of this process, the African partners played an important role and positive externalities were generated for them such us further access to research fundings and training of students for participating universities.

Yet, key challenges remain for the commercialisation of research results in these models and lie mainly in **access to financial resources** to sustain the research and exploitation outcomes at the end of the projects. Most of the time, the business models privileged lead to attracting public funding rather than private ones in order to sustain project outcomes. In fact, most of the time, the context for the development of research implies keeping an affordable price to end-users, which is perhaps not compatible with private companies' interests. This dependency on public resources and aid is not sustainable in the long run because these resources tend to not be stable.

Finally, one key best practice that came in every interview conducted is that consortium partners shall engage in collaborative research projects from an equality basis, recognising that each partner from Europe and Africa has a unique input to bring. Technology without the local know-how can be useless.

5 Recommendations

Horizon 2020 positions itself as a powerful instrument to foster technology and knowledge exchange by allowing collaborative efforts and research between Europe and Africa to solve development issues. The few examples we studied proves that. The following recommendations for technology transfer officers (TTOs) and policymakers are directed to improve technology and knowledge exchange outcomes in the context of H2020 projects.

5.1 Recommendations to TTOs

TTOs can use Horizon 2020 for **technology scouting, as well as technology and market assessment and identification of partners**. This is particularly facilitated because most Horizon 2020 projects privileged an open science approach, meaning that research results are accessible to everyone. In the same line, H2020 consortium partners can be contacted through the CORDIS database. Therefore, TTOs can benefit a great deal from completed H2020 projects for identifying new inventions and technologies as well as selecting and assessing the potential of innovative ideas. In addition, exploitation and commercialisation plan are usually also publicly disseminated in H2020 projects. TTOs can use H2020 projects to help them in the process of identifying the most appropriate business model and the most effective commercialisation strategy.

5.2 Recommendations to policy makers

African participation in H2020 projects remains low and concentrated in a limited number of countries. In fact, we have identified 475 African participations in H2020[3]. There are nine countries concentrating 82% of projects[4] with South Africa leading 172 participations. This could be explained by the fact that countries with a stronger innovation ecosystem attract more easily interest from European partners to form a consortium. However, without disclaiming the potential

[3] NB: Two databases have been used, one identifying 474 participants and the other 475.

[4] South Africa, Kenya, Senegal, Uganda, Ghana, Ethiopia, Tanzania, Burkina Faso and Nigeria.

risks, it is possible to find good partners in African countries with relatively lower innovation ecosystem (Senegal, Niger, Ghana, …). Policy makers (AU, EC namely) are encouraged to pursue activities and events to promote African H2020 participation at a panafrican and national level.

Policy makers (AU, EC, national governments namely) also can be more involved in finding ways to bring research results to the market. In fact, currently a lot of H2020 research results remain under the radar and are not know by key actors. This could be a government to government initiative to ease access to key stakeholders in public administrations, international organisations for consortium partners for commercialisation matters.

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Appendix B Fact sheets on selected projects

B.1 EBODAC project

Project title: Ebola Vaccine Deployment, Acceptance and Compliance (EBODAC) Geographical coverage: Sierra Leone	Status: Ongoing project Start date: 1 December 2014 End date: 30 November 2020

Consortium members

The EBODAC consortium consists of 4 partners: Janssen (EFPIA), London School of Hygiene and Tropical Medicine (LSHTM), World Vision of Ireland and Grameen Foundation. These partners have experience and expertise in:

- Ebola vaccine development and vaccine acceptance; m-health deployments for disease management in resource limited settings (Janssen)
- Vaccine acceptance; risk management in health programs (LSHTM)
- Mobile health deployments for emergency assistance; communication and training delivery in emergency settings (World Vision)
- Mobile health software development and deployment in resource limited settings (Grameen)

Objective

The project is supporting clinical trials of Ebola vaccines in Sierra Leone, while simultaneously preparing for the future deployment of a licensed vaccine through a series of linked projects focused on communications, community engagement, and enabling technologies.

The EBODAC consortium is committed to deliver:

- **A communication strategy** that will optimize vaccine acceptance, supported by local anthropology research data
- **A platform, based on mobile phone technology**, for Ebola vaccine recalls, information/education on Ebola and vaccines in general; and tracking of vaccination coverage
- **An identification tool** (iris scan) to allow to match the identity of individuals in the prime and boost vaccine regimens
- **A training program in the local setting**, and a helpdesk function, to support the m-health platform

B.2 WAZIUP project

Project title: Open Innovation platform for IoT-Big data in Sub-Saharan Africa (WAZIUP) Geographical coverage: Sub-Saharan Africa (namely Senegal, Ghana, Togo and Burkina Faso)	Status: completed project Start date: 1 February 2016 End date: 31 January 2019

Consortium members

WAZIUP consortium involved 7 partners from 4 African countries (Senegal, Ghana, Togo and Burkina Faso) and 5 partners from 4 EU countries (Italy, France, Portugal and Germany) combining business developers, technology experts and local African companies operating in agriculture and ICT. The project also involved regional hubs with the aim to promote the results to the widest base in the region.

The complete list of partners is as follow:

- Fondazione Bruno Kessler (former CREATE-NET) (coordinator)
- Easy Global Market SAS
- Université de Peau et des pays de l'Adour
- Unparallel Innovation LDA
- Innotec21 GmBh
- Université Gaston Berger de Saint Louis
- CODERS4SN
- CTIC Dakar
- Université Polytechnique de Bobo Dioulasso
- ISPACE Foundation
- Farmerline Ltd
- L'Africaine d'Architecture

Objective

The WAZIUP project used cutting edge technology from IoT and Big Data to improve the working conditions in the rural ecosystem of Sub-Saharan Africa. First, WAZIUP involved end users of IoT and Big Data in order to define focused validation cases. Secondly, it engaged the ICT ecosystem by fostering new tools and good practices amongst entrepreneurs and start-ups.

WAZIUP proposed solutions aiming at long term sustainability, by:

- Engaging the most well-known innovation spaces in Africa
- Engaging open source communities
- Organising high-level innovation events
- Launching IoT related startups competitions
- Organising a series of hackathons and startup weekends

B.3 SafeWaterAfrica project

Project title: Self-Sustaining Cleaning Technology for Safe Water Supply and Management in Rural African Areas (SafeWaterAfrica) Geographical coverage: South Africa, Mozambique	Status: completed project Start date: 1 June 2016 End date: 30 November 2019

Consortium members

Ten transdisciplinary partners from Europe and Africa, assisted by eight enterprises and organisations in the Advisory Board, worked jointly in the project.

The complete list of consortium partners is as follow:

- Fraunhofer gesellschaft zur foerderung der angewandten forschung e.v. (coordinator)
- Condias Gmbh
- Universita Degli Studi Di Ferrara
- Universidad de Castilla – La Mancha
- Advance Call Pty Ltd
- Virtual Consulting Engineers Vce
- Tshwane University of Technology
- Stellenbosch University
- Council for Scientific and Industrial Research
- Salomon LDA

Objective

The SafeWaterAfrica project will research and develop an autonomous and decentralized water treatment system for rural and peri-urban areas which is highly efficient in the degradation of harmful pollutants and at the same time very effective in killing microbiological contaminants.

Appendix C List of interviewees

H2020 Project	Name of interviewee	Organisation
EBODAC	Paula Mc Kenna	Johnson & Johnson Global Public Health
EBODAC	Annik Willems	Johnson & Johnson Global Public Health
EBODAC	Robert Kanwagi	World Vision
WAZIUP	Abdur Rahim	CREATE-NET Research CenterFondazione Bruno Kessler (FBK)
WAZIUP	Ousmane Thiare	Université Gaston Berger Saint-Louis
SafeWaterAfrica	Lothar Schaefer	Fraunhofer IST
SafeWaterAfrica	Bob Bond	Tshwane University of Technology Enterprise
AfriCultuReS	Juan Suárez	GMV- Remote Sensing Services and Exploitation Platforms Division
AfriCultuReS	Issa Garba	Centre Régionale AGRHYMET
AfriCultuReS	Tomás Chiconela	University Eduardo Mondlane