From output, to impact.

The impact of Human Capacity Development activities in the ACEWATER II Project

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Index

List of Tables

List of Figures

List of Acronyms

AAiT – Addis Ababa Institute of Technology

ACEWATER – Africa Centres of Excellence in Water Sciences

AGHRYMET – A specialised institute of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), West Africa

AMCOST – African Ministerial Council on Science and Technology

AMCOW – African Ministers' Council on Water (AMCOW)

AU – African Union

AU/NEPAD – African Union / New Partnership for African Development

AUDA-NEPAD – African Union Development Agency NEPAD

AU/NEPAD Networks of WCoEs – African Networks of Centres of Excellence in Water Sciences and Technology Development

HRDC – Botswana Human Resources Development Council

BQA – Botswana Qualifications Authority

CEANWATCE – Central/East African Network of Water Centres of Excellence

EC – European Commission

EC-JRC – European Commission Joint Research Centre

ECOWAS – Economic Community of West African States

ESS – Eco-Systems Services

EU – European Union

EIWR – Ethiopian Institute of Water Resources

GWP – Global Water Partnership

HCD – Human Capacity Development

HRD – Human Resources Development

ICPAC – IGAD Climate, Prediction and Applications Centre

IOM – Impact Orientated Monitoring

IWRM – Integrated Water Resource Management

LGA – Local Government Agency

MER – Monitoring, Evaluation, and Reporting

HRD – National Human Resource Development [Botswana]

NBA – Niger Basin Authority

NESTI – National Experts on Science and Technology Indicators

NPM – New Public Management

NRDC or NORTEC – National Resources Development College [Zambia]

NTCWR – National Technical Committee on Water Resources [Nigeria]
NUST – National University of Science and Technology (Zimbabwe)
NWRI – National Water Resource Institute (Nigeria)
OECD – Organisation for Economic Co-operation and Development
RSAP – Regional Strategic Action Plan on Integrated Water Resources and Development Management
SADC – Southern African Development Community
SADC GMI – SADC Groundwater Management Institute
SA-DST– South African Department of Science and Technology
SA-DWS – South African Department of Water and Sanitation
SANWATCE – Southern African Network of Water Centres of Excellence
SASSCAL – Southern African Science Service Centre for Climate Change and Adaptive Land Management
SCI – Science Citation Index
TVET – Technical and Vocational Education and Training
UNESCO-IHP – United Nations Educational, Scientific and Cultural Organization, Intergovernmental Hydrological Programme
WANWATCE – Western African Network of Water Centres of Excellence
WASSCAL – Western African Science Service Centre for Climate Change and Adaptive Land Management
WASH – Water, Sanitation, and Hygiene
WEFE – Water-Energy-Food-Ecosystems Nexus
WRC – Water Research Centre at the University of Khartoum
ZAMCOM – Zambezi Watercourse Commission
ZRB – Zambezi River Basin

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1. Overview and Background

1.1 Background to the AUDA NEPAD Networks of Water Centres of Excellence

It has been almost 20 years, in September 2000, when African countries and the international community adopted the Millennium Development Goals at the United Nations Millennium Summit. African leaders identified water scarcity and related insecurity due to water stress as one of the sources of the continent's underdevelopment and increasing social and economic decline.

The first African Ministerial Council on Science and Technology (AMCOST), held in Johannesburg in 2003, decided on water science and technology (S&T) to constitute one of the main flagship programmes of African Union / New Partnership for African Development (AU/NEPAD). Thus, in the framework of the AU/NEPAD, the leaders have committed themselves to "ensure sustainable access to safe and adequate clean water supply and sanitation, especially for the poor". They decided that Science and Technology (S&T) will play an important role in water development, supply and management and that S&T is crucial for assessing, monitoring and ensuring water quality. The flagship programme should strengthen the continent's capabilities to harness and apply S&T to address challenges of securing adequate clean water as well as managing the continent's resources to become a basis for national and regional cooperation and development.

On 22 November 2006, the African Ministers responsible for science, technology and water (AMCOST and African Ministerial Conference on Water, AMCOW) met in Cairo, Egypt. By resolution, the delegates committed themselves to establish African Networks of Centres of Excellence in Water Sciences and Technology Development (further referred to as AU/NEPAD Networks of WCoEs).

Since the mid-2000s, resources (human and financial) from various organisations have been mobilised in support of the AU/NEPAD Networks of Water CoEs. Direct funding has been mobilised from the South African Department of Science and Technology (SA-DST) to directly support the Secretariat of the Southern African Network of Water Centres of Excellence (SANWATCE) since 2009. The African Union (AU) provided funding for a research project on the use of Integrated Water Resource Management (IWRM) for development, involving members from SANWATCE and WANWATCE (2013 to 2015). In addition, the South African Department of Water and Sanitation (SA-DWS) has also provided financial support to the SANWATCE-secretariat in 2015 and 2018.

Progress has been reported to various institutions and platforms, which include regular presentations and reports to AMCOW, the African Union (AU), the European Commission, UNESCO-IHP, the SADC Ministers of Water and also SADC ministers of Science and Technology and Education, the Economic Community of West African States (ECOWAS) and various ministerial and governmental forums. In addition, project reports were submitted to implementing partners such as the DST/NRF in Southern Africa, with the European Commission initiating a project-specific ROM review in 2017. Often, these reports include an element of “achievements”.

1.2 The ACEWATER project.

Following this resolution by AMCOW and AMCOST in 2006, the European Commission (EC) initiated a process to support the establishment of African Networks of Water Centres of Excellence, thus the birth of the Africa Centres of Excellence in Water Sciences (ACEWATER) project. Over the past ten years, the ACEWATER Project has been implemented in two phases, with ACEWATER I implemented between 2009 and 2014, and ACEWATER II implemented between 2016 and 2020. It was through this funding, that two initial networks of WCoEs were established in West Africa (WANWATCE) and Southern Africa (SANWATCE) in 2008. Later, in 2016, an AU/NEPAD Network of WCoEs was established in Central/East Africa (CEANWATCE) as part of ACEWATER II. All Network members participated in shared activities such as joint-learning, knowledge management, human capacity development, infrastructure, and designing staff and student exchange for mobility and research. These activities were implemented to support as well as to build a functioning and shared network identify between the members of the networks. ACEWATER II now includes a dedicated action to Human Capacity Development, which is being implemented with resources and technical support from UNESCO-IHP.

1.3 The objective of the Impact Study.

In essence, the study aims to identify and report the contribution or influence (or impact) the Human Capacity Development (HCD) activities in Phase 2 of the ACEWATER project has made to policy development, knowledge production, contributions to Higher Education in the African water sector, socio-economic impact and ecological impacts. In addition, pathways to impact will be identified, from which lessons can be learnt for future phases of the ACEWATER project.

When considering the impact of a programme or project, various aspects need to be taken into account and include:

- What is meant by the term '*impact*'? In this study, a framework will be presented to demonstrate various aspects of impact, including knowledge, policy, social, economic and ecological impact. Indeed, the various aspects of impact cannot be viewed in isolation where for example, the interlinked nature of socio-economic impacts and socio-ecological impacts, needs to be considered.
- What is meant by, and what is the importance of, *attribution*? In measuring the benefit of scientific research, or in the case of the ACEWATER project, the question will always be asked whether the outputs are really the key driver for the eventual impact, referred to as *attribution* [1–4]. This has led to some studies tending to use language that focuses on the influence of research rather than impact [4]. Researchers such as Buxton [5] affirm that "any impact is the product of the whole R&D system and not exclusively produced by the original researcher" [5] (p. 260) or that impact could be made through a series of "productive interactions" [6] (p. 212).
- What is meant by, and what is the importance of, *additionality*? Aspects related to *additionality* also need to be considered within the ACEWATER project, and how does the contribution this project has made to impact, relate to those of other projects [8], and would the same benefits be achieved without the research programme [9].
- A challenge exists whereby the ability to quantify and establish attribution reduces over *time* [4]. When research findings are published as outputs in the form of reports and/or articles; initial, intermediate and final outcomes can take quite a while to occur, resulting in a decrease in the ability to track attribution over time as evident in Figure 1. An opportunity presents itself in this project to identify outputs from ACEWATER I and, to an extent, in the currently ongoing ACEWATER II, and to identify and report on the extent such outputs have contributed to impacts.

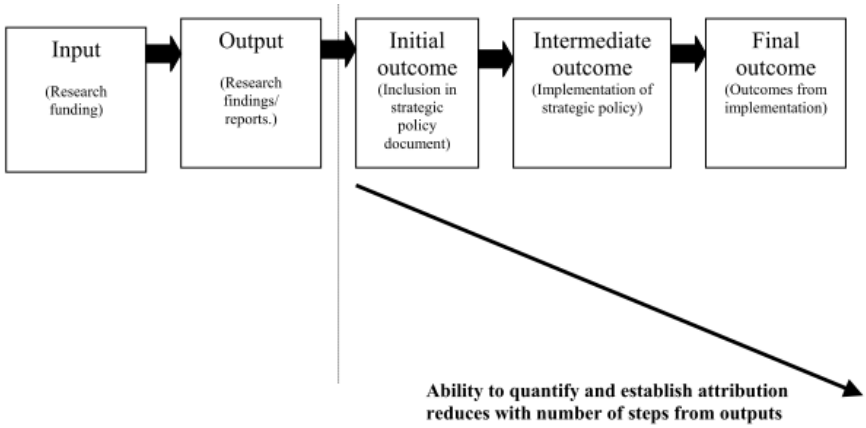


Figure 1: Losing attribution of research benefit over time

Source: Boaz et al. (2009)

- The *timing* of study – As mentioned earlier, the current ACEWATER project spans a period from 2010 to early 2020. Research impact assessments can be conducted either *ex-ante* (i.e. prior to the research) to assess the potential significance and used to evaluate what the R&D project aims to do, or *ex-post* (i.e. once the research has been completed) in order to measure the final outcomes and performance of the project [10]. Literature tends to focus on *ex-post* evaluation [11–14] of projects, or *ex-post* evaluation at the programme level [15–19].

  This study has been undertaken in the final stages of ACEWATER II, thus, taking an *ex-post* view on most of the ACEWATER project's duration. It does, however, provide an opportunity to set a basis and framework for the continued identification, monitoring and reporting outcomes and eventual impact, when certain outputs are presented in the concluding stages of the ACEWATER II. With further ACEWATER project activities envisaged, results of this study can be carried forward and integrated into any and all future ACEWATER activities, thus providing an opportunity for the *ex-ante* framework on the significance of such a project.

1.4 Methodology

A mixed-methods approach has been used, which includes surveys and interviews, and the collection of qualitative and quantitative data. Gatherings of researchers and stakeholders, for example, the annual consultative workshops planned for February 2020 in Dakar, Senegal and Addis Ababa, Ethiopia, will be used as opportunities to workshop activities, and to build impact cases for this study. Refer to section 2.5 for further detail on the application of the PaybackPLUS framework within this study.

2. Theoretical Framework

2.1 Introduction

This chapter provides a background and overview of the theoretical framework used for this study. In this chapter, the PaybackPLUS Framework will be presented. First, background and context on research impact assessment within the university and research environment are presented.

2.2.1 Accountability of universities and research institutions

Since the 1960s, greater awareness was seen of the importance of accountability emerged throughout the world. This growing need for accountability was complicated by less funding for research [20], creating greater pressure on universities to be more efficient and more accountable [21].

The 1960s the Frascati Manual - also referred to as *The Proposed Standard Practice for Surveys of Research and Experimental Development*[1]*,* was produced by experts from the Organisation for Economic Co-operation and Development (OECD), and the National Experts on Science and Technology Indicators (NESTI) who met in Frascati, Italy. This manual provides basic definitions and conventions; institutional classification; functional distribution; measurement of R&D personnel; measurement of expenditures devoted to R&D; survey methodology and procedures and finally Government Budget Appropriations or Outlays for R&D by socio-economic objectives (GBAORD). Importantly, the Frascati manual structures different fields of research into main and sub-categories, which build on each other in a linear model. These main categories (or modes) being *basic research*, *applied research* and *experimental development* [22]

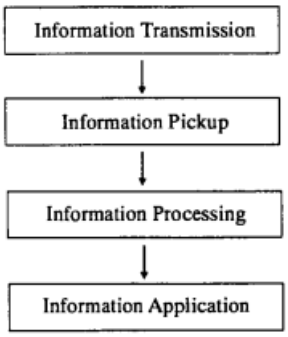
In the late 1980s, early 1990s, an emergence of the importance of accountability grew even greater throughout the world, with phrases such as "*performance management revolution*" being coined in the late 1990s by scholars such as Neely [23]. This further saw the introduction of an approach referred to as New Public Management (NPM) whereby private sector/market-based techniques are applied to public service [24–26]. Universities and research institutions, such as in the case of partners in the ACEWATER project were also affected by NPM, with an

[1] Updated versions of the document have been released over the years, with the latest being the 6th edition in 2002. In 2007 an updated Field of Science and Technology (FOS) classification was published, in order to present the latest changes in emerging technologies such as ICT, biotechnology and nanotechnology. A further annex update was released in 2012 addressing the use of the OECD guidelines to measure R&D in developing countries. [105]. In April 2013, NESTI approved the commencement of the publication no a new revision, to be known as Frascati 7.0 [106].

increased application of bibliometric analyses (bibliometrics) whereby citation data and quantitative analysis is used to trace published literature, contributing to quantifying the contributions to knowledge production. This was followed in 1963 with the publication of the 1961 *Science Citation Index* (SCI) where the term "Impact Factor" was first used [27], describing how the Impact Factor can be used as a citation-based measure, to indicate the significance and the performance of a scientific journal [28–30]. Today, the Impact Factor is widely used within the science community.

2.2 How do we measure the impact of research?

As will become evident, measuring the impact of research is multi-dimensional, with various aspects that need to be considered to measure the benefit of research and capacity development activities. First of all, measuring knowledge utilization is a *process*, and not a single event in time and consists of various generic steps, which includes Information *transmission (*the "trigger" step for knowledge utilization); Information *pickup*; Information *processing* and Information *application*, as presented in Figure 1. These steps can take a few minutes or occur over a long period of time and could involve a single user who could perform these steps cognitively, within an organization, within a network or by multiple users and organizations.



Source: [31]

Figure 1: Knowledge Utilization as a stepped process

In addition, research impact assessments can be conducted either *ex-ante*, prior to the research to assess the potential significance and used to evaluate what the R&D project aims to do, or *ex-post*, once the research has been completed in order to measure the project's final outcome and performance [10]. Moreover, most literature often focuses on *ex-post* evaluation of public R&D projects [11–14], or *ex-post* evaluation at a programme level [15–19,32].

In comparison, less *ex-ante* evaluations have been carried out possibly due to the difficulty in quantitatively measuring what a project will do as opposed to quantitatively measuring *ex-post*, what impact a project has had [10]. In addition, *ex-ante* evaluations are often used as an internal process, with a smaller audience than in the case of *ex-post* evaluations, thus adding to the difficulties in undertaking *ex-ante* evaluations as opposed to *ex-post* evaluations of R&D projects [10].

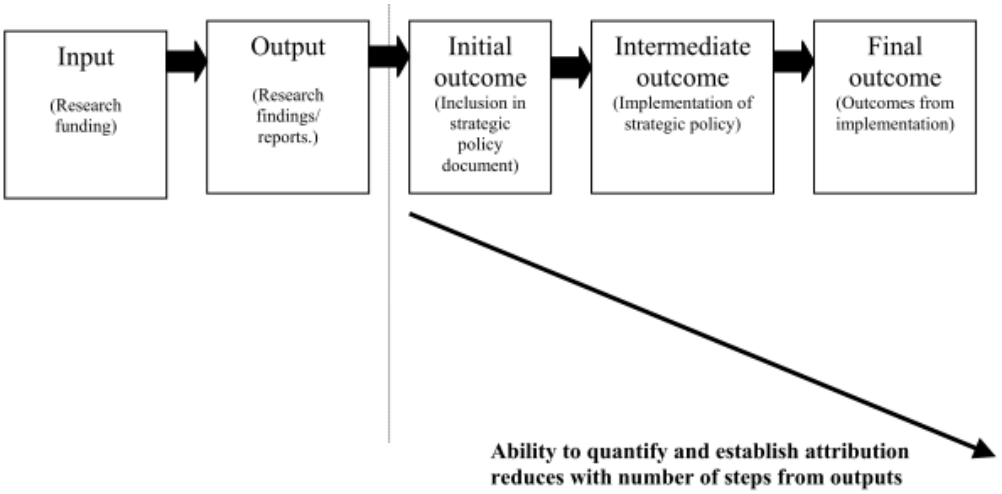
2.2.1 Challenges in linking research to research impacts

There are challenges when the impact of research is identified and reported on. Some challenges related to attribution, additionality, time lag and the timing of assessments, which are discussed in more detail.

2.2.1.1 Attribution, additionality and time lag

In measuring the impact of scientific research, the questions will always be asked if the research output is really the key driver for the eventual impact - *attribution* [1–3,3]. This has led to some studies preferring to use language that focuses on the influence of research rather than impact [33]. Moreover, questions will be asked on how does the contribution of the research compare to that of other drivers – referred to as *additionality*, [34], and would the same impacts be achieved without the research programme [9]. There are some mitigating arguments which include the establishment of counterfactuals and by asking key informants about the outcomes they would have expected without the input of the research [35]. In addition, the adoption of demand-side approaches to impact evaluation (as opposed to supply-side) and using major policy events to work retrospectively to establish influences and further to institutionalise impact evaluation processes and ensuring that staff take the responsibility to record outputs, dissemination efforts and known policy responses which directly relates to the research [35]. Of importance though, when institutionalising impact evaluation process, is the risk of adding additional administrative burdens on staff [36].

In addition, a challenge exists whereby the ability to quantify and establish attribution reduces over *time* [3]. When research findings are published as outputs in the form of reports and/or articles, initial-, intermediate- and final outcomes could take quite a while since the initial research output, with a decrease in the ability to track attribution as evident in Figure 2.



Source: [33]

Figure 2: Losing attribution of research impact over time

2.2.1.2 Timing of assessments

If the evaluation of the impact of research is undertaken too early after the conclusion of the research, the impact of the research might not have occurred yet, or if the evaluation is undertaken too late, some impacts might have occurred without a lasting effect. The challenge lies in capturing the duration of the research impact [35]. As a possible solution, a two-stage evaluation process could be undertaken, with the measurement of impacts shortly after the project completion, and another later when the intended benefits should emerge. This suggestion is in line with Guinea at al. [37] who propose, as part of Impact Orientated Monitoring (IOM) tools, that *Coordinators' surveys*, *End users' opinion surveys* and/or *Assessment tools (scoring matrix)* be undertaken in the middle of the project (for projects lasting four or more years), at the end of the project, or three years after the project.

2.2.2 Models and methods used for research impact assessment

Over a number of years, various models and frameworks have been developed to evaluate the impact of research, and have been applied in various studies. Greenhalgh et al. [38] reviewed six of the most established approaches and their applications, which include the [HERG] Payback Framework, the Research Impact Framework, The Canadian Academy of Health Sciences (CAHS) Framework, Societal Impact Assessment and Related Approaches, the UK Research Excellence Framework and the Participatory Research Impact Model. Greenhalgh

et al. [38] further identified other approaches which could hold future potential, and include electronic databases such as Researchfish® [39], Realist evaluation [40,41], Contribution mapping [42], The SPIRIT Action Framework [43], and the Participatory research impact model [44,45]. It was also found that most frequently, semi-structured interviews, case studies and documentary analysis are applied to the study of research impact [46]. However, it was found that most studies used more than one research method. Other methods used and/or discussed included bibliometrics; peer panel reviews; surveys; workshops; literature reviews; field visits; user evaluations; telephone interviews; historical tracing; patents/ new technologies, network analysis, positive utilization narratives, impact logs and tracing post-research activity. It was also found that forward tracking of research is most commonly used, from a piece of research to an outcome such as a policy change as opposed to backward tracking from an outcome to the research [46,47] In addition, forward tracking tends to identify a greater level of impact, due, in part, to the reliance on self-reported data from lead investigators. However, it was further found that some research evaluators tracked research projects in both directions in order to create a high-level account of the relationship between research and policy [47]. In the studies [38,46] it was concluded that the HERG Payback Model is the most used.

2.3 The PaybackPLUS Framework

As will be presented, the HERG Payback Framework already identify four impact dimensions, which are the scientific or *knowledge benefits* derived from research, benefits to *policy* formulation, benefits to the *economy* and *social* benefits from research. It is however evident, that in recent years there has been an increased focus on what benefits could be derived from research in natural sciences, which could be expanded upon from the HERG Payback Framework. In addition, more recent research related to Impact Oriented Monitoring Tools (IOM) [37] can be integrated into the HERG Payback Framework. For these reasons, an adapted PaybackPLUS Framework is proposed.

In the following sections, the elements and integration of IOM Tools of the PaybackPLUS Framework will be discussed.

2.3.1 Elements of the PaybackPLUS Framework

The PaybackPLUS Framework, presented in Figure 3, consists of two elements, which are 1) a *logic model*, representing the complete research process as research projects are conducted over time, and 2) a set of research impact *dimensions* to classify the individual paybacks from the research. In addition, the relationship between the research process and the different research impact dimensions are presented and indicate that scientific impacts

relate to the scientific knowledge production, whereas the policy-, economic-, ecological- and social impact dimensions relate to the political-, professional-, economic- and ecological environments and the wider society.

2.3.1.1 Element 1: The logic model

The research process consists of seven stages, as presented in Figure 3 of the logic model. These stages include the Research Needs Assessment (stage 0) when the research project is initiated, followed by Inputs to research (stage 1); the Research process (stage 2); Primary outputs from research (stage 3); Secondary outputs from research (stage 4); Practitioners applications (stage 6) and finally Research outcomes (stage 6). Each of the seven stages of the logical model is discussed in more detail.

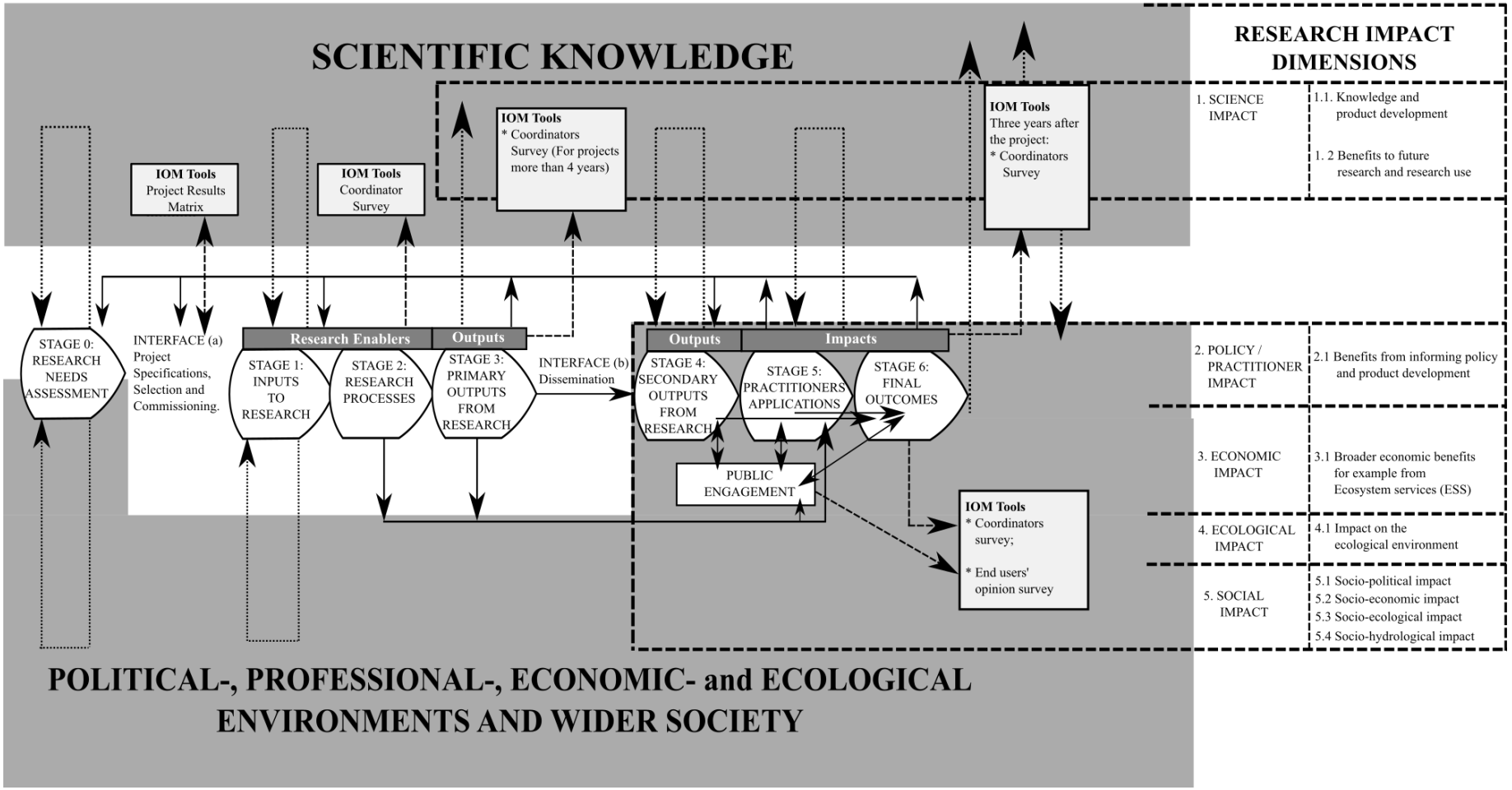


Figure 3: The PaybackPLUS Framework

Acknowledgement: Elema, N.M, Cloete, T.E.

The early stages of the research process – Stage 0

Initially, a research needs assessment (Stage 0) is undertaken with inputs from the reservoir of knowledge and inputs from the political-, professional-, economic- and ecological environments, and the wider society. Here, with inputs from the scientific body of knowledge and other stakeholders, the research question is framed and defined, often with various assumptions framing the research question, which could be potentially be mapped through impact pathway mapping and logic models [48]. The research needs assessment provides the motivation for the research, which could then be translated into a research proposal for potential funding.

Conducting research – moving from Stage 0 to Stage 3

Once the research needs have been identified and typically captured in a research proposal [49,50], the research needs assessment stage is followed by the first of two interfaces within the research system. Interface (a), between Stages 0 and 1, provide the opportunity for researchers to draft the project specifications, where it is often submitted for funding. These could be in response to a call presented by local or international funding mechanisms to fund research projects, or as in response to established funding grants and where projects are evaluated and selected for commissioning. Only then, do research project pass on to stage 1, where inputs are gained from the scientific body of knowledge and the larger stakeholder group to initiate and conduct the research process in stage 2 for the eventual production of primary research outputs from the research in stage 3. It is important to note that inputs from the scientific knowledge and the broader stakeholder group in stage 1 continuously feed into the research processes in stage 2. The research process can take a number years depending on the type of research, but typically post-graduate qualifications, research publications, knowledge models and frameworks, patents and scientific knowledge products developed by the researchers result from the research over a number of years.

An enabling environment for research – Stage 1 to 3

When research is conducted, in Stage 1 and 2 and when primary outputs are produced from research in stage 3, creating an enabling environment is essential for the success of the research. Such research enablers include *human resources* and critical mass in terms of *expertise in focus areas* found in Centres of Excellence and Institutes supported by Research Chairs. Moreover, universities and research institutions rely on

funding from contract research, government grants, bursaries and philanthropic donations to enable research. In most cases, *infrastructure* is required, including research laboratories which often contain high-end and expensive research equipment. Finally, *collaboration* with other institutions enables training opportunities for post-graduate student support in the form of workshops and supervisor training, summer and winter schools, joint and double degree opportunities, and the sharing of high-end infrastructure, as mentioned earlier.

Research dissemination for secondary outputs and practitioner applications – moving from Stage 3 to Stage 5

The second of the two interfaces occur when between Stages 3 and 4 after the primary outputs from the research have been produced and disseminated from where secondary outputs are produced in stage 4. At this stage, decisions also need to be taken by the science communication practitioner on the modalities of science communication such as science promotion and science education, and the intended effect of the science communication process [51]. Only after these knowledge products have been developed, are they "re-packaged" as secondary outputs such as policy briefs, policy- and legislative documents, information guidelines, and outputs aimed at the "non-academic" audience is produced (stage 4). Moreover, practitioner applications (stage 5) result from these secondary outputs and could further result directly from the primary outputs produced by the researchers in stage 3, and need not necessarily result from secondary outputs.

The logic model further acknowledges how the impact from research processes (Stage 2) and primary outputs from research (Stage 3) can have a direct influence on practitioners' applications (Stage 5), with input into, and from, public engagement at these latter stages.

Public engagement

Following the dissemination of primary outputs from the research (Stage 3), public engagement is highlighted at stages 4, 5 and 6, when secondary outputs result from the research, practitioners apply the research and outcomes now result from the research in stage 6. In these stages, public engagement with stakeholders in the political-, professional-, economical- and ecological environments, in the wider society, assist delivering outcomes of the research.

Over the past number of years, a wealth of research has been undertaken on the field of research dissemination and research utilisation which provide insight into how research can be disseminated and utilised to influence policy-makers and practitioners.

The interface between the body of knowledge and external stakeholders into the research process.

Throughout the entire research process, from stage 0 when the research project is incepted to the outcomes in stage 6, inputs are gained from the scientific body of knowledge and broader stakeholders. In the early stages of the research process (when the research needs assessment and the initial stages of input into the research take place), the knowledge grabbing occurs from the reservoir of knowledge, feeding into the research process. The latter is repeated later in the research process when secondary outputs are generated (stage 4) and when practitioners' applications are being developed (Stage 5) – both these processes are influenced through systematic reviews which take place through the reservoir of knowledge. Moreover, the PaybackPLUS framework acknowledges inputs from the political, professional, economic and ecological environments and the wider society in stage 1 when inputs are gathered into the research conducted. This is often through stakeholder engagements such as workshops and meetings to gather data. Finally, as indicated earlier, public engagement when secondary outputs and practitioner application result from the research, support the outcomes in the research process.

Feedback loops

To create a feedback loop back to the research process, knowledge is fed from primary outputs of the research (Stage 3), the practitioners' applications (Stage 5) and from the final outcomes (Stage 6) back into the policymakers secondary outputs (Stage 4). The feedback loop extends to when inputs into the research occur (stage 1) and at Stage 0 when the needs assessment into the research is undertaken.

2.3.1.2 Element 2: The impact dimensions

The second element of the PaybackPLUS Framework consists of a set of research impact *dimensions* (also refer to Figure 3). The research impact dimensions include

- Science impacts (such as knowledge and product development and further benefits to future research and research use),

- Policy and practitioner impact such as benefits where research inform policy and product development.
- Economic benefits derived from the research
- Ecological benefits as they relate to the biosphere and
- Benefits to society, where social impact can further be defined as socio-political-, socio-economic-, socio-ecological and socio-hydrological benefits.

Moreover, the various impacts manifest at various stages of the research process, with science impacts typically resulting in stage 3 as primary research outputs, the policy impacts as secondary outputs in stage 4, and economic, ecological and social impacts manifesting as outcomes in stage 6 of the logic model (also refer to Annexure A later in this document).

The individual dimensions are discussed in more detail:

2.3.1.2a Dimension 1: Science impact

Dimension 1.1 Knowledge and product development.

As researchers publish their work in journals, conference presentations, books, book chapters and research reports, findings are made public. Often, innovative scientific research also results in the development of products and techniques, which could include knowledge products such as theoretical frameworks, computer software, hydrological- and climate change models which are often used for further academic research.

Typical knowledge outputs include publications where any type of publication could be considered, but it is generally thought that peer-reviewed articles in international papers [52] are most important, as they reflect quality, and papers that are accompanied by an editorial are seen as significant.

Master's and PhD dissertations and also research reports which result from the research are often stored in local institutional libraries and often published in electronic format, are also regarded as knowledge and innovation products. Moreover, patent applications are an indication of innovative products resulting from scientific research. This dimension of research impact can directly be linked to the researcher as the author or patent applicant.

Over the years, international citation index databases such as the Thomson Reuters™ Web of Science™ and the Elsevier™ Scopus databases have been developed whereby the citation information of research papers are collected. These databases

provide insight into the scientific knowledge produced and are used to assess the impact of research papers in terms of scientific use and the research productivity of individual researchers. With the further development of altmetrics [53], cited references in webometric databases such as Google Scholar are also useful but should be used with caution, as these developments are still in their relative infancy [54–56].

Dimension 1.2: The benefits derived from current and future research use

As recipients of funding for scientific research, researchers could be enabled to better target future research, leading to leveraging of future research and funding. The scientific research can contribute towards the development of research skills, personal and overall research capacity within fields of interest and expertise, and can result in a critical capacity to absorb and utilise existing research. Related impacts can also include personal (such as promotion) or institutional staff development.

Outputs would include employment of staff on research programmes, explicit funding for research training, and also in higher or research degrees resulting, either totally or in part, from research funding [57–60]. The impact of such a dimension would typically be related to the individual researcher and potential collaborators, and also their organizations or institutions.

2.3.1.2b. Dimension 2: Policy impacts

Dimension 2.1: Benefits from informing policy and product development.

Research project findings can be used for a wide range of policy/decision making at any level and the ability to influence organizational or governmental policy through scientific research has been studied, resulting in various frameworks and models [61–66]. Such influence on policy could have been the initial objective of a research project or occurred inadvertently because of the research project. Policy interventions are often facilitated through policy briefs, guidelines, or by an individual being appointed in an influential position to affect such impact [67–69]. By making their research more relevant to political and executive decision-makers, knowledge producers could contribute to such policy interventions through scientific research.

Typical outputs from this dimension include resulting national policies, local guidelines, and policies developed by those responsible for training/education/inspection. Training packages, curricula and audit and evaluation criteria are examples of this [70]. Other

outputs could include policies about media campaigns [71], and the adoption of policies and products [72] that would contribute towards the impact of this dimension.

With projects with an ecological aspect, an example would include the global awareness and negotiations around climate change impact and resilience, is a good example of how scientific output (in the form of climate change models) have informed discussions at the various Conference of the Parties (COP) meetings on Climate Change.

2.3.1.2c. Dimension 3: Economic impacts

Dimension 3.1: Benefits derived within the broader economy

Within a broader economy, scientific research could impact on the wider economic benefits from commercial exploitation of innovations arising from R&D related to the ecological environment. An example of such an innovation which has had a far-reaching impact on its industry, was the development of the biological nutrient removal process, or Bardenpho process whereby nitrogen and phosphates are removed from wastewater without the use of chemicals. First developed in the 1970s by Dr James Barnard of South Africa, this process has had unquantifiable positive impacts on water resources and costs in recycling water in many countries [73].

Benefits included in this dimension would be measured through indicators such as an increase in employment, working-days and profits, resulting in manufacture and sales [74] of water-related products and services. Further benefits to the national economy could include an increase in exports and/or import substitution [75,76]. Research in certain water-related aspects could also have had a positive impact on livestock, which could potentially have a positive impact on export.

Again, the challenge is to identify, attribute, and quantify benefits as a result of research undertaken. This could be achieved through an investigation of a few case studies resulting from the research.

2.3.1.2d. Dimension 4: Ecological impacts

Dimension 4.1: Impact on the ecological environment

The PaybackPLUS framework provides a dimension for the impact of research related to the ecological environment as various benefits can arise from the application of research project findings which have a positive impact on both fauna and flora within the ecological environment.

Benefits would include an increase in water quality and quantity, better management of floodwater or the return of a balanced natural sustainable ecological environment following ecological events such as floods and periodic droughts or, destructive human interventions. Benefits would also include an increase in the numbers of indigenous fauna and flora within an ecological area. Research into invasion ecology also offers insight into the impacts that alien plants have on the natural ecological environment and ecosystems. These impacts are often being seen as negative, but sometimes positive where invasion species support the production of firewood, food, fodder, building material and nectar for bees [77].

Moreover, in terms of Ecosystem Services (ESS), ecosystems, directly and indirectly, contribute goods and services to society in order to maintain human wellbeing [78,79]. According to the report of the Millennium Ecosystem Assessment [80], ecosystem services can be categorized in four main types which include the *provisioning* of food, freshwater, wood and fibre and fuel; the *regulating* of the climate, -flood, -disease and water purification; *cultural* contributions in the form of aesthetics, spiritual, educational and recreational and finally *supporting* primary production, nutrient cycling and soil formation. By making use of these main categories, the Common International Classification of Ecosystem Services (CICES) has developed a set of common classifications and indicators, especially where a link to economic accounting is made [81]. The latest version 4.3 classifications and indicators were developed in 2013 and accessible at http://cices.eu/, which could be used as a guide to develop indicators for ecological impact.

2.3.1.2e. Dimension 5: Social impacts.

Since the 1990s there has been a clear trend to not only measure the impact of research on academia and scientific knowledge, but also an expectation that evidence needs to be demonstrated of the value of science to society [82]. Various social, cultural, environmental and economic returns or benefits can arise from research and the uptake of new products, which is not easy to separate (Bornmann 2013, P. 218), and, as further argued by Giddings et al. (2002), these entities are interconnected with the economy dependant on society and the environment, while at the same time, society is dependant and within the environment. Moreover, within the ecological environment, this “interconnectedness” is highlighted in the definition of Integrated Water Resource Management (IWRM), which aim to promote ‘*the* ***coordinated*** *development and* ***management of water****, land and related resources in order to maximise the resultant*

economic *and* ***social welfare*** *in an equitable manner without compromising* ***the sustainability of vital ecosystems***' [85].

The impact of research on society can be measured in various ways, and be "much harder to assess than scientific research" (Bornmann 2013, P.230), with various advantages and disadvantages associated with different methods. Examples would include case-study methods that, even though they record the complexity of societal impact, can be very expensive, and do require a uniform approach with the same indicators in order to assess the impact of different institutions.

Within the PaybackPLUS Framework, the various societal benefits are associated with the political-, economic- and ecological benefits as mentioned earlier. As first sub-dimension *Socio-political benefits* are derived, where sociologists work to better comprehend the operations and constraints of organizations with political influence, thus bringing them into the water policy dialogues, and a better environment can be created that can better collaborate with other water-related disciplines to address water problems in an area. [86,87]. Moreover, *socio-economic benefits* can be achieved from improved health as a result of better water purification techniques [88–90] or a decrease in water pollution where communities rely on such water sources [91–93]. Moreover, cost savings could occur, with benefits to society, through sustainable development [94–96]. *Socio-ecological benefits* could include an increase in the establishment of a food-secure environment [97,98]. Lastly, the PaybackPLUS framework provides for benefits derived through a better understanding of the *socio-hydrology,* where the focus of socio-hydrology is on "observing, understanding and predicting future trajectories of co-evolution of coupled human-water systems" and can be seen as the science which underpins the practice of IWRM [99]. Benefits from a socio-hydrology perspective would be for example in the case of human-flood interactions [100,101] and the development of flood-warning systems.

Challenges within this impact-dimension are the attribution of research impact in such a broader impact-dimension, and to relating such impact directly to the scientific research.

2.3.2 Strengthening the PaybackPLUS Framework by making use of Impact Orientated Monitoring (IOM) tools

As indicated earlier in this study, attributing research impact to a specific research project is a challenge [1–3,3]. Moreover, such attribution decline over time [33]. A study [37], does propose a set of Impact Orientated Monitoring (IOM) tools at various stages of a research project. Having presented the two elements of the PaybackPLUS Framework above, being the local model (research process), and the various research impact dimensions, such IOM tools can

be integrated into the PaybackPLUS Framework to strengthen the identification, monitoring and attribution of research impact.

Table 1: Summary of IOM tools

IOM elements	Purpose	Timing
Project results matrix	To structure the expected results and impacts. Assess specified short-term impacts.	During negotiations for a grant agreement.
Coordinator survey.	The main data collection tool (web-based questionnaire) for the capturing of results and evidence of research impact.	• For projects of more than four years, in the middle of the project. • At the end of the project. • Three years after the project.
End-users' opinion survey.	A web-based questionnaire to gather data on end-users' opinions on non-academic impacts of the research project.	At the end of the project.

Source: [37]

The IOM tools within the PaybackPLUS Framework consist of three elements, including 1) a Project results matrix, 2) a coordinator survey, and 3) an end-users' opinion survey, as presented in Table 1.

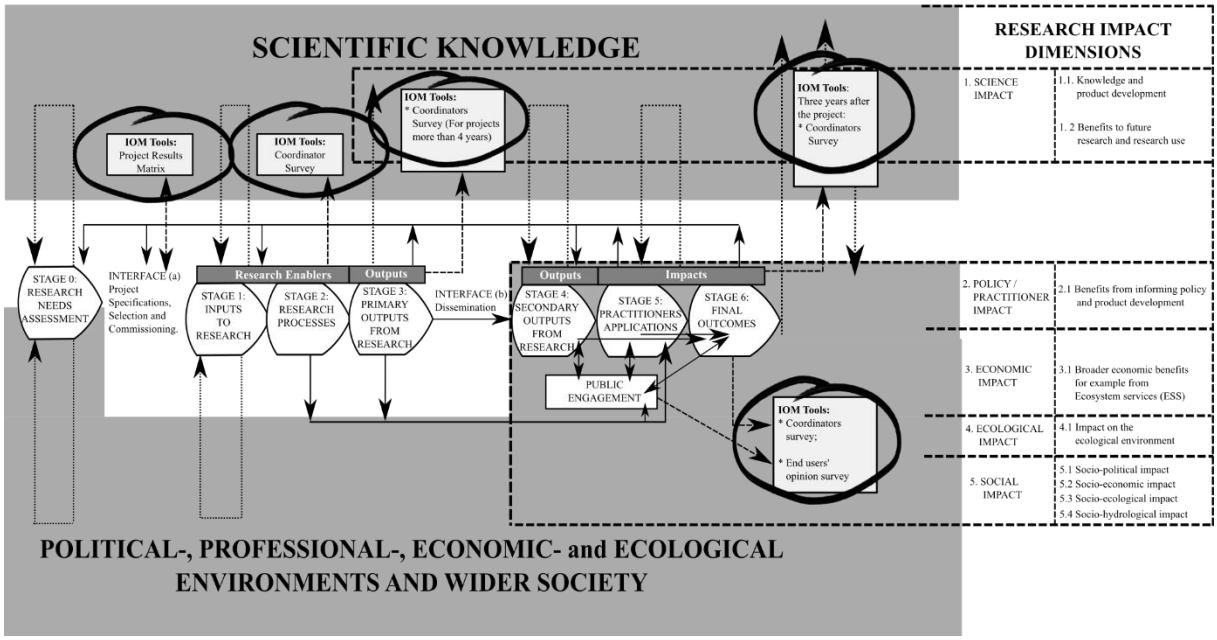


Figure 4: Integrating IOM tools into the PaybackPLUS Framework

Referring to Figure 4, the integration of IOM Tools at various stages of the PaybackPLUS Framework are indicated. Starting very early in a research project and at the initial stages of project conceptualisation, the *Project results matrix* would feed from, and influence, the project specifications at the first Interface (a) between stage 0 and stage 1. This influence would take place during the grant negotiation process, and assist in organizing project information and linking objectives with activities, results and the impacts. It is important that researchers start identifying potential research impact dimensions over the broad spectrum of dimensions as provided by the PaybackPLUS Framework. Project results matrix can be referred to by the coordinator of the research project when periodical reporting on the project occur. Moreover, such forward tracking would further support the tracking of research impacts as forward tracking tends to identify a greater level of impact [47]. Forward tracking of research impacts is also identified by Boaz et al. [46] as the most common method used for tracking research impact, as opposed to backward tracking.

In addition, a *coordinator survey* could be undertaken in stage 2, during the research project, feeding into the research process, and at the conclusion of the project, when the final outcomes from the research are potentially reached (Stage 6). Such *coordinator surveys* would assist in collecting data about project results and evidence from the research project. Results of this survey should feed into the knowledge reservoir for future reference. Where a project last more than four years, a coordinator survey should take place in the middle (following Stage 3, when the primary outputs from the research are achieved) is also

recommended. The questionnaire will collect quantitative and qualitative data on the advancement of knowledge; capacity building and research targeting; informing of decision-making, practice and policy; social benefits, ecological environment benefits; broader economic benefits, and data on dissemination and knowledge transfer. Guinea et al. [37] recommend that such a coordinators' survey be repeated three years following the conclusion of the research project, to obtain evidence of outputs and impacts, and how these relate to the final outcomes as identified in Stage 6 of the Payback Framework. Again, results from this survey should feed into the knowledge reservoir for future reference, and into the political-, professional-, economic- and ecological environments and wider society.

The third IOM tool, as defined by Guinea et al. [37], is an *end-users' opinion survey* which is now integrated following stage 6 of the PaybackPLUS Framework, when the final outcomes are potentially achieved and public engagements have concluded. Such a survey would assist in identifying non-academic impacts and identifying high impact projects. It is, however, important that the researchers involved in the project clearly identify the most relevant end-users to take part in the survey questionnaire, and that project officers actively participate in the monitoring of projects, as they will have to contact and motivate end-users to participate in the survey. As in the case of the final coordinators' survey, results from this end-users' opinion survey should feed into the knowledge reservoir.

2.4 Data collection techniques for the PaybackPLUS Framework dimensions

To operationalise the PaybackPLUS Framework, data collection and analysis techniques are identified for each of the five research impact dimensions (refer to Annexure A). These techniques include bibliometric methods, documentary reviews, personal interviews, analysis of student and funding statistics, user surveys and selected case study analysis. For example,

- bibliometric methods such as citation analysis, interviews with researchers and the analysis of patents, licenses, will be undertaken when primary outputs such as publications are produced to identify the contributions a project has made to the knowledge production and the benefits to research and research use.
- To identify the contributions to policy, reviews of secondary outputs such as national; regional and local regulations, existing policies, acts, laws or regulations, document review and interviews could be undertaken to assess to what degree informed decision-making has occurred.
- Broader economic benefits from research can be identified through, surveys, personal interviews and selected case studies, often in later outcome stages of a project - for this dimension, statistics would also be important.

- The determine the impact on the ecological environment, various quantitative and qualitative techniques could be used. For example, data from measurements related to the health of an ecosystem such as improved water quality and water quantity; the number of species of fauna and flora and further counts of fauna and flora in an area; the use of Common International Classification of Ecosystem Services (CICES) as available from http://cices.eu to identify indicators for Eco-System Services (ESS); personal interviews and selected ecological-related case studies.
- Lastly, various data collection techniques could be used to identify Socio-political impacts, Socio-economic impacts, Socio-ecological impacts and Socio-hydrological impacts. Measurements include identification of actors involved in water resource management; the identification of forums and arenas for discourse on water resource management; the measure or review of the level of service; review and analysis of user complaints; compliance with quality standards; the level of awareness of water health; review or study of existing training and knowledge building initiatives; analysis of decrease (or why not increase also?) in the loss/improvement of crops, and human and animal life in the case of floods; selected case studies and relevant statistics data can be collected and analysed. it should be acknowledged that such societal contributions are often only realised as outcomes after a few years, and often after the completion of a research project.

With a better understanding of the research process, how 'impact' is defined and how the various impact dimensions relate to the research process, the application of the PaybackPLUS Framework can be discussed and how it was applied to the HCD component of the ACEWATER project.

2.5 Application of the PaybackPLUS Framework in the ACEWATER project

The discussion above shows how the PaybackPLUS Framework provides a framework to identify, and report on various impact dimensions, and how contributions to impact relate to the different stages within the research process. The different stages are also identifiable in the ACEWATER project where the different networks are at different stages of the ACEWATER project implementation. As discussed in the introduction, the ACEWATER project comprises three networks of universities and research institutions located across the continent. These networks are SANWATCE in Southern Africa, WANWATCE in West Africa and CEANWATCE in Central/Eastern Africa. Within the implementation of various activities in the ACEWATER project, one needs to consider that various networks are at different stages of the ACEWATER project, with progress resented in Figure 5 - the

progress of each network are marked accordingly on the PaybackPLUS Framework with the corresponding letter, for example, (A).

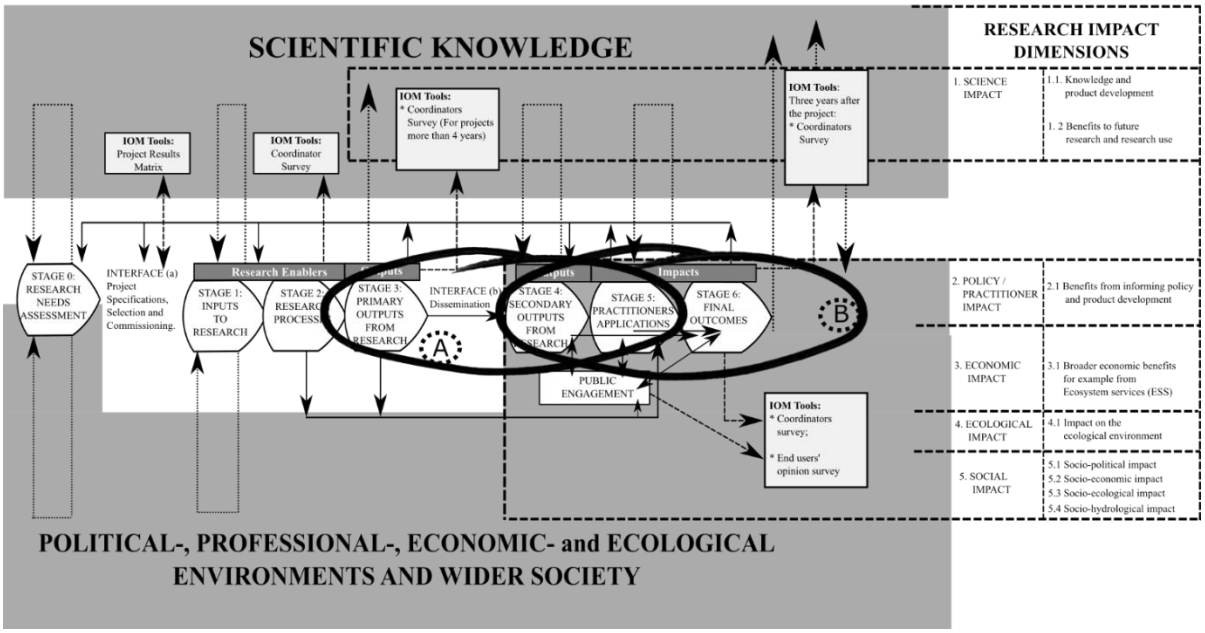


Figure 5: Application of the PaybackPLUS Framework within this study

With reference to Figure 5:

A. To recall, the CEANWATCE was established in the second phase of the ACEWATER around 2017/2018. During the undertaking of this impact-study, it is expected that primary outputs should be realised in early 2020, with initial and anticipated secondary outputs identified soon after – some secondary outputs would result by end of the project, with additional secondary outputs, which is not necessarily within the scope of the project, materialising beyond the end of the project

B. In the case of the SANWATCE and WANWATCE, activities started around 2009 in the first phase of ACEWATER, with expected outcomes now realized from this phase. In addition, the SANWATCE and WANWATCE started the second phase of the ACEWATER earlier than CEANWATCE around 2016, with some outcomes now becoming evident.

   In the case of the SANWATCE and WANWATCE, an *ex-post* view can be undertaken, looking back at the first and second phases of the ACEWATER project to identify the contribution the project has made to impact. In the case of CEANWATCE, a more *ex-ante* perspective needs to be taken, as primary outputs are now being realized, with impacts which may be anticipated in the coming years. The identification of impacts

should however not be excluded completely, as it is possible that some impacts may be realized directly from current research outputs.

To identify and report on the impacts, document reviews and IOM Tools such as coordinator surveys with the CoEs were undertaken to identify and report on the impact of the Human Capacity Development (HCD) activities on the ACEWATER II project. For the cases related to Joint Learning and Cooperation with Continental and Regional agencies, the narratives were developed based on documented evidence and evidence gathered over a number of years during meetings. For the cases addressing water sector skills gaps in the various African regions, consultative workshops were fortunately undertaken in each of the networks between November 2019 and February 2020. These workshops included the research groups and key stakeholders which were part of the activities throughout the project. During these consultative workshops, impact-cases were developed based on detail presentations by each research group, with inputs from the key stakeholders (refer to Annexure B). For each case, aspects such as the relevant network, the impact dimension, relevant deliverables, and a brief and full description of the impact will be identified. In addition, evidence of the impact needs to be identified, which can be in the form of formal agreements and communications, to ensure that attribution of the impact to the ACEWATER project can be identified. Finally, the pathways which led to the impact and factors which supported and/or hindered the achieving of the impact were identified.

3. Impact Cases

The assessment of the impact of a program or activity involves the identification, analysis, and reporting of quantitative- and qualitative data. Reporting on the beneficial impact a program has, (or had) on the various impact dimensions is undertaken in various forms. In the case where benefits to knowledge production and scientific impact have materialized, the number of graduates from a program or a workshop, or the number of published articles and the related citations can be counted. The number of policy briefs and policy and guideline documents can be counted and the eventual as outputs towards a policy impact. Other contributions, which cannot be counted quantitatively, can be reported on in the form of a case, which, when analysed as a case study, present the full contribution a program or activity had on the various impact dimension. The following section presents a number of cases on the contributions the ACEWATER program had on impact. For each case, the relevant AUDA-NEPAD Network of CoEs, the relevant impact dimension and a description of the impact are identified. To further support reporting on the impact, the relevant stakeholders, the pathways to impact, and how specific activities and role-players contributed towards a specific impact are identified.

3.1 Case: Joint Learning

Since the inception of the ACEWATER project in the mid-2000s, an important aspect of establishing Networks of Water Centres of Excellence was to create capacity in the Centres of Excellence (CoEs) to address African water- and sanitation-related issues. This was done with a specific Joint-Learning activity which also contributed greatly to the building the identity of the Network. This aspect was highlighted as a key component in the early stages of the ACEWATER project (2011 to 2013) and included activities such as a series of workshops and seminars to raise awareness on a Sector Wide Approach. The seminars and workshops were jointly conceptualized based on regional needs, designed with surveys to determine thematic needs, with results of the workshops and seminars analysed and reported. These activities had an organizational impact with the members of the network gaining experience and building confidence in collaborating with each other in some cases for the first time. The Central East African Network of Water CoEs (CEANWATCE) was established in the second phase of the ACEWATER project in 2016. Their research tasks included Human Capacity Development (HCD) activities during this second phase of ACEWATER, and also served to contribute to the Centres of Excellence universities to build a network in this region; nurturing collaborative skills and which contribute towards the broader aspect of Joint-Learning already underway with CoEs in the other regions of Africa.

Part of the governance of the AUDA-NEPAD Networks of Water CoEs is the establishment of secretariats for each network. In SANWATCE, the secretariat is hosted at the Stellenbosch University (South Africa), for WANWATCE, the secretariat is hosted at the Université Cheikh Anta Diop de Dakar (Sénégal) and for CEANWATCE, the secretariat is hosted at the University of Khartoum (Sudan). These secretariats regularly communicate and coordinate activities amongst network members. In SANWATCE, an annual Steering Committee meeting is organized back-to-back to the WaterNet/WARFSA/GWP symposium. In the case of WANWATCE and CEANWATCE, annual project meetings are an integral part of the ACEWATER activities, which result in network members physically meeting at least once a year. Such Steering committee meetings and annual project meetings present the opportunity for network members to discuss and report on collaboration activities, thus contributing to the aspect of Joint-Learning and collaboration.

By continuously collaborating under the auspices of the AUDA-NEPAD Networks of Water CoEs, members of (at least) the SANWATCE have reported during annual Steering Committee meetings that there has been an increasing institutional research capacity, among the university network members, which resulted in direct benefits to knowledge production such as new collaborative research projects, an increase in joint publications, joint supervision of post-graduate students, and increased staff and student mobility amongst member institutions. Such joint collaborations have extended to other programmes such as SASSCAL (Southern African Science Service Centre for Climate Change and Adaptive Land Management), WASSCAL (Western African Science Service Centre for Climate Change and Adaptive Land Management), WaterNet and the Pan African University.

Joint Learning activities further extended to collaborative participation of AUDA-NEPAD Water CoEs in project conceptualisation and project development during initial stages of the ACEATER II project. Moreover, through well-established partnerships with key-stakeholders at a continental and regional level, other key stakeholder could also be consulted during the project proposal stages. Evidence, such as letters of support from AMCOW, the secretariats of the AUDA-NEPAD CoEs and the African Network of Basin Organisations (ANBO), confirm that the European Commission Joint Research Centre (EC-JRC) actively engaged with members of the AUDA-NEPAD CoEs and key-stakeholders in the design and development of the proposal of the ACEWATER II project, following the AMCOW Declaration in 2013 (refer to section 3.2 for more detail on the AMCOW Declaration). The collective participation of AUDA-NEPAD CoEs where not limited to the ACEWATER project, and CoEs regularly participate in projects in SASSCAL, WASSCAL and WaterNet, as reported during annual Steering Committee meetings.

In terms of policy-formulation, joint-learning activities have contributed in policy formulation where, through the HCD activities in the ACEWATER II project (refer to sections 3.3, 3.4 and 3.5), CoEs made specific contributions to national HCD Frameworks as part of the ACEWATER II project. CoEs have reported by continuously involving CoEs in the various activities of the HCD component of ACEWATER II, best practices could be shared which strengthened CoEs.

3.2 Case: Cooperation with Continental and Regional agencies

Since the inception of the ACEWATER project in the mid-2000s, a principle was established whereby the CoEs not only function as an academic network but that they would also partner and collaborate with regional and continental agencies and other research and capacity development networks in the water and related sectors. Given that the AUDA-NEPAD CoEs have their origin in the African Union, and specifically AMCOW and AMCOST, the secretariats of the AUDA-NEPAD Networks of Water CoEs, SANWATCE, WANWATCE, and CEANWATCE are regularly invited to participate in AMCOW meetings to update ministers on activities of the AUDA-NEPAD CoEs. Since the inception of the AUDA-NEPAD Networks of Water CoEs in 2006 when AMCOW and AMCOST established the programme, activities are framed by AMCOW Decisions, and specifically two decisions in 2013 and 2018/2019:

- In 2013, the AMCOW General Assembly approved the decision for the AU/NEPAD Centres of Excellence “to develop a Human Capacity Development Program aimed at addressing junior professional and technician level capacity challenges in the water sector”. This is based on a Decision taken during the 11th General Assembly of AMCOW in 2013 (Decision: EXCO/11/2013/CAIRO/17) [102].
- In 2018/2019, the AMCOW General Assembly Council further approved Decision GA/11/2018/LBV/7 [103] which “directs the [AMCOW] Secretariat to work with the AUC and NEPAD Centres of Excellence to support the understanding of patterns of knowledge and skills demand and migration in order to both strengthen the resilience of Africa’s Water Resources Sector at a national and transboundary level and promote Youth Employment.”

In addition to the African Union, the partnership with the European Commission (EC) through the Joint Research Centre (EC-JRC) is worth noting. Since the initial establishment of the (then) NEPAD Networks of Water CoEs in 2006, the EC-JRC actively support the CoEs through the ACEWATER I and ACEWATER II project. Over time, cooperation has evolved to the collective conceptualisation, project proposal and eventual support of research and HCD activities in the ACEWATER II project by the EC. Moreover, the EC-JRC facilitated the

partnership between the AUDA-NEPAD Water CoEs and UNESCO-IHP in the ACEWATER II project, whereby the HCD component of the project is channelled through UNESCO-IHP.

At a regional level, such partnerships and collaborations continued throughout the life of the ACEWATER project which would have an impact on various impact-dimensions. Examples and evidence of such impacts are as follows:

In the West-African Region, the CoEs in WANWATCE entered into a Memorandum of Understanding (MoU) with the Economic Community of West African States (ECOWAS) during the ACEWATER I, with the objective to seek opportunities to strengthen research and capacity development cooperation. There is a need to further support the intended activities in the MoU and to support the institutionalisation of the agreement.

Apart from the MoU with ECOWAS, AGHRYMET and the Niger Basin Authority (NBA) both entered into partnerships with AUDA-NEPAD CoEs in the WANWATCE more recently during ACEWATER II, to collaborate in various research, policy and capacity development initiatives. AGHRYMET is a Regional Centre established in the mid-1970s as a specialized institute of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS). The CILSS comprise of various member states in West-Africa and includes Burkina Faso, Cape Verde, Chad, Gambia, Guinea Bissau, Mali, Mauritania, Niger, Senegal. Similarly, the NBA is a West-African intergovernmental organisation with member countries which include Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria and Chad which aim to promote cooperation amongst the member states. Through activities during ACEWATER II such as regional stakeholder meetings to identify the Human Capacity Development needs and skills gaps, both AGHRYMET and the NBA committed their organisations to establish formal Memoranda of Understanding with the West African Region CoEs for research and capacity development activities in support of the ACEWATER II Project and beyond.

Another example of AUDA-NEPAD Water CoEs cooperation with an agency facilitated by the ACEWATER II project, is the involvement of the Université Cheikh Anta Diop de Dakar (UCAD) as the secretariat of the AUDA-NEPAD WANWATCE, participating in the Priority Pilot Groups and Priority Action Groups related to Water Security, Sanitation and Cooperation of the 2021 World Water Forum. [104]

In East Africa, an AMCOW representative from the regional body, the East African Community (EAC), actively participated in the application, evaluation and recommendation of members of the AUDA-NEPAD CEANWATCE in 2016. In addition, the cooperation from the EAC regularly translates into regional meetings.

In the Southern African Region, the AUDA-NEPAD SANWATCE secretariat regularly participates in meetings of the SADC ministers of Water (though the Water Resource Technical Committee – WRTC) and the SADC ministers of Science and Technology. This culminated in a decision in 2013 whereby the SADC Ministers of Water approved the AUDA-NEPAD SANWATCE business plan and activities of the AUDA-NEPAD SANWATCE. Regularly, the AUDA-NEPAD SANWATCE secretariat reports to the SADC ministers of Science and technology, where activities are formally noted by ministers, thus providing input into policy formulation.

In addition, the AUDA-NEPAD SANWATCE has made significant contributions by partnering with key regional role-players such as the Southern African Development Community (SADC) Water Desk, WaterNet, the SADC Groundwater Management Institute (SADC-GMI) and the Zambezi Watercourse Commission (ZAMCOM). Based in the SADC headquarters in Gaborone, Botswana, the SADC Water Desk is responsible to oversee and facility regional instruments for water cooperation and include the Regional Water Policy, the Regional Water Strategy and the Regional Strategic Action Plan on Integrated Water Resources and Development Management (RSAP) which was introduced in August 1998 to run in five-year phases. Eleven members of the AUDA-NEPAD SANWATCE actively participate in contributing towards the RSAP and were instrumental in establishing the SADC Water Science Research Agenda. In involvement of AUDA-NEPAD SANWATCE member institutions in the development of the SADC Water Science Research Agenda was an indirect consequence of the ACEWATER II project.

To further address research and capacity development in the SADC region, the AUDA-NEPAD SANWATCE has concluded formal Memoranda of Understanding between the Zambezi Watercourse Commission, WaterNet and SADC GMI, the latter two also being formal implementing agencies of the SADC Regional Economic Community.

The AUDA-NEPAD SANWATCE further has a long-standing arrangement with the South African Department of Science and Innovation and the South African National Research Foundation for the direct financial support for activities through the Secretariat hosted at Stellenbosch University – this agreement has been in place since 2009, whereby the national agency support research grants and secretariat activities on an ongoing basis.

From the above case, it is evident that the AUDA-NEPAD Networks of Water CoEs have sought and established cooperation with continental and regional agencies and in cases, resulting in formal ministerial decisions and bilateral MoUs to undertake research and capacity development activities. These decisions and agreements can be attributed to being a **pathway to impact**, and being leveraged to seek support and initiate projects such in the case of ACEWATER II, which led to research and HCD activities in West, East and Southern Africa.

3.3 Case: Addressing water sector skills gaps in West Africa, Eastern and Southern Africa

As part of the second phase of the ACEWATER Project, network members contributed towards Human Capacity Development (HCD) with specific activities designed into the project to undertake a sector-wide assessment for specific countries in the WANWATCE, CEANWATCE and SANWATCE. These countries are Nigeria, Senegal, Ghana, Sudan, Ethiopia, Uganda, Kenya, Botswana, Mozambique, Malawi, Zambia and South Africa. For each country, the in-country AUDA-NEPAD Water CoE undertook a desk-top study to analyse the water sector to determine the *status quo* of in-country HCD activities, and the identification of various stakeholders in the countries' water sectors. The desktop-study was followed by a series of consultation and validation workshops with stakeholders in each country to identify needs, from where National Frameworks (or contributions to existing strategies) could be developed. It should be noted that the process differed in some countries, and guided by in-country factors such as national directives on who should develop National Frameworks and the status of existing water sector HCD Frameworks and Strategies. For example, in Mozambique, the process of developing a National water sector HCD Framework was initiated by the Ministry of Science and Technology with interventions from IWEGA at Universidade Eduardo Mondlane and in South Africa, various activities have been underway which address national water-sector HCD needs, with major involvement by the Ministry of Water and Sanitation. In East and West Africa, the role of national ministries also differed, which will be highlighted in specific cases in the following sections. For each country, national priorities were identified which relate to Young Professionals and Technical Vocational Education level (TVET), and validated at a regional level through a series of regional stakeholder workshops were held in late 2019 and early 2020 in each of the three regions, to present findings from activities. These regional meetings were attended by members from all the AUDA-NEPAD Water CoEs, other capacity development role-players in the regions, and relevant representatives from the different RECs.

It should be noted at this stage that academics are not always primarily involved in driving policy-making processes. In developing inputs into National water sector HCD Framework within the ACEWATER II project, some academics confirmed during the SANWATCE regional meetings that the initially felt 'out of their comfort zones' while engaging with policy-makers. However, it was found that the activity had a positive impact in that through the processes, **individual and organisations growth took place**, especially when the outputs were valorised, and academics experienced that their inputs were accepted.

To further contribute towards National water sector HCD Frameworks, pilot courses were identified to address in-country needs. All CoEs planned to conduct on-site training as part of the HCD component of the ACEWATER project, however, due to the outbreak of the Covid-19 pandemic, initial pilot courses could only be presented in Sudan and Ethiopia before all

universities were affected by lockdown regulations. Subsequently, where feasible, pilot training courses were planned to be presented online as part of a re-alignment of project activities by UNESCO-IHP. The presentation of online courses are however scheduled to take place after this reporting period.

In the following sections, different cases are presented to report the training needs which were identified which eventually informed the pilot courses. In addition, factors which contribute to impacts are presented as pathways to impact, and also the identified and anticipated impacts.

3.3.1 Nigeria

In a case study of Nigeria (a network member in the WANWATCE), the National Water Resource Institute (NWRI) in Kaduna identified that a shortage of skilled human resources was a major challenge, and further identified a spectrum of training needs in various water resources sub-sectors. The training needs were identified at Federal, State, and Local Government Agency (LGA) levels in Nigeria. The method used for the study included reporting on the background and overview of water sector HCD in Nigeria, preparing preparatory meetings, the development, and administration of a structured questionnaire, with the results of the survey documented.

Through the stakeholder engagement, various actors at State- LGA- and Community levels were identified and guided the development of customized training. For example, Borehole Geophysical Logging training was identified as a need amongst Water Supply Officers at State level, and Pump Installation and Maintenance training was identified amongst Water Supply Officers and Hand Pump Mechanics at State Level, amongst Water Supply Officers and Mechanics at LGA level and among Community Water Point Caretakers. Non-technical needs such as Human Resources Development Planning and Strategies and Training Managers were also identified.

As part of the Implementation plan, ten priority courses were identified for roll-out which would target Geologists, Engineers, Technicians, Managers, Supervisors, Sanitation Officers, Mobilization and Community Development Officers, and new employees in Nigerian water sectors. Participants were identified by Federal Agencies, States Rural Water Supply and Sanitation Agencies (RUWASSAs), Local Government and Community Workers in the Nigerian water sector with an Induction Course for Fresh Engineers deployed in the water sector and mandatory Career Progression Courses for the water sector personnel were implemented.

Pathways to impact. In what can be identified as a pathway to impact, the close involvement of government agencies in the national water sector assessment led to the decision whereby government agencies were directed to sponsor their staff for further

training specifically at the NWRI. In addition, by playing a leading role in identifying water sector HCD needs, a pathway to impact at an institutional level is created at the NWRI which would result in building the reputation of the institution as a water sector skills provider in Nigeria.

Impact: The pilot courses will contribute towards knowledge production in the Nigerian water sector, and contribute towards the NWRI's reputation as a skills provider in the Nigerian water sector.

There is further evidence that the HCD activities in the ACEWATER II project have contributed to policy contributions and stimulated the National Technical Committee on Water Resources (NTCWR) to approve mandatory courses in the Nigerian water sector. In addition, NTCWR directed relevant government agencies to sponsor their staff for further training especially at the NWRI. The benefits of other training at the NWRI have been noted whereby follow-up assessments three months after the training indicated that some of the trainees that attended the NWRI training courses have benefited by way of promotion and financial socio-economic benefit through increased salaries. Although it is still too early to identify similar benefits from the ACEWATER II pilot courses, it is anticipated that similar assessments would reflect similar results.

3.3.2 Senegal

For the water sector in Senegal, the Cheikh Anta Diop University undertook a national assessment of the water sector with stakeholders such as the Senegal Ministry of Water with, as part of the national assessment, a survey indicated that a lack of qualified human resources (63%), followed by insufficient equipment (52%) and lastly (16%) a lack of financial resources contribute towards to ineffective execution of tasks in the water sector. It was evident that training and capacity development needs were principally in project planning, management, and monitoring; project design; financing research and the development of institutional and regulatory frameworks. In addition, the sector assessment indicated that there are various academic and polytechnic institutions with professional and private institutions supporting research and capacity development in Senegal.

The results of the above study also showed that various courses needed to be developed to support capacity development aimed at technical/senior professionals and in addition, young professionals. These courses include project management (design, planning monitoring and evaluation, fundraising, and the development of institutional and courses in regulatory frameworks for technicians and senior professionals. In addition, the new

courses incorporate GIS and remote sensing technologies and hydrological modelling (including SWAT, Mike 11, Gr4J, TopModel, WEAP).

Pathways to impact. With the involvement of the Senegal Ministry of Water from the outset of the project and the alignment of training priorities to national priorities, the uptake of training programs is increased, leading to an increase in the impact of training and capacity development activities. In addition, by playing a leading role in identifying water sector HCD needs, a pathway to impact at an institutional level is created at the Cheikh Anta Diop University which would result in building the reputation of the institution as a water sector skills provider in Senegal.

Impact: The impact of the HCD activities in Senegal has been in at various levels. At an institutional level, the pilot courses have contributed towards knowledge production at the Cheikh Anta Diop University, and the courses will be an asset in future for the institution. Also at an institutional level, the reputation of the university as a knowledge producer and skills developer in the Senegalese water sector is strengthened by the ACD activities in the ACEWATER II project. The coordination of activities as the secretariat of the WANWATCE, and specific activities in the ACEWATER project, has further strengthened the capacity of personnel at the secretariat of at the university and has indirectly lead to the promotion of the programme manager. At this stage, the impact of the pilot courses are anecdotal, and further evidence and examples will be required to fully articulate the role and uptake of the Senegal Ministry of Water in training programmes emanating from the ACEWATER II project.

3.3.3 Ghana

In Ghana, the Kwame Nkrumah University of Science and Technology (KNUST), undertook the activity to develop a Ghana National HCD Framework as a member of AUDA-NEPAD WANWATCE. Through the national assessment of the Ghanaian water sector with capacity and skills gaps identified for young professionals and technicians, in four sub-sectors of the Ghana water sector. These sub-sectors include water resources management; water supply management; environmental sanitation management and lastly environmental health and hygiene.

The study resulted in the development and implementation of four courses in a Higher National Diploma (HND). The courses are 1) Water laboratory instrumentation, 2) Water systems instrumentation, 3) Sanitation technology and construction, 4) Borehole construction, and groundwater treatment. The courses are institutionalized and certified at the relevant National Board for Professional and Technician Examinations (NABPTEX).

In addition, four training courses were designed targeting young professionals which include 1) Waste resource recovery and entrepreneurship, 2) Onsite sanitation and faecal sludge management, 3) Water safety planning and management, and 4) Water Resources Modelling, IWRM & WEFE Nexus. In addition, two new MSc programs in Environmental Sanitation and also in Resource Recovery and Entrepreneurship are aimed at young professionals. Depending on the training course, KNUST would target professionals and technicians at government institutions and the private sector. All the pilot courses contribute to the Ghana National HCD Framework.

Pathways to impact: Such a wide range of programs can only be implemented with the involvement of various stakeholders including the Ghana Community Water and Sanitation Agency; the Ghana Water Company; Municipal Authorities; National Board for Professional and Technician Examinations (NABPTEX); Plant and Process Automation Ltd, the Food and Drug Board and the Ghana Standards Board. Through the involvement of stakeholders in workshops designed within the ACEWATER II project, pathways to impact were created and the uptake of pilot courses will be increased. In addition, by playing a leading role in identifying water sector HCD needs, a pathway to impact at an institutional level is created at the KNUST which would result in building the reputation of the institution as a water sector skills provider in Ghana.

Impact: By designing programmes that are in line with the valorised needs in the water sector, the training courses will contribute towards knowledge production at KNUST and contribute towards the reputation of KNUST as a skills and knowledge provider in the Ghanaian water sector. Moreover, given the involvement of the wide range of stakeholders in workshops, the probability of future uptake of the pilot courses are increased.

3.3.4 Sudan

In Sudan, the Water Research Centre (WRC) at the University of Khartoum water sector assessment targeted specifically at Ministry of Water Resources, Irrigation and Electricity and its various Divisions, Universities and Research Institutes in the country, UN organizations, NGO's working in the water sector Sudan, and the Private Sector. From the sector-wide assessment, various urgent training needs were identified and categorized into six main themes. These themes are 1) Water Supply and Sanitation, 2) Irrigation Management, 3) Surface Water Hydrology, 4) Groundwater Sustainable Management, 5) Integrated Water Resources Management, and 6) Data Acquisition and Management Tools.

Following the validation workshop, six training courses were identified, specifically aimed at young professionals and Technicians. At the time of reporting at the end of January 2020, three training courses were presented on Water, Sanitation and Hygiene (WASH), Data acquisition and Analysis in Water Management, and Data Acquisition in Surface and Groundwater.

Pathways to impact: Given the involvement of key stakeholders in consultative workshops, pathways to impact were created, and one can anticipate that this contributed to increased uptake of the training workshops. By involving ministry officials during the opening of one of the workshops, support from decision-makers are demonstrated, and affirmation of Government buy-in that the courses are strongly relevant to the needs of the Sudanese water sector. By playing a leading role in identifying water sector HCD needs, a pathway to impact at an institutional level is created at the WRC which would result in building the reputation of the institution as a water sector skills provider in Sudan.

Impact: In terms of impact, the training courses contributed to knowledge production in the Sudanese water sector, with 96 young professionals participated in the training. The training courses further contribute towards the reputation of the WRC as a knowledge producer and skills developer in the Sudanese water sector. As a contribution to a social impact, there was a clear gender balance with 54% of the attendees being female. From the interviews and questionnaires with the stakeholders' institutions after the pilot courses, indications are that the training was useful in enhancing the abilities of their professionals and hence the role of the institution in the development of the water sector. The WRC further reported that the project created a good relationship with the stakeholder institutions which will enable the WRC to provide policy advice and also successfully carry out project activities in the future that serve the needs of these institutions.

3.3.5 Ethiopia

The Ethiopian Institute of Water Resources (EIWR) at Addis Ababa University identified HCD gaps and training needs relating to operational hydrology; surface water resources assessment using advanced modelling techniques; irrigation system diagnosis, on-farm water management and operation management; water productivity and irrigation systems modelling. Courses to address these needs were planned to be synchronized and linked to existing training courses at the EIWR.

Aimed at technicians at TVET level, two training courses were conducted in January 2020 on Operational Hydrology: Flow and Sediment Monitoring in Streams and Irrigation

System Diagnosis, On-farm water management, and Operation and maintenance. Participants were from 6 public institutions: the Basins Development Authority, the Irrigation Development Commission, the Awash Basin Development Office, the Abay Basin Development Office, the Rift-valley Lake Basin Development Office, and the Ethiopian Water Technology Institute. In addition, two HE level Professional training courses were conducted in February 2020, with participants being staff and MSc and PhD students from the Addis Ababa Institute of Technology (AAiT), the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), and the EIWR, the Ethiopian Irrigation Development Commission, Basins Development Authority and Basins Development Offices.

Pathways to impact: By specifically designing a consultative workshop and validation workshop into the ACEWATER II project which includes a wide range of key stakeholders, a pathway to impact was created and is also true of the ACD activities in Ethiopia. Given the wide range of participants in the consultative workshops and specific dissemination activities designed as part of the ACEWATER II project, it can be anticipated that the uptake of pilot courses will increase. At an institutional level, the synchronized and link of pilot courses to existing training courses at the EIWR will increase the sustainability of the pilot training programs whereby training is not dependent solely on the resources from the ACEWATER II project and could be presented beyond the project. By further playing a leading role in identifying water sector HCD needs, a pathway to impact at an institutional level is created at the Ethiopian Institute of Water Resources (EIWR) at Addis Ababa University which would result in building the reputation of the institution as a water sector skills provider in Ethiopia.

Impact: As in the case of other countries in the ACEWATER II project, the pilot courses will contribute towards knowledge production in the water sector and increase the reputation of the Ethiopian Institute of Water Resources (EIWR) at Addis Ababa University as a skills producer in Ethiopia. To further increase the potential for policy uptake, the National Human Capacity Development Framework prepared for Ethiopia has been disseminated to various main partners and stakeholders which include relevant government bodies, other higher education and research institutions, international implementing partners in the Ethiopian water sector, and private industry in the Ethiopian water sector.

3.3.6 Uganda

In Uganda, the Makerere University has a long-standing and very productive relationship with the Ugandan Ministry of Water, and in partnership with various stakeholders from the

sector were engaged to identify priority areas for capacity development. Key to the HCD activities in Uganda is the relationship between Makerere University and the Ugandan Ministry of Water which played an instrumental role in reviewing and finalizing the pilot courses designed to address the water sector HCD priorities, the selection of participants, and the procurement of training consultants. The priority areas are 1) The preparation of bankable project proposals, 2) Negotiation and Water Diplomacy, 3) Borehole Drilling and Pump testing Supervision and 4) the Design, Construction and Operation & Maintenance of Solar Water Pumping Systems.

Pathways to impact: the Long-standing relationship between the Makerere University and the Ugandan Ministry of Water, creates a pathway to impact and is a typical example of additionality where other activities have contributed towards the impact in the ACEWATER project (also refer to section 2.2.1.1 for a description on additionality). Moreover, by further playing a leading role in identifying water sector HCD needs in Uganda along with the Ugandan Ministry of Water, a pathway to impact at an institutional level is created at Makerere University which would result in building the reputation of the institution as a water sector skills provider in Uganda.

Impact: It is evident that the training courses have contributed towards knowledge production in the Uganda water sector and, with the close partnership between the Makerere University and the Ugandan Ministry of Water, support for the HCD Framework pilot courses could result in further uptake of the pilot courses. By further playing a leading role in identifying water sector HCD needs in Uganda, a pathway to impact at an institutional level is created whereby the reputation of the Makerere University is developed as a water sector skills provider in Uganda.

In addition, the close partnership between the education and government institutions ensured that relevant pilot courses were developed that address more closely the needs of the Ugandan water sector, and it is anticipated that this would increase the eventual impact of the pilot courses.

3.3.7 Botswana

In Botswana, a National Human Resource Development (HRD) Strategy exists, however, the Strategy is not specific to the water sector and does not address junior professionals and technical level actors. Through a national consultation dialogue, other shortcomings were identified in the HRD Strategy, including inadequate policy and legal instruments, inadequate water-related courses offered for TVET and the limited involvement of youth in strategy development. In order to make a niche contribution, the HCD gaps and needs

specific to the water sector, and in particular, for Junior Professionals and Technical level actors, was addressed through a sector-wide analysis. The Botswana Human Resources Development Council (HRDC) was targeted to address the ACEWATER HCD inputs, given their mandate for policy advice on all matters of national human resource development, and to coordinate and promote the implementation of the National HRD Strategy. As part of the national assessment, key institutions were identified as stakeholders for collaboration and consultation in drafting proposals for water sector HCD needs and priorities to present to the HRDC. The institutions include the Botswana Qualifications Authority (BQA), Department of Water and Sanitation, Water Utilities Corporation, Tertiary institutions and Technical Colleges. These institutions were consulted in a validation workshop.

From the scoping study and through the stakeholder engagement, certain priory needs were identified. In Botswana, training in isotope hydrology and integrated groundwater-surface water hydrology is a priority for young professionals, with training needs in borehole drilling and well maintenance and groundwater monitoring and analysis priorities for at a TVET level. As a result of the sector-wide assessment, pilot courses have been developed to address the needs of the Botswana water sector at both a professional and technical level. For professional training, two courses in advanced hydrology and training in water resource management were identified. The technical level training, a further two courses in applied and field hydrology for practitioners and principles of hydrology for technicians were identified.

Pathways to impact: By strategically and specifically targeting the Botswana Human Resources Development Council as a relevant governmental body to drive the ACEWATER HCD contributions through, a pathway to impact is created which could support potential impact in future. The leading role of the University of Botswana in identifying water sector HCD needs in Botswana would further create a pathway to impact at an institutional level in that reputation of the Botswana University is nurtured as an institution for knowledge production and skills development in Botswana.

Impact: In terms of impact, these courses have contributed to knowledge production in the Botswana water sector, since the pilot courses were designed based on national needs. As indicated, the University of Botswana's reputation as a knowledge producer and skills developer in the sector is further increased through HCD activities in the ACEWATER II project. Given the contribution of the University of Botswana and stakeholders into the HRDC, policy impact is to be anticipated. Due to the Covid-19 pandemic, physical training could not be undertaken, with online teaching and learning planned.

3.3.8 Mozambique

In Mozambique, the process of developing a National water sector HCD Framework was mainly initiated by the Ministry of Science and Technology as this is required by national directives. As part of the ACEWATER II project, IWEGA at Universidade Eduardo Mondlane undertook the desk-top study in investigating the *status quo* of HCD activities in the Mozambican water sector, and further supporting the Ministry of Science and Technology in the process to identify sector skills needs and undertake consultative workshops while focussing on Southern and Northern Mozambique.

From the national assessment, it became evident that priority areas for young professionals are in water quality management, water economics, and governance and integrated water resources management. In addition, skills development needs were identified in the monitoring and evaluation of water quality and design and assembly of different water supply systems at a TVET level. This resulted in two courses identified a graduate training and are 1) Management and maintenance of networks and water losses and 2) Community education. For technical training, two courses were identified namely 1) Environmental Impact Assessment and 2) Water quality assessment.

Pathways to impact: As indicated above, the main role player in identifying HCD needs in Mozambique was the Ministry of Science and Technology, with IWEGA at Universidade Eduardo Mondlane being in support of the process. This is important in terms of creating a pathway to impact since ownership of ACEWATER HCD Strategy contributions lies with the National ministry, which will contribute to the longer-term uptake of contributions. Through the close involvement of IWEGA in the process, a pathway to impact at an institutional level is also created whereby the institutional reputation as knowledge producer and skill developer in the Mozambican water sector.

Impact: The training programmes have an impact on knowledge production at the Universidade Eduardo Mondlane and the Mozambican water sector, especially if the pilot courses are presented in future. In addition, the institutional reputation of the Universidade Eduardo Mondlane as a knowledge producer and skills developer in the Mozambican water sector is increased through the supporting role of the ministry in identifying HCD skills gaps in the country. It is anticipated that the leading role of the Ministry of Science and Technology would increase the potential for policy interventions, however, given the timing of this impact study directly, it is too early to find direct evidence of such policy interventions, with future monitoring required to report on such.

3.3.9 Malawi

The sector-wide assessment undertaken by the University of Malawi confirmed that water sector skills gaps are in-line with current HCD needs identified by the Malawi Government, with capacity gaps mainly for water engineers, water law and policy experts, in communication skills, project management, data managers, social scientists, surveyors, extension workers and water researchers. Through consultative meetings with Government Ministries, Water Boards and NGOs, two courses were proposed to address professional level training namely 1) Water quality modelling and 2) Hydrological modelling. In addition, two courses were identified aimed at technical level training, namely 1) Water supply and 2) Water and sanitation technology. These courses would address training in the principles of hydrology, hydrological modelling, and water supply was identified as priority areas for young professionals, and a certificate program for water technicians and an apprentice diploma for water technicians were identified as a priority at a TVET level.

Pathways to impact: In creating pathways to impact, the *purposeful* consultative workshop and validation workshop with Government Ministries, Water Boards and NGOs would increase the potential for impact in future, since the sector skills needs were valorised through the activities. Moreover, the leading role of the University of Malawi took to confirm water sector HCD needs in Malawi would further create a pathway to impact at an institutional level in that reputation of the University of Malawi is strengthened as an institution for knowledge production and skills development in Malawi.

Impact: As in other cases, the pilot courses will have an impact on knowledge production in the Malawian water sector and, given the process whereby key stakeholders were consulted in the ACEWATER II project, the reputation of the University of Malawi as a knowledge producer and skills developer in the Malawian water sector is further strengthened. Moreover, given the consultative workshops with key stakeholders in Government Ministries and Water Boards policy interventions could be anticipated. However, given the timing of this impact study directly, it is too early to identify direct evidence of such policy interventions at this stage.

3.3.10 Zambia

In Zambia, the national assessment of the water sector identified the need to establish an activation of the water trust to finance capacity development at the different educational levels. Short term courses presented over a few days or a few weeks depending on the content, were regarded as an immediate intervention that would support changes in the

mandate of the Zambia Ministry of Water. In addition, a need was identified to develop a training plan as a document to direct potential funders and uphold priorities for capacity enhancement and a need to explore mechanisms in which prior learning would be recognized as a formal qualification for example drillers. The consultative process further highlighted a need for internships which should be supported to allow graduates to acquire some industrial experience was also a priority. The national dialogue was supported by various role-players such as the Ministry of Water Development, Sanitation and Environmental Protection, the National Resources Development College (NRDC or NORTEC) and representatives from TVET colleagues and other Higher Education institutions. To address skills gaps, a course in Water resources monitoring and a course in Environmental quality modelling were identified to address the needs of young professionals. To address technical needs, a course in Field hydrogeology and a course in Drilling methods and training related to well completion were identified.

Pathways to impact: The purposeful participation of key stakeholders in the Zambian water creates a pathway for impact whereby legitimacy for the activity within the ACEWATER project is created. Moreover, the leading role of the University of Zambia played in identifying water sector HCD needs in Zambia would further create a pathway to impact at an institutional level in that reputation of the University of Zambia is strengthened as an institution for knowledge production and skills development in Zambia.

Impact: In terms of impact, the training courses will contribute towards knowledge production in the Zambian water sector. In addition, during the national dialogue workshop, various key role-players were identified to address specific human capacity development activities in the Zambia water sector. This mapping of role-players will contribute towards decision-making and could have an impact in guiding policy interventions in future. As indicated earlier, the leading role the University of Zambia played in the sector-wide assessment to identify water sector HCD needs further adds to the reputation of the University of Zambia as a leading skills developer in the country.

3.3.11 South Africa

In South Africa, various initiatives are currently underway to address HCD needs in the national water sector, with the FETWater program one of the major initiatives, being implemented by the National Department of Water and Sanitation (refer to http://fetwater.co.za/ for more detail). The FETWater program objective is to ‘Develop a competent person’, and follows an occupational-oriented approach where the traditional academic training is encouraged to match the occupational training to ensure that the knowledge, practical skills, and work-based modules are aligned and a competent person

is produced who will be relevant to the prevailing and upcoming market to do the actual work.

In addition, South Africa has a new Water and Sanitation Master Plan (2018), addressing various HCD needs and related programs. There are also numerous capacity building institutions, water utilities, and government department which offer a variety of HCD initiatives. There is, however, a need for a Monitoring, Evaluation, and Reporting (MER) Framework for the different initiatives at a national level, which was confirmed during a validation workshop with various stakeholders in September 2019. During the National Validation Workshop, key stakeholders agreed that an MER Framework should be developed, and inputs were given on the elements, indicators, usefulness, ownership, and funding of the proposed MER plan. It was further agreed that the MER framework should be commissioned, supported and owned, by the Department of Water and Sanitation (DWS) as the sector leader while the Department of Higher Education and Training (DHET), through Sector Education and Training Authority (SETA) - such as Energy and Water and Local Government SETAs should co-fund the process.

Pathways to impact: The consultative workshop and validation workshop created a pathway to impact whereby buy-in from stakeholders for the ACEWATER activity was established. In further strengthening a pathway to impact, it was proposed that the AUDA-NEPAD SANWATCE Secretariat through the centres of excellence (the South Africa Council for Scientific and Industrial Research, Stellenbosch University (SU), the University of Kwa-Zulu Natal (UKZN) and the University of the Western Cape (UWC) act as researchers during the process, thus identifying the specific role of AUDA-NEPAD SANWATCE member institutions. The activity would further create a pathway to impact and contribute towards the reputation of the AUDA-NEPAD CoE secretariat and CoEs as important role-players for capacity and skills development in the South African Water sector.

Impact: By involving key stakeholders in the process, ownership of the MER Framework has been established with the policy-making environment, and specifically in the South African Department of Water and Sanitation. This participation and ownership of the process at a policy-making level will increase the adoption of an MER Framework and was facilitated through the interventions of members in the AUDA-NEPAD SANWATCE. As indicated, the leading role CoEs played in interacting with key role-players in the South African Water sector, further increases the reputation of the AUDA-NEPAD Water CoEs as capacity and skills development institutions in the country.

4. Conclusions and recommendations

In considering the impact of the HCD activities in the ACEWATER II project, it is worth noting that the member institutions in the AUDA-NEPAD networks of Water CoEs are universities and research institutions, and at the core of their mandates are capacity development and research. The question can be asked 'for what purpose or for whose benefit?', and at the heart of this answer lies society: universities and research institutions who undertake research and capacity development in the service to society. While the primary objectives of universities may not necessarily influence policy, knowledge production, capacity development and being a driver of innovation, influences decision-making and results in the uptake of knowledge products which in turn lead to benefits to society, the economy and the ecological environment.

4.1 Impacts and pathways to impact

In essence, the primary objective of the HCD activities in the ACEWATER II project was to identify water sector skills needs and to further contribute towards the National water sector HCD Frameworks, through pilot training courses. These HCD activities in the ACEWATER II project were not done in isolation and was benefited by activities such as the long standing Joint Learning activities and Cooperation with Continental and Regional agencies.

From the case studies related to Joint Learning and Cooperation with Continental and Regional agencies, the continuous involvement of all members of the AUDA-NEPAD Networks of Water CoEs in project activities and the governance of the networks, translate into the **continuous learning** whereby best-practices are shared and which impact on the general knowledge production amongst AUDA-NEPAD Water CoEs. Moreover, the cooperation with continental and regional agencies since the inception of the ACEWATER project in the mid-2000s, further contribute towards the participation of key stakeholders in consultative-, validation and regional workshops of the HCD component of the ACEWATER II project. This participation impacted positively on the **eventual valorisation** of the pilot courses.

The continuous support of the ACEWATER Project of AUDA-NEPAD Networks of Water CoEs in continental and regional bodies and River Basin Authorities have further resulted in regular **water-related dialogues** on continental, regional and national water issues. Examples included the participation of network members in the annual WaterNet/WARFSA/GWP-SA Symposium in Southern Africa and the involvement of the Université Cheikh Anta Diop de Dakar (UCAD) as the secretariat of the AUDA-NEPAD WANWATCE, participating in the Priority Pilot Groups and Priority Action Groups related to Water Security, Sanitation and Cooperation of the 2021 World Water Forum. The participation of AUDA-NEPAD Water CoEs

in such dialogues have strengthened the **reputation** of the network members as water-sector knowledge and skills providers at continental, regional at respective national levels.

Laying the foundation for future capacity development, the activities in the ACEWATER project supported formal **Memoranda of Understanding** concluded between the various organisations. In the case of West-Africa, an MoU exists between ECOWAS and members of the AUDA-NEPAD WANWATCE. In Southern Africa, the AUDA-NEPAD SANWACTE secretariat has MoUs with key regional role-players such as the Southern African Development Community (SADC) Water Desk, WaterNet, the SADC Groundwater Management Institute (SADC-GMI) and the Zambezi Watercourse Commission (ZAMCOM).

The participation of AUDA-NEPAD Water CoE secretariats at continental and regional decision-making platforms such as AMCOW and SADC have contributed towards **policy formulation**, as evident by the declarations related to skills development taken by AMCOW in 2013 and 2018/2019 and the decision taken by the SADC minister of Water to support AUDA-NEPAD SANWATCE activities taken in 2013, and the regular formal noting and support for activities by the SADC ministers of Science and Innovation. Such support **impact on the valorising of activities** in the AUDA-NEPAD CoEs and **contribute to the reputation** of the CoEs as institutes of research and capacity development in the respective countries and regions. These ministerial decisions and formal noting of activities by ministers, contributed to a **pathway to impact** in the HCD activities of the ACEWATER project, as it provided a broader framework and added legitimacy to activities, which had a positive impact on stakeholder participation and valorisation of pilot courses.

In all cases addressing skills development in the HCD component of the ACEWATER II project, the pilot training courses contributed towards **knowledge production** at an institutional level with government and can the universities in the AUDA-NEPAD Networks of Water CoEs consider the pilot training courses as an **asset to be used in future training**. In some countries, such as Sudan and Ethiopia, initial pilot courses were presented, but due to the Covid-19 pandemic, the usual face-to-face training could not be undertaken in the other AUDA-NEPAD Water CoEs, which resulted in a re-alignment of activities towards online teaching and training. The impact this realignment of training will have is beyond this reporting period and should be monitored in order to identify the impact on various dimensions.

The stakeholder engagement activities such as the consultative-, validation and regional stakeholder workshops *purposefully* involved key stakeholders from the regional and national government, private industry, society and NGOs – this a clear example of “productive interactions” [6], *specifically designed* into the project. At the very least, these workshops had the **benefit of bringing** a broad range of stakeholders in the national water sectors together, which resulted in a broader and more representative contribution to the national discourse,

and again contributed towards **knowledge production**. By taking a leading role in organising the workshops, the **reputation** of AUDA-NEPAD Water CoEs as water sector knowledge and skills developers was further strengthened. In the case of SANWATCE where regional stakeholders from WaterNet and SADC Water Desk were present in regional meetings, the role of SANWATCE as a regional knowledge and skills developer were strengthened.

Further evidence can be found where HCD activities in the ACEWATER II project actually contributed to **policy interventions** where, for example in Nigeria, the HCD activities in the ACEWATER II project contributed to policy interventions and stimulated the Nigerian National Technical Committee on Water Resources to request and approve mandatory courses for the local water sector. In addition, Nigerian government agencies were directed to sponsor their staff for further training especially at the NWRI. In Mozambique, the Ministry of Science and Technology actively took ownership of the HCD process initiated by IWEGA at Universidade Eduardo Mondlane to identify skills needs for the water sector, and which resulted in key proposals to skills development in the country. These are some examples of evidence of policy interventions and impacts.

Since academics are not always primarily involved in driving policy-making processes, some academics in the SANWATCE confirmed during the consultations in the regional meeting that they initially felt ‘out of their comfort zones’ while engaging with policy-makers on the HCE sector-wide assessment. However, it was found that the activity had a positive impact in that through the processes, **individual and organisations growth took place**, especially when the outputs were valorised, and academics experienced that their inputs were accepted.

The coordination of activities in the ACEWATER project has further **strengthened the capacity of personnel at the secretariats** of the WANWATCE and SANWATCE, and further indirectly lead to the promotion of the programme manager at WANWATCE.

In all activities, the specific (and budgeted for) activity in the ACEWATER II project to organise in-country consultation and validation workshops and the series of regional stakeholder workshops created **pathways to impact** and contributed to building wider ownership of the process with and within key-stakeholder institutions such as ministries and relevant government institutions, and the Centres of Excellence. Concerning the element of additionality, relationships with key-stakeholders were developed over time, which contributes towards the success of the activity. However, the ACEWATER II project leveraged these relationships to new levels during the validation- and regional workshops, thus having a beneficial impact on the role the AUDA-NEPAD Water CoEs have to play in research and capacity development.

4.2 Recommendations

Based on the results of this study, the following section presents both general recommendations and specific recommendations.

General recommendations

- Even though it can be regarded as standard practice, the case related to Joint Learning confirmed that during the *development stages* of a project proposal, even before the project is commissioned, key stakeholders need to be engaged in designing activities, should there be a need for their eventual support. This does require time and effort, but as demonstrated by the AUDA-NEPAD Water CoEs, such engagement can be built over time, and existing relationships can be leveraged to provide input into project development.
- Moreover, in designing a project, *specific and significant budgets* need to be allocated to enable consultative workshops such as the consultative-, validation and regional workshops of the ACEWATER II project. This study confirms the value of well-designed workshops that span multiple days that should not be underestimated as they need to provide ample inputs for researchers, key stakeholders and decision-makers to make presentations, deliberate and provide input into eventual deliverables.
- Even if key stakeholders were not involved in the early design stages of the project proposal, activities such as workshops and validation workshops need to be undertaken during the *research process* itself, where key stakeholders could contribute, as it will contribute towards the uptake of the outputs – in this case, the pilot courses.
- Where decision-maker support is required in a project, this study confirms that specific *validation workshops* add value to a project. Such ownership of decision-makers in the validation workshops significantly contribute to the support of deliverables.
- The *timing* of the sector-wide impact assessment is important. As proposed by the IOM Tools in the PayBackPLUS Framework, initial actions related to impact assessments should preferably be undertaken as early as the project design stages of a project. Although broad impacts were described in the proposal of the ACEWATER II project by the EC-JRC in their submission to the EC, detailed impact indicators and assessment criteria were not necessarily designed that target project outcomes and should be undertaken in future projects.
- In future projects, Impact Assessments should be designed in such a way that they support and feed into and benefit from results of a Monitoring & Evaluation (M&E) activity, from the outset of the project. The symbiosis should be established where the

M&E activity identifies project outputs, and the Impact Assessment activities would focus on project outcome and impact pathways.

This impact assessment specific recommendations:

- To measure longer-term impacts of this support which will materialise over time, it is recommended that the participation in courses are monitored, evaluated and analysed over the longer term. This must include continuous monitoring of outputs and pathways to impact and reported benefits.
- This impact assessment focused on the HCD activities of the ACEWATER II project which were undertaken between 2016 and 2020. There is evidence in this study that the impacts that were realised in this project could not have been realised in isolation from the other project's science and research-oriented activities, and that, for example, research and capacity development activities from ACEWATER I (2009 to 2015) and possibly other projects in WASSCAL, SASSCAL and the Pan African University contributed towards impacts. The evidence of such additionality of such activities should be investigated to capture a wider range of impacts of the ACEWATER project.
- The impact of the implementation of the pilot courses is being affected by the re-design of the HCD activities in the ACEWATER II project towards online teaching and learning, due to the impact of the Covid-19 pandemic in early 2020. An initiation of an impact assessment in the early stages of this re-alignment of activities, can assist greatly in potential pathways to impacts being identified and monitored early in the activity, and provide a more comprehensive view of the impact as the activity evolves over time.

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Annexure A: Associated stages of research impact and data collection techniques of the PaybackPLUS Framework dimensions

Impact Sphere	Category/Dimension	Operational Definition	Associated stage as per logic model (Figure 3)	Data collection and analysis techniques
1. Science impact	1.1 Knowledge and development of ecological-related products and techniques.	• Peer-reviewed journal articles. • Conference presentations, books, book chapters, research reports. • Computer software. • Development of theoretical frameworks, hydrological- and climate change models.	• Primary outputs - stage 3	• Bibliometric methods (citation analysis) • Interviews with researchers • Analysis of patents, licenses, etc.
	1.2 Benefits to future research and research use.	• Better targeting of future research. • Development of research skills, personal and overall research capacity. • A critical capacity to absorb and utilise appropriately existing research including that from overseas. • Staff development and educational benefits. • The impact research has had on the leverage of future research and funding.	• Primary outputs – stage 3	• Documentary review including an analysis of personal CVs. • Personal interviews. • Analysis of student statistics. • Analysis of funding statistics.
2. Policy impact	2.1 Benefits from informing policy. 2.2 Benefits to informing protocols, training material and guidelines	• Improved information bases (as developed as knowledge products) for political and executive decisions. • Development of teaching and training material, training material and guidelines	• Secondary outputs – stage 4	• Review of national; regional and local regulations. • Review of existing policies, Acts, Laws or Regulations to assess to what degree informed decision-making has occurred. • Document review and interviews. •
3. Economic impact	3.4 Broader economic benefits.	• Benefits from commercial exploitation of innovations arising from R&D. • Economic benefits through an increase in crop production, more efficient water delivery influenced by better water management, • Economic benefits of a healthier population resulting from more effective provision of WASH and Ecosystem services	• Final outcomes – stage 6	• Surveys • Personal interviews. • Selected case studies. For this dimension, statistics would also be important.

Impact Sphere	Category/Dimension	Operational Definition	Associated stage as per logic model (Figure 3)	Data collection and analysis techniques
4. **Ecological impact**	4.1 Impact on the ecological environment	• Effects on the ecological environment. • Return of the ecological balance after an event such as a disaster (flood, periodic drought etc.) • Improvements in the quality and quantity of water in an ecosystem. • Increase to the numbers of indigenous fauna and flora within an ecological area. • Benefits derived from Ecosystem Services (ESS).	• Final outcomes – stage 6	• Data from measurements related to the health of an ecosystem such as improved water quality and water quantity. • The number of species of fauna and flora and further counts of fauna and flora in an area. • Use of Common International Classification of Ecosystem Services (CICES) as available from http://cices.eu to identify indicators for Eco-System Services (ESS) • Personal interviews • Selected ecological-related case studies
5. **Social impact**	5.1 Socio-political impacts 5.2 Socio-economic impacts 5.3 Socio-ecological impacts 5.4 Socio-hydrological impact (Refer to the section on social impacts in the Logic Framework above for detail	• Increased public and Private sector participation in environmental management; • Improved health as a result of improved water quality • Equitable access to reliable water supply and sanitation • A decrease in water pollution where communities rely on such water sources • Cost savings to society through sustainable development • A better response of society in the case of floods and flood warning systems	• Final outcomes – stage 6	• Identification of actors involved in water resource management • Forums and arenas for discourse on water resource management • Measure or review of Level of service • Review and analysis of User complaints • Compliance with quality standards • Level of awareness of water health • Review or study of existing Training and knowledge building initiatives • Analysis of Decrease (or why not increase also?) in the loss/improvement of crops, and human and

Impact Sphere	Category/Dimension	Operational Definition	Associated stage as per logic model (Figure 3)	Data collection and analysis techniques
				animal life in the case of floods • Selected case studies. • Relevant statistics data can be collected and analysed

Annexure B: Template for Case study

Network:	
Impact Dimension	Science / Policy / Economic / Ecological / Social
Brief description of the impact:	
Project Name	
Deliverable/Output:	
The following stakeholders were involved	
Full description of the impact	
Evidence of the impact (MoUs, Comms…)	
Pathways to impact (e.g. via the workshops?)	
Factors which supported or hindered the impact	