

PROJECT Report - FIUWA Frugal Innovation and Entrepreneurship in Water 4.0 in Africa (FIUWA)



BMBF Water Security in Africa (WASA)

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1.0 Executive Summary

Access to clean water in many African countries is still far from being universal as envisioned under SDG 6 (clean water and sanitation for all). The Southern Africa Region (SAR) lacks sufficient infrastructure (and processes) for sustainable distribution, utilization, and management of water resources. An estimated 40% of the population in the region lacks access to clean drinking water. Additionally, climate change is compounding the region's water access/supply challenges by altering the way water resources are distributed both spatially and temporally, heightening the need for new and innovative solutions that support efficient and sustainable access to, utilization, and management of water resources towards water security.

FIUWA project headed jointly by African and German actors addresses the questions of existing challenges and needs in the water sector in the region (water supply, water use efficiency, etc.), specific/potential interventions required to address the water challenges (technology, policy interventions, etc.), through the identification, development, and support of frugal digital innovations, through the enrolment and support of young entrepreneurs in Africa. The project focuses on knowledge co-creation and ecosystem setting to support youth in the development of low costs, economically viable, socially acceptable and locally adaptable innovative solutions/start-up building on digital technologies in response to core water challenges.

As a research and design project, the project was structured into six technical work packages plus a project coordination and management work package. The project activities were focused on research and design namely the identification of water sector challenges and existing digital technologies and frugal innovations that may improve the current situation, which are not legally recognized as inventions and are therefore without property right. Thus, no proprietary rights or licenses were used for the project.

The report outlines the results based on the works during the project's first main phase namely i) The activities focused on identifying the needs and water challenges in the case study countries, ii)examination of the Southern Africa digital landscape, and database of digital technologies and frugal innovations in the thematic selected water sectors iii) a conceptual FIUWA ecosystem and iv)frugal innovation database and insights from Germany v) open innovation process vi) capacity, curriculum concept and experiences to illustrate specific/potential interventions required to address the identified and validated water challenges and existing options to transfer the project's results.

1.1 Project Objectives

The project "Frugal Innovation and Entrepreneurship in Water 4.0 in Africa" had a duration of 12 months, from the 1st of December 2021 to the 28th of February 2023. FIUWA addresses the questions of existing challenges and needs in the water sector in the region (water supply, water use efficiency, etc.), specific/potential interventions required to address the challenges (technology,

policy interventions, etc.), and what role digital/frontiers technologies (IoT, AI, big/smart data, crowd sensing, etc.) can play and how can they be adopted/adapted, jointly by African and German actors to support frugal innovation, and job creation to leapfrog water sector in SAR while also inspiring youth entrepreneurship. The project borrows from and builds on the recent success of frugal innovations and youth entrepreneurship in the mobile sector in Africa.

As an African and German consortium-led project, comprising of six partners and several associate partners and local institutional supporters. The FIUWA project, aims to:

1. assess the potential of digital technologies to improve and leapfrog water infrastructures,
2. develop a framework that brings together actors and stakeholders of water infrastructure, technology, innovation and entrepreneurship in the Southern Africa Region,
3. develop conceptual structures to identify and ideate solutions, organize and support digital frugal innovators and innovations in water with a focus on youths.

The project aims to kickstart an innovation community of practice that not only improves water infrastructure but also has the capacity to spur entrepreneurship and create jobs for youths. The project sets a focus on knowledge co-creation and innovation by preparing and establishing joint African-German innovation teams in order to develop technically feasible, economically viable, socially acceptable and locally adaptable solutions in response to core challenges in the field of water security. The project envisions the establishment of an innovation hub in Namibia focusing on sustainable water resources management and two satellite centers, one in South Africa focusing on climate information services for water solutions and one in Angola focusing on water solutions in the context of agriculture and food security in line with the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) priorities and jointly with the SASSCAL graduate program in the respective countries.

The project's scientific objectives are summarized below.

- Review the state of the water sector in the Southern Africa region (SAR) in order to understand the current challenges and needs and discuss potential interventions.
- Assess which digital technologies have the potential to improve or leapfrog water infrastructure and create business opportunities especially for youths.
- Analyze and contextualize the current landscape of digital frugal innovations in the context of water in SAR, Africa and Germany.
- Identify and organize key actors and stakeholders involved in digitalization, innovation, entrepreneurship and mentorship in the context of water supply, use and management in SAR.
- Develop a structure of a digital frugal innovation ecosystem (community of practice) in SAR with potential linkages to similar frugal innovators/ecosystems in Germany.

- Define a coherent process that supports ideation and open innovation among youths to address water security issues in SAR.
- Establish a skills development, incubation and acceleration framework that supports youth innovation and transformation of ideas into entrepreneurial ventures.

1.1.1 Project Initial Goals and Targets and Work Package Distribution

UNU-EHS was actively involved in other work packages, namely WP 1 under the leadership of Fraunhofer with each work package having specific goals and activities. The main goals in this work package were:

- Analyzing existing needs and challenges in the water sector in SAR and identifying specific sectors relevant to water security where interventions are required
- Assessing the potential contribution of different intervention measures and solutions
- Identifying the role digital technologies can play in addressing the water sector needs and challenges identified above

In (WP2) UNU EHS worked with the subcontracted partners Africa Water Association (AFWA) and Global Water Partnership (GWP). The main goals within this (WP) were:

- Analyzing existing digital technologies in SAR/Africa and their potential to improve or leapfrog water infrastructure and create business opportunities esp. for youths
- Examining and contextualizing the current landscape of frugal innovations in the context of water in SAR/Africa, highlighting the extent to which existing frugal water innovations and innovators integrate digital technologies
- Assessing available frugal innovations in the German market which can be contextualized for improving water security in Africa

In work package 3 (WP3), UNU EHS subcontracted Africa Water Association (AFWA) and German Water Partnership (GWP). The main goals in this work package (WP3) were

- Identifying key actors and stakeholders involved in digitalization, innovation, and entrepreneurship in the context of water in Southern Africa
- Clustering the identified stakeholders in Southern Africa and showing linkages to similar innovators/ecosystems and stakeholders in Germany
- Developing a conceptual plan for Water Infrastructure, Technology, and Sustainability Knowledge Hub to improve processes and policies of stakeholders of the quadruple helix of innovation

In work package 4 (WP4) UNU EHS subcontracted AfriLabs working closely with three technology hubs from Angola, Namibia, and South Africa. The main goals in this work package (WP4) were;

- Defining an open innovation process for generating frugal innovative solutions for water security in Africa
- Specifying roles and responsibilities of different players in the innovation process

In work package 5 (WP 5), UNU EHS subcontracted Stellenbosch University as Secretariat of AUDA-NEPAD Southern African Network of Water Centers of Excellence (AUDA-NEPAD SANWATCE) and Namibia University of Science and Technology. The main goals in this work package (WP5) were;

- Defining a structure for an online capacity-building program with an entrepreneurial curriculum
- Developing a framework for a venture and acceleration program to support rapid growth, replication, and upscaling of innovations.

In work package 6 (WP6), UNU EHS led the planning of the implementation phase, with all partner associates and strategic partners for the next phase of the project. The main goals in this work package (WP6) were;

- Reflecting on the results of the initial phase
- Preparing the implementation plan of the main phase

In work package COR (WPCOR), UNU EHS led the project coordination and management activities. The main goals in this work package (COR) were;

- Appropriate and transparent management of the proposed joint project about the collaborative planning and conduction of work packages, time planning, and quality control to achieve the overall project goals
- Collaborating with other relevant projects in the thematic area/region and identifying synergies

1.2 Research Methods

As a Research and Design project, most of the information and documentation services were conducted mainly through desk-based research, interviews, and workshops with key stakeholders. Data sources used to identify water need and challenges in Southern Africa were a desk-based literature review entailing over one hundred reference. The databases of Scopus, ScienceDirect and Google Scholar were used with a Water-related Journals such as Water SA, Water and Sanitation Africa to name a few and use of reports such as UN-Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) data portal, (WHO 2022a), the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) and the SADC Research Agenda used. Furthermore, the AFWASA database of water and sanitation practitioners and its Young Water Professional network in Southern Africa were leveraged for an online survey capturing

the water challenges and innovations in the three priori thematic clusters of integrated water management, climate information services and agriculture water management in Angola, Namibia and South Africa.

The take-ups from AfriLabs in Angola, Namibia and Angola were also engaged to conduct a three-country validation exercise using key-informant interviews and focus group discussions to validate the challenges identified from the literature review and surveys, leveraging on their networks depending on strategic relevance and interests/potential contributions to the project. Furthermore, a desk-based mapping exercise of digital technologies and frugal innovations application across the three priori thematic clusters of integrated water management, climate information services and agriculture water management were conducted and results documented and summarised based on experiences from South Africa and respective publications.

1.3 Results

UNU-EHS was the main lead of work package 2 (WP2), work package (WP3), work package 4 (WP4), work package 5 (WP5), work package 6 (WP6), and work package COR (WPCOR), and contributed to work package 1 led by Fraunhofer. The subsequent sections detail the results achieved by UNU-EHS and the following subcontracted partners namely Africa Water Association (AFWA), Global Water Partnership (GWP), AfriLabs, and Stellenbosch University as Secretariat of AUDA-NEPAD Southern African Network of Water Centres of Excellence (AUDA-NEPAD SANWATCE) within the framework of the project.

1.4.1 Work Package 1: Development of a Problem typology in SAR's priority water sectors and evaluation of the potential role of digital technology

i) Identification of Water Challenges and Needs

UNU EHS conducted a qualitative desk-based literature review of water challenges plaguing the region. The assessment entailed a broader stock-taking exercise of fifty-three reference sources ranging from the SADC Research Agenda document to scholarly research publications. The challenges identified were sorted based on an inductive reading of the literature, according to the categories of "technical" and "governance." and clustered into three priori defined clusters, namely challenges in sustainable water resource management, water, and climate information services, and water for agriculture; and a fourth main cluster, related to transboundary water management. Annex 1 presents the summative output of the identified main water challenges used to establish the problem typology of the project.

Fraunhofer, UNU EHS and subcontracted AFWA co-designed an online survey and a hardcopy survey document to assess the problems in the water sector and identify innovations in the water sector. The survey was distributed via Lime-survey mainly through AFWA's networks to water sector practitioners in Southern Africa from the 4th of July 2022 until the 1st of January 2023. Annex 2

presents the hard copy version of survey, used to collect data from the water utilities and AfWA's networks of water practitioners with limited internet access.

AfWA engaged four AfWA consultants from four Southern African countries and, ten Southern African AfWA young water professionals to disseminate the survey to stakeholders such as water professionals, practitioners, research and academia, and policy from each of their respective countries. Annex 3 presents a list of the AfWA's consultants and young water professionals engaged in the dissemination exercise.

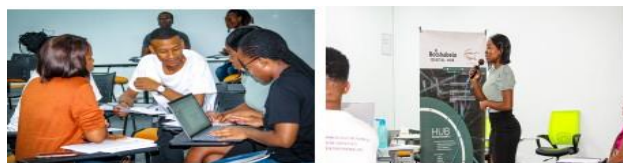
ii) Validation of The Survey Results on Water Challenges and Innovations/Solutions

Building from the results of the survey, AfriLabs worked closely with three technology hubs from Angola (KiandaHub), Namibia (R Labs) and South Africa (Softstar BTI) respectively to validate the prior identified challenges and water innovations from the online survey. Three research instruments namely focus group discussion, key informant interviews, and virtual stakeholder engagements were adopted and Annex 4 outlines the AfriLabs challenge validation methodology adopted for the process in detail. Images below showcase the validation processes across the three countries;

R labs Innovation Hub (Namibia)



SoftStar BTI (South Africa)



Group 1



Group 2

Group 3



Group 4

FOCUS GROUP: INNOVATORS, YOUTH, SMMS



FOCUS GROUP: COMMUNITY MEMBERS



The validation process conducted by the three innovation hubs engaged many stakeholder groups including academia, policymakers, youth entrepreneurs, community members, water and sanitation practitioners, researchers across the three countries of Angola, Namibia, and South Africa. Annex 5 presents the research output of the rigorous validation process by AfriLabs and the three innovation hubs.

1.4.2 Work package 2: Digital water infrastructure technologies and frugal innovations analysis

UNU-EHS subcontracted Africa Water Association, Global Water Partnership and AfriLabs

i) Assessment of the digital landscape in Southern Africa

UNU EHS evaluated the digital landscape of Southern Africa to assess to what extent each country is ready to perform in digital innovation based on an online search of indexes such as the digital innovation index and scientific reports. Findings revealed that the digital innovation landscape in the water sector is still young and evolving for South Africa, Namibia and Angola, with varying barriers that need urgent attention. Table 1 shows a summative outline of the ranking of Southern African countries based on digital economy indexes and indicators.

Table 1: Ranking of Southern African countries based on digital economy indexes and indicators

Rank	Digital Government	Digital Business	Innovation Driven Entrepreneurship	Digital Skills	ICT Infrastructure	G5 Digital Economy Benchmark
1	South Africa	Mauritius	Mauritius	Seychelles	South Africa	South Africa
2	Mauritius	South Africa	South Africa	Mauritius	Mauritius	Mauritius
3	Seychelles	Seychelles	Tanzania	Zimbabwe	Seychelles	Botswana
4	Tanzania	Zambia	Namibia	Tanzania	Botswana	Malawi
5	Namibia	Botswana	Botswana	Botswana	Namibia	Eswatini
6	Zimbabwe	Tanzania	Malawi	Namibia	Zimbabwe	DRC
7	Mozambique	Madagascar	Madagascar	Zambia	Eswatini	Tanzania
8	Angola	Namibia	Zimbabwe	Lesotho	Zambia	Zambia
9	Eswatini	Eswatini	Zambia	Eswatini	Lesotho	Lesotho
10	Malawi	Lesotho	Mozambique	South Africa	Tanzania	Zimbabwe
11	Botswana	Malawi	Angola	Madagascar	Mozambique	Angola
12	Lesotho	Mozambique		Malawi	Angola	Madagascar
13	Madagascar	Zimbabwe		Mozambique	Comoros	Namibia
14	Zambia	DRC		Angola	Malawi	Comoros
15	DRC	Angola			DRC	Mozambique
16	Comoros				Madagascar	Seychelles

Key: South Africa Angola Namibia

Source: CCARDESA, World Bank (2021)

Annex 6 outlines a comprehensive summarized report of the digital landscape of Namibia, Angola and Namibia developed by UNU EHS and AfWA outlining key areas that support innovation and those requiring urgent attention.

2) Mapped water innovation solution incorporating digital technologies

UNU EHS conducted a desktop-based mapping exercise of existing digital water innovation solutions incorporating digital technologies through an online desk search of start-up databases and reports from established innovation ecosystem practitioners in Africa. Annex 7 shows the mapped digital technologies across three priori thematic areas namely climate information services, integrated water management, and agricultural water management in Namibia, Angola and South Africa.

3) Mapped frugal innovation water solutions

UNU EHS, AfWA and Afrilabs collaboratively assisted in the Fraunhofer-led exercise of mapping of frugal innovation landscape based on an innovation template, filled out by the project partners respective to their expertise, experience and a web search. Findings in Annex 8 revealed 19 innovations across the three thematic areas of climate information services, integrated water management and agriculture water management.

Identification of relevant frugal innovators/innovations from Germany

German Water Partnership working closely with UNU EHS assisted in the development of a database of frugal innovators and innovations in Germany that can contribute to solving challenges in Southern Africa. Relevant frugal innovators/innovations in German water were assessed in line with potential to solve the identified water challenges, contextualization and collaboration fit for innovators in Southern Africa as shown in Table 2 below;

Table 2

Country	Name of project	Short description of innovation	Lead innovator	Organization type
Cameroun, Congo,Eritrea, Uganda, Tanzania,Ghana, Gambia, Kenya, Mozambique,Niger, Somalia,Eritrea (also in Latin America and Asia)	Water Backpack Paul	PAUL, the 'WaterBackpack', is a small and portable (23 kg) membrane filtration unit which removes bacteria, virus and other pathogens by 99.99% (avg., up to 99.99999%) without chemicals or electric energy, and can be operated even by illiterates in emergencies. (3,300+ PAUL units exist in 85 countries worldwide).As PAUL has a 10+ year lifetime, the so-called PAUL station arrangement – with a standard PAUL unit as the core – provides a permanent water supply for communities, schools, hospitals, offering the chance for local community to decrease their cost for water and in addition earn their own money.	http://waterbackpack.org/	German Innovation from Kassel
Kongo, Kenya, Uganda, Cameroun, Tanzania	PAULA Water	<i>PAULA stands for Potable Aqua Unit – Lasting & Affordable. PAULA is a stationary system that is capable of supplying drinking water around the clock. It offers high efficient, sustainable water purification plants in different dimensions, which deliver hygienically safe drinking water to the population</i>	https://www.paula-water.co.m/	SME from Viersen, Germany
Ghana	RAIN	The goal of RAIN is the capacity building of local workers on climate change's effects on living spaces in Ghana (an increase of floods, storm water and droughts) and the integrate that knowledge into the education agendas of WASCAL and PAUWES	https://www.fiw.rwth-aachen.de/referenzen/rain	Research project
Cameroon	INTEWAR	Innovative Technologies to contain water-associated diseases from floods and droughts in Cameroun (data research, decentralized provision of drinking water, technical protection from floods, hydrodynamic modelling,	https://intewar.org/	Research project

		development of guidelines, communication & training)		
Kenya	HAP-AQUA	HAP AQUA is a pure apatite granulate used in filter stations in the Nakuru region to remove fluoride from fresh water and prevent the dangerous bone disease fluorosis	https://shambaza.com/listing/hap-aqua.html	Innovative Technology
South Africa	Green Hygiene: proton-IQ Securo	Water disinfectant with a focus on industrial applications. Production of up to 60.000 L Disinfection Solution per day.	https://visiongreensolutions.com/	Innovative technology applied by German Start-Up placed in Cape Town
East Africa	SolarSpring potabe water treatment plant	Decentralized and solar-powered plant to be fixed directly on house walls (industrial use with bigger versions as well)	https://solarspring.de/home-3/kommunen-hotel-ressorts-wohngebäude/	SME from Freiburg, Germany
All across Africa	Boreal Light	Affordable solar-based water desalination systems for off-grid communities. The systems are capable of delivering high quality hygiene drinking, irrigation, fish farm and sanitation water from any kind of high saline and polluted water resources.	https://www.winture.de/	Berlin-based SME
South Africa	SOG Water Solutions	Atmospheric Water Generation Harvests Water Vapour from the AIR to produce a sustainable supply of high-quality drinking water. BBBEE L2 contributor thereby ensuring 100% local component sourcing with 125% procurement recognition	https://sogwater.co.za/	Cape Town- and Berlin-based German start-up
Germany (to be implemented in megacities around the globe)	Drop by Drop – Water 4.0 (Digital Twin of a pumping station)	To make the relevant water and wastewater infrastructures more efficient and easier to manage, particularly in major cities, researchers at TU Berlin are creating innovative, intelligent concepts and strategies and conducting realistic environment research. Currently, they are working together with Siemens AG and the Berliner Wasserbetriebe to develop a digital twin for a pumping station. This will help virtually detect problems in wastewater systems as well as proactively operate and maintain these systems in functioning order using intelligent technology.	https://www.tu-berlin/en/about/profile/press-releases-news/2020/juli/digital-twin/	Public private partnership

Source: Research findings

Conceptualization and Definition of Frugal Innovation

AfriLabs working closely with Fraunhofer contributed to the working conceptual definition of frugal innovation in the frame of the project based on literature and practical examples in Africa. Annex 9 outlines the definition and typology of frugal innovations as adopted in the frame of the FIUWA project.

1.4. 3Work package 3: Stakeholder analysis, mapping and ecosystem setting

UNU-EHS subcontracted Africa Water Association, Global Water Partnership, Stellenbosch AUDA-NEPAD SANWATCHE, and AfriLabs in WP3 and the outputs of these partners were as follows;

i) Development of a Stakeholder Database of water actors in digitalization, innovation, and entrepreneurship

UNU EHS prepared templates to collect information on relevant water sector stakeholders. AfWA, Stellenbosch AUDA-NEPAD SANWATCHE complemented the efforts in stakeholder mapping by adding their clustered stakeholder databases to align to the categories defined from the innovation ecosystem. Annex 10 presents the stakeholder groups identified including actors engaged in academia, policy space, funding associations, research groups, and technology innovation hubs.

ii) Structure of a Digital Frugal Innovation ecosystem

UNU-EHS, Africa Water Association and German Water Partnership contributed to a framing based on a web search on innovation and entrepreneurship ecosystems in Africa to develop a conceptual structure of a digital frugal innovation ecosystem. The components constituting the conceptual framework were developed further through deliberations with AfriLabs to identify the required innovation stakeholders, funding and entrepreneurship relevant elements, while AfWA, UNU and GWP selected relevant policy, research, academia and water relevant stakeholders in Southern Africa based on relevancy. The conceptual framework of the FIUWA innovation ecosystem is illustrated below in Fig 1;

FIUWA Innovation Ecosystem – Components and stakeholders

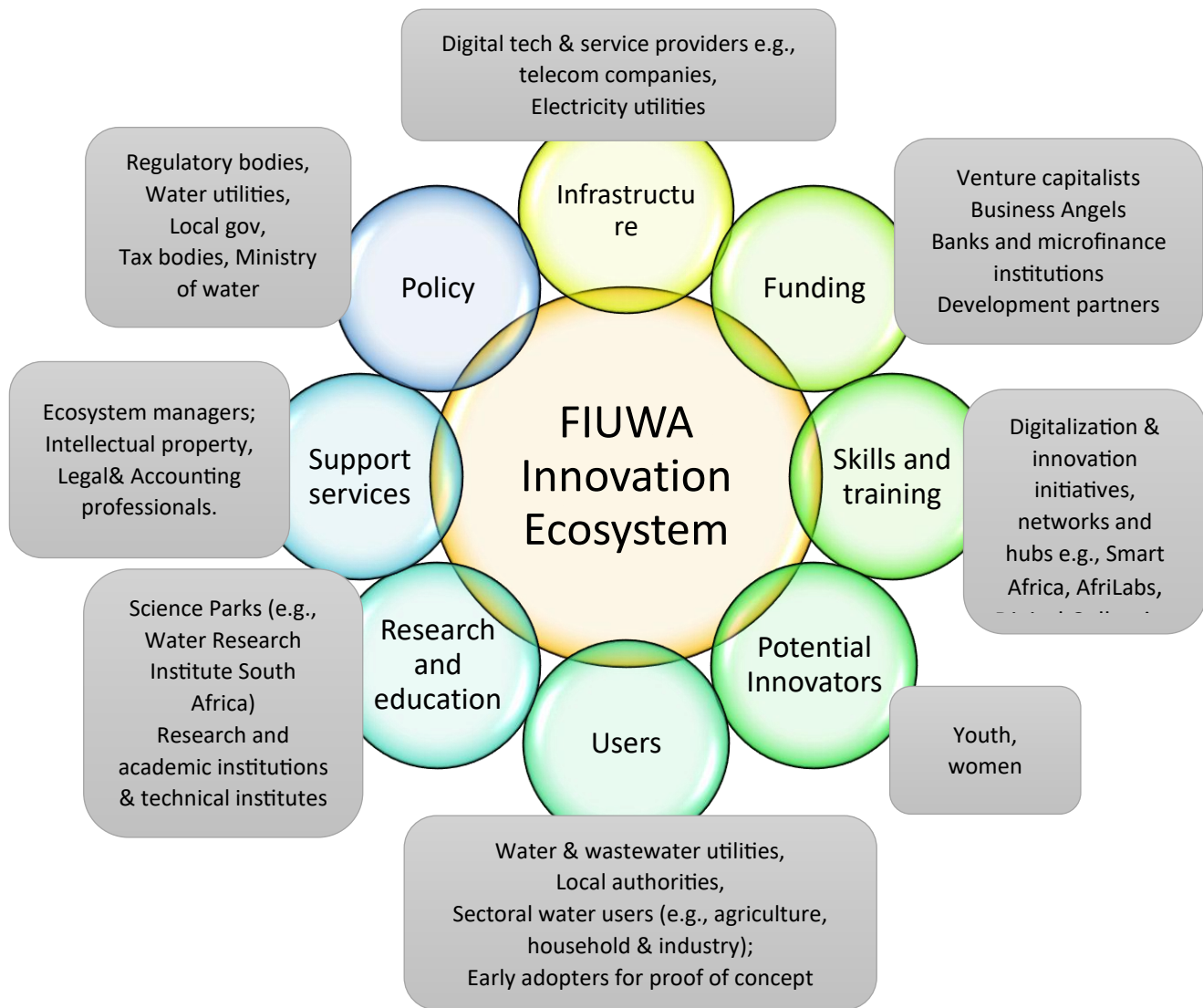


Fig 1: FIUWA Innovation Ecosystem

1.4.4. Work Package 4: Ideation, open innovation and Co-creation of solutions

UNU EHS subcontracted AfriLabs and sub-contracted AfriLabs and the outputs include;

i) Defining the scope and process of Open innovation

AfriLabs working closely with three technology hubs from Angola, Namibia, and South Africa developed written descriptions of hub processes to be used for open innovation. Annex 11 outlines the hub processes including: (i) the requisite steering team composition to drive the open innovation

process, ii) Roles, responsibilities, and minimum requirements of actors/participants in the open innovation process well defined, and iii) eligibility criteria for the actors for the innovation process.

1.4.5 Work Package 5: Conceptual planning of capacity/skills development, incubation & acceleration

UNU EHS subcontracted Stellenbosch AUDA-NEPAD SANWATCE and AfriLabs respectively and the outputs of they produced a report on the capacity building program, training needs assessment guide and marketing strategy of the capacity building program.

i) Report on the capacity building/skills development program

AUDA-NEPAD SANWATCE Secretariat led work package 5 in partnership with its member institution, the Namibia University of Science and Technology (NUST) to define a structure for an online capacity-building/skills development program with an entrepreneurial curriculum. Tasks under this included work package are graphically represented in Figure 2 below:

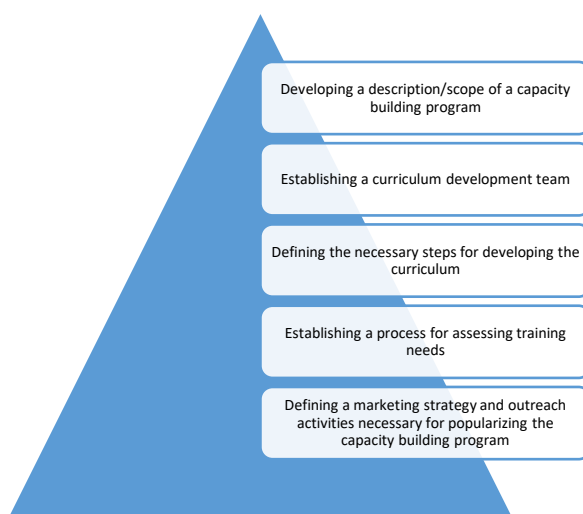


Figure 2: Tasks undertaken under work package 5

In developing the above-referenced deliverables, the NEPAD SANWATCE and NUST team reviewed the NUST Curriculum Development Framework, the NUST Quality Management Framework, NUST Policy on Cooperative Education, Teaching, Learning and Assessment Framework, and the NUST Regulations Setting-Up the National Qualifications Framework for Namibia.

ii) Policy Document Information Coordination

For the assessment of policy documents, the project team convened the following meetings: Firstly, the Faculty of Computing and Informatics and department discussions to unpack the scope of the Innovation and Entrepreneurship curriculum. Secondly the meeting with the NUST Programme Development Unit for guidance on the process of developing the curriculum and approval levels. Lastly, the meeting with the Deputy Vice: Chancellor of Research, Innovation, and Partnerships and the Deputy Vice-Chancellor: Teaching, Learning, and Technology for guidance on the scope and process of developing the new curriculum. Annex **12** outlines the online capacity building program and Annex **13**, the marketing and communication process co-developed by AUDA-NEPAD SANWATCHE and Namibia University of Science and technology.

1.5 The scientific and technical result of the project

The results of the initial phase of FIUWA have helped refine understanding on successful transnational knowledge and technology transfer processes, especially in the field of frugal innovations for developing and emerging countries. The conference contribution at the 1st Digitalization Africa Water Association congress has enriched knowledge accessibility to a broader expert public across the water, research and academia and policy space in Africa. Furthermore, the scientific publications currently under writing will enhance the knowledge and accessibility in the medium to a larger regional and global audience. The research outcome of the initial phase has contributed to providing science base evidence that will improve the way the water challenge typologies and open innovation will be done by collaborating between academia, technology hubs, and water practitioner-oriented institutions leading to youth entrepreneurship and addressing water security.

The results output on core water challenges and the mapping of digital technologies and frugal innovations has provided crucial science-based evidence supplemented by stakeholder insights, that will help provide specificity regarding problem-solution matching to develop technically feasible, economically viable, socially acceptable and locally adaptable solutions in response to core challenges in the field of water security. The project's mapping exercise of digital technologies and the digital innovation landscape assessment has contributed new knowledge in response to an absence of a documented database for digital technology solutions across the water sector in Southern Africa and an understanding of the current state and innovation potential of the digital innovation landscape of Southern Africa.

Furthermore, the generated stakeholder insights gained from the online survey and focus group discussions by technology innovation hubs in Angola, Namibia and South Arica have raised pertinent questions regarding water innovation at the micro-scale and the necessity of contextual experiences to informing the type of innovation developed and the innovation process. Such open questions present a strong basis for future research work at the country level and potential extension to continental coverage. The strong endorsement by high-level authorities at local partner institutions and the close collaboration with AUDA-NEPAD SANWATCHE and its network of higher tertiary institutions within Southern Africa, GWP, AfriLabs, and AfWASA's networks have created a positive

and welcoming environment for an ongoing and strong partnership, laying the foundation for an important follow-up project between the Germans and African partners.

The German partners namely German Water partnership and Fraunhofer have initiated synergies and strategic partnerships in the frame of the project that will establish new impulses through cooperation with excellent African scientific partners, in particular the AUDA-NEPAD SANWATCHE networks and the University of Stellenbosch in South Africa. In addition, German companies, entrepreneurs, innovators, or institutions planning to do cooperation activities within Southern Africa can count on the visibility and synergies established by the FIUWA African and German consortium partners to be integrated into them.

New markets for smart technologies and innovative infrastructure will be created from the linking of the frugal innovation ecosystem (community of practice) in Southern Africa with similar frugal innovators/ecosystems in Germany, which will open up new business opportunities for innovators and businesses in Germany to sell their already existing products or jointly develop solutions that are relevant to Southern Africa together with African innovators. The developed water challenge problem typology will open up opportunities to offer the systematic approach to "problem-solution matching" tested in FIUWA's first phase to private sector actors or other sectors and regions to optimize the fit of the solutions offered by the companies and increase the likelihood of successfully developing a market segment of the innovative solutions in the long run.

2. Necessity and Appropriateness of Project

The FIUWA project reflects multiple goals of the WASA funding scheme from varying perspectives such as;

- i) FIUWA's core aim of developing technically feasible, economically viable, socially acceptable and locally adaptable solutions in response to core challenges in the field of water security aim aligns with the WASA's aim of knowledge co-creation and innovation. Furthermore The FIUWA project brought together an international consortium of partners from Germany, Angola, Namibia and South Africa and other institutions such as AfWA and, AfriLabs and which work across the continent's academia, technology hubs, and water practitioner-oriented institutions to support water supply/security, innovation and entrepreneurship in line with WASA'S aim of collaborative efforts between African and German partners in developing projects co-created from conception stage and developed into a long-term approach focused on knowledge generation to demonstration and implementation to transfer into practice and long-term adoption.
- ii) FIUWA project has consolidated the cooperation between AfWA and GWP, and AUDA-NEPAD and SASSCAL considering their complementarity in establish high-quality scientific work to address the water crisis for Southern Africa and strengthening regional and continental collaboration in line with WASA's aim to contribute to Africa's Science, Technology and Innovation Strategy for Africa 2024 (STISA 2024) and strengthen coo-operation with

African partners in order to address global challenges. Furthermore, FIUWA project's three innovation hubs from Angola, Namibia and South Africa brought in varying stakeholder groups such as local communities, water practitioners, young innovators, policy actors to gain insights and perspectives that can inform tailored innovation solution in line with WASA's aim of developing innovation potential and new markets.

- iii) The project leveraged its strong and extensive association networks of AUDA-NEPAD, GWP, AfriLabs and AfWA to expand cooperation with other institutions and networks such as AfWA's Young water professionals in the Southern Africa region, AfriLabs technology innovation hubs and Namibia University of Science and Technology from Stellenbosch AUDA-NEPAD's network. The project has enhanced existing collaborations between German and Africa institutions of Fraunhofer, UNU-EHS, PAUWES, AfriLabs, AUDA-NEPAD centers of excellence for closer collaboration in future projects. The participation of the AfWA's young water professional and the young innovators insights from the technology innovation hubs in the three countries during data collection has brought on board young people with regards to skills development which will be beneficial for the main phase of FIUWA project.
- iv) The participation of GWP in the project and creation of a database of frugal innovations from Germany's water sector has potentially enabled the involvement of a wide range of German water sector players into the project activities, be it consultancies, engineering offices, operators, scientific institutions, etc. Moreover, GWP has established a link to the Young Water Professionals network of the DWA in Germany that can be connected for skills building and co-creation initiatives in the main phase.
- v) WASA's policy focus on contributing to the successful implementation of the African Union's Agenda 2063 and are aligned with the FIUWA project objective. FIUWA's initial phase has laid groundwork that will be refined and enhanced in the main phase to support and develop youth entrepreneurship, jobs and decent work in line with broadly realizing the UN Agenda 2030 (Sustainable Development Goals, SDG 6 and SDG 13) and creating youth employment in line with Agenda 2063 goals.
- vi) WASA's aims for the development of innovative and sustainable solutions for water supply security and wastewater management are underlined within FIUWA's project's FRIST PHASE which has formulated a capacity building program to be adopted in the main phase as a toolkit aimed at young innovators to help their processes of digital frugal innovation ideation, proof of concept and acceleration of their developed solutions into the market while simultaneously addressing the challenges of water security in Africa.

2.1 Project Partners Contributions in Kind

The inclusion of associate partners such as WASCAL Competence Center, and AUDA-NEPAD SANWATCE has contributed to strengthening collaboration, with other higher tertiary institutions such as the Namibia University of Science and Technology, Stellenbosch University, and these organizations' networks. In addition, it has strengthened collaboration and grown the network of

UNU with water-related institutions of the Southern African region. Furthermore, the inclusion of Phumlani Nkontwana from Stellenbosch University in the project has enhanced expertise and knowledge on the entrepreneurial state and growth within South Africa and the Southern Africa region based on the evidence-backed research experience of the university. The very strong endorsement from high authorities from the local partner higher tertiary institutions, the AUDA-NEPAD SANWATCHE, the technology hubs across Angola, South Africa, and Namibia, and the close collaboration with a local university and regionally has created a favorable and welcoming environment for a sustained and strong partnership, which lays the foundation for the main-phase of the FIUWA project. Moreover, the presentation at the AFWA 1st Digitalization conference of initial results on the challenge typology and the transdisciplinary methodology adopted for the project highlighted UNU visibility on the continent and kick-started an internal institutional discussion on how digitalization solutions can be fostered within water utilities, private African water institutes and by the network of water practitioners and created opportunities for collaboration with the local/regional water and sanitation stakeholders.

2. 2 Utilization of Main Phase Project Outcomes

Target group	Topic	Description of utilization of scientific/technical result	Timeframe
Young innovators	Capacity building and development of new innovations skills	A platform will be setup to help young innovators to showcase their innovative ideas and to enhance their skills to turn ideas into action	Medium to long term
Local, national, regional and continental stakeholders	Innovation support system set-up	A strong network/ecosystem of researchers, practitioners and policy makers will be set up, enabling a synergetic approach to address water security issues in the region through innovation and entrepreneurship.	Medium to long term
Local, national, regional and international stakeholders	Methodologies, tools and work plans for a main implementation phase	The results of the project will be used in the main implementation phase to kickstart an innovation community of practice that improves water infrastructure and has the capacity to spur entrepreneurship and create jobs for youths	Medium to long term

Local, national, and regional stakeholders	Transferability	Involvement of local/regional stakeholders in planning/design (and later in the implementation phase) will build local capacity and ensure local ownership, sustainability and transfer (with necessary adaptations) of methods, tools, work plans to other sectors (agriculture, energy, etc.) where innovation can play a major role towards societal transformation.	Medium to long term
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2.3 Expected Use of 1st Phase Project Outcomes by Project Partners and Timeline

Partner Exploitation Activities	Expected results	Uptake	Timeline
AfriLabs	<p>The validated water challenges and contextual experiences at country level from Namibia, South Africa and Angola will be utilized by tech hubs under AfriLabs to develop toolkits such as training content and program support for entrepreneurs informing the innovation process.</p> <p>knowledge on the water challenge typology will be converted into innovative products and services</p>	<ul style="list-style-type: none"> Present findings and toolkits idea at Southern Africa Tech hubs Innovation seminar Annual AfriLabs conference 	<ul style="list-style-type: none"> September 2023 October 2023
AUDA-NEPAD Stellenbosch and Namibia University of Science and Technology (NUST)	<p>Academic Conferences Knowledge dissemination through events/ conference / leveraging on associate partners WASCAL Competence Center, Namibia University of Science and Technology, Stellenbosch University, and these organizations' networks.</p>	<ul style="list-style-type: none"> side event workshop at Stellenbosch and Namibia university of Science and Technology on Innovation across Water sectors Conference on Research Innovation in Southern Africa hosted by AUDA-NEPAD 	<ul style="list-style-type: none"> September 2023 October 2023:

AFWASA	Utilise the validated water challenge knowledge and insights of water professionals across the region to create an institutional ecosystem to promote digital innovation solutions with a focus on young water professionals	<ul style="list-style-type: none"> • 2ND Digitalization Conference • AFWASA Young water Professionals Chapter workshop on water and sanitation innovation 	<ul style="list-style-type: none"> • September 2023 • October 2023
UNU EHS	<ul style="list-style-type: none"> • Use of project output in shortlisted projects working on a similar domain • Leveraging on the water thematic issues of agriculture water management and integrated water management in the yearly Climate academy program at UNU to explore digital technology application beyond at continental level 	<ul style="list-style-type: none"> • Leveraged the identified digital technology startups for water sector as input to the Greenovation Project's water management sector startup mapping. (deliverable) • Use of identified digital technologies application in the agriculture water management for the Coins project (Senegal and Ghana) value chain analysis • Side webinar on thematic issues and digital technology application across the water sector in the continent leveraging on the project results 	<ul style="list-style-type: none"> • February 2023 • September 2023 • October 2023
GWP	Science -based evidence generated on the water challenge can be leveraged to build training program of GWP and AFWA'S Young Water Professional Chapters for	<ul style="list-style-type: none"> • Conference by GWP and AFWASA on 	<ul style="list-style-type: none"> • July 2023

	Southern Africa through integrating capacity /skill training in the identified areas. by collaborating between academia, and water practitioner-oriented institutions leading to youth entrepreneurship and addressing water security.		
Fraunhofer	<ul style="list-style-type: none"> • The challenge typology and transdisciplinary methodology Used as background for future national and innovation-oriented research projects • Identified problem-solution matching attained with the “frugal innovations database matched with challenge “will inform the design of future products and developing the right environment for innovation and knowledge transfer in current projects in Asia. 	<ul style="list-style-type: none"> • Shortlisted innovation-oriented projects for water and agriculture by Fraunhofer will leverage FIUWA outputs on digital landscape analysis and mapping methodologies • 	<p>July -December 2023</p> <ul style="list-style-type: none"> • 6 months
Publications	2 Journal Publications Transdisciplinary methodology and mapped digital technology & frugal innovations landscape across the water sector	V01: First Draft V02: Complete Draft V03: Comments from partners incorporated for deliverable published	25/09/2023 9/10/2023 23/11/2023

2. 4 Project Coordination and Communication

The overall project management and coordination of FIUWA 4.0 was done by UNU -EHS working closely with German and African partners. UNU-EHS led six WPs working closely with subcontracted partners namely Global Water Partnership (GWP), Africa Water Association (AFWA), AfriLabs and Stellenbosch University as Secretariat of AUDA-NEPAD Southern African Network of Water Centres of Excellence (AUDA-NEPAD SANWATCE) in the implementation of the other WPs given the institute’s research and capacity-building expertise. Dr. Erick Tambo and Paul Nduhuura handled the management and coordination of the project at UNU-EHS respectively. All the activities from WP2,

WP3, WP4, WP5, WP6, and WPCOR described in Section 1.2 above were duly completed and goals attained.

There were no significant delays in the overall project. As a joint project, the constant communication and synergic work among the partners was key to the completion of the work packages (WP2, WP3, WP4, WP5, WP6, WPCOR). However, the work package activities (WP 3 activity 2 and work package 3 activity 3 (WP3.2 & WP3.3) and work package 4 activity 4 (WP 4.4) regarding synergies with external stakeholders/partners are to be addressed as integral activities for the main-phase. Consortium meetings and regular meetings with other stakeholders were organized periodically to gain early insights into deficiencies during the project work that could threaten the realization of the desired results throughout the whole duration of the project.

i) Preliminary Online workshop

A preliminary online workshop was held on 8th February 2022 with all project partners of the FIUWA project to discuss activities under WP1 and WP2. The workshop created a platform to introduce as well as strengthen collaboration between the respective work packages and the expertise of the project partners.

ii) Organization of Project Kick-Off Workshop

UNU-EHS organized a project kick-off workshop held from 30th March – 01st April in Stellenbosch South Africa. The workshop was attended by a total of 18 participants (14 – in-person, 04 – online). The workshop was opened by Prof Eugene Cloete, the Vice-Rector, of Research and Innovation at Stellenbosch University who is also a water expert. The workshop presented an opportunity to share preliminary results from activities completed, fine-tune the topical focus of the project, revise activity timelines, and agree on the next steps.





iii)2nd Closing Workshop in Bonn

FIUWA Closing workshop was held at UN Campus in Bonn Germany from 16.01.2023 to 18.01.2023 with all partners, associate and strategic partners representatives of extended networks in Germany, for the planning of the next phase of the project. The workshop facilitated a discussion arena to reflect on the project work activities, reframe approach, and strategy for the main phase as shown in images below:





- ***Presentation of preliminary results at Digitalization Congress***

UNU EHS, AfWA and Fraunhofer collaboratively with joint partners virtually presented the preliminary results of the challenge typology and the transdisciplinary methodology adopted for the FIUWA project at the AfWA 1st Digitalization conference on 26.09.2022 organized by AfWA. The project was presented under the segment of Water Technical and Approaches and the paper presented was titled “Developing a Challenge Typology for the water sector in Southern Africa as Input to the Identification of innovative solutions” as outlined in Annex 14. The presentation received positive feedback from water utility practitioners who requested that the initiative be expanded to other regions not just to Southern Africa. Other organizations and state agencies have applauded the initiative.

iv) Meetings coordination Updates and Reporting

UNU EHS organized five online project meetings with each one scheduled for every two months. In addition, sixteen working group meetings were arranged fortnightly with partners respectively working on a mutually assigned work package. Key highlights/key points discussed in these meetings were shared via e-mail with meeting attendees, in place of meeting protocols.

UNU-EHS developed/ contributed to to the project kick-off workshop report containing key highlights of the deliberations on project-defined work targets, assigned tasks, and adjusted timelines to attain set tasks. NU EHS also contributed jointly with Fraunhofer IMW to the intermediate report to PT-DLR which outlines the completed tasks, revised timelines, and focus of the projec

3.0 Appendix

1. Annex 1: Summative Report of the main water challenges and implication for innovation

https://drive.google.com/file/d/1GmBlaDByZdt8W7xbSoLVW_Dvl4HN16hy/view?usp=drive_link

(2) Survey (hard copy) version

https://drive.google.com/file/d/1jAvQmKm8i7-7wXQ3t2vUpE03tUjss5ap/view?usp=drive_link

(3) List of AfWA consultants and young water professionals engaged in Survey Dissemination-

https://drive.google.com/file/d/1SzMw7qJFnOV90JN3VvmtPifC_QehndV/view?usp=drive_link

(4) AfriLabs Challenge Validation Methodology

https://drive.google.com/file/d/1TpoCuG3Qzqx2fz-XUOO5iwYcPELv2ds1/view?usp=drive_link

(5) AfriLabs and Take ups Consolidated Validation of Survey Report

https://drive.google.com/file/d/1151XVQfsbkA09FMHqKmcD7Tp8VVdXBxg/view?usp=drive_link

(6) Report of the digital landscape of Southern Africa and potential of application to water sector

https://drive.google.com/file/d/1PotclaSqVpX-22XMFmuRd228VA0w4FFV/view?usp=drive_link

(7) Mapped digital technologies across water sector in Angola, Namibia & South Africa

https://drive.google.com/file/d/1yYDrDZuoqgKtbJz3RqSbZcP0jLGSWVHy/view?usp=drive_link

(8) Table of existing water Frugal innovations in Southern Africa

https://drive.google.com/file/d/1_WPAuO--qCMC8dEEqOY0rM_tlbDHOTFS/view?usp=drive_link

(9) Conceptualization and Definition of Frugal Innovation

https://drive.google.com/file/d/1LaC19Sgfr-4vSbFkmacYnXfvLu140QaA/view?usp=drive_link

(10). FIUWA – Stakeholders database structure

https://drive.google.com/file/d/1nYb9wsM8IXAm3CR8DjilQtx7RU3b462y/view?usp=drive_link

(11) AfriLabs Open Innovation Process

https://drive.google.com/file/d/1ITLm3c8RMhXd5VQqZ6VSNR9G34sN97si/view?usp=drive_link

(12) Online Capacity Building Development

https://drive.google.com/file/d/1A1eiGTO3Gsye1NcGOqazl7gplwQhAlzP/view?usp=drive_link

(13) Marketing and Communication Strategy for Capacity Building Program

https://drive.google.com/file/d/15gxFHVuzNW7H0Q_ArFejkaUCUecVPLc-/view?usp=drive_link

3.1 Appendix 2

FIUWA dissemination and outreach events:

14. AFWA Congress: 1ST Digitalization Congress - High-Level Policy and Water Practitioner Forum Side Event

Date: 27 September 2022 Online

Presentation: https://drive.google.com/file/d/1mMFiUglLUKF5_Prw6264tHxrfV2ft4Tp/view?usp=drive_link