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AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation

Final report

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AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation

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List of Abbreviations

ACDI	Africa Climate Development Initiative
ACE	African Centre of Excellence
ACE MITIC	African Centre of Excellence in Mathematics and ICT
AIMS MS4CR	Africa Institute for Mathematical Sciences
AIMS NEI	Africa Institute of Mathematical Sciences Next Einstein Initiative
ARUA	African Research Universities Alliance
AUC	African Union Commission
CC	Climate Change
COVID	Coronavirus disease 2019
EE	External Evaluation
EU	European Union
FCDO	Foreign, Commonwealth & Development Office
GAC	Global Affairs Canada
GIS	Geographical Information System
HEI	Higher Learning Institutions
ICCA	The Institute for Climate Change and Adaptation at the University of Nairobi
ICT	Information and communications technology
IDRC	The International Development Research Centre
IPCC	The Intergovernmental Panel on Climate Change
MEL	Monitoring, Evaluation and Learning
MTE	Mid-Term-Evaluation
NGO	Non-governmental Organisation
OECD	Organisation for Economic Cooperation and Development (OECD)
SASSCAL	The Southern African Science Service Centre for Climate Change and Adaptive Land Management
SGCI	Science Granting Councils Initiative (SGCI)
STEM	Science technology, engineering, and mathematics
STI	Science technology and innovation
STISA	AU Science, Technology, and Innovation Strategy for Africa 2024
ToC	Theory of Change
UNFCCC	The United Nations Framework Convention on Climate Change
WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use
WICCS	Women in Climate Change Sciences

Executive summary

Climate change presents a colossal challenge to the development of the African continent. The impact of extreme weather events has reverberated across various sectors, most notably agriculture, leading to diminished production and exacerbating the continent's food security concerns. Moreover, it has ignited climate-related conflicts in already fragile regions, further compounding the economic difficulties faced by Sub-Saharan Africa. Additionally, the repercussions of climate change have cast a shadow on sectors like healthcare, pushing them toward deterioration.

These consequences of climate change have transformed into a pressing developmental issue, as they jeopardize the achievement of sustainable development goals by 2030 and the ambitious Africa Union Agenda, 'Africa We Want Agenda 2063.' The limited action on climate change in Africa can be attributed to inadequate research and information, which hampers coherent interventions for climate resilience.

The African continent's ability to adapt to the impacts of climate change hinges on the development of suitable solutions tailored to the continent's unique needs, often referred to as 'African Solutions to African Problems.' Central to this approach is the production of African research that offers a deeper understanding of the climate change challenges facing the continent. A crucial first step in this endeavor is the training of African researchers. Historically, Africa has heavily relied on research conducted outside the continent by scholars with limited connections to its unique challenges.

In response to these gaps in information and capacity, various initiatives have emerged to enhance the research and technical capabilities of African scientists in the field of climate change. Notable among them is the Africa Institute of Mathematical Sciences (AIMS) MS4CR program, which employs mathematical science as a lens for increasing research and technical capacities.

The AIMS Mathematical Sciences for Climate Change Resilience (MS4CR) program, a CAD $20 million, 5-year initiative, is funded by Canada's International Development Research Centre (IDRC) and Global Affairs Canada (GAC) and implemented by the African Institute for Mathematical Sciences. AIMS, a pan-African network of centers of excellence, is dedicated to providing postgraduate education, conducting research, and engaging with the public to advance Science, Technology, Engineering, and Mathematics (STEM) fields in Africa.

The MS4CR program's objectives are twofold: firstly, to elevate the role of African mathematical scientists in addressing climate change challenges in Africa through training, internships, and research, and secondly, to bolster the consolidation of AIMS' operations across the continent by enhancing existing AIMS centers.

The program is structured around five pillars: the master's program, the internship program, the research program, the climate science fellowship for women, and the consolidation of the AIMS network.

Following six years of implementation, which included an extension due to program start delays, restructuring of activities, and a mid-term evaluation in 2020, IDRC has commissioned an end-of-program external evaluation (EE). This evaluation aims to assess the program's performance, including achieved results, key drivers, obstacles to success, gender equality aspects, the evolution of AIMS training, the program's alignment with regional development priorities, the African Union's Science, Technology, and Innovation Strategy for Africa, and the program's overall appropriateness in advancing higher education and research in mathematical sciences across the African continent.

The evaluation offers a set of recommendations designed to fortify postgraduate training and research programs in mathematics and climate science offered by AIMS and across Africa. The report also provides strategic guidance for AIMS as an organization, taking into account existing challenges and emerging opportunities. This guidance is informed by an extensive review of the relevant landscape and the AIMS 10-year Strategic Plan.

The content of this final EE report has been meticulously crafted through a comprehensive approach. This approach includes an in-depth analysis of relevant literature and program documentation, a series of 41 interviews with key stakeholders, including AIMS central management, AIMS centers, IDRC, GAC, university partners, and external stakeholders such as ministries and lecturers. Furthermore, it incorporates insights gathered from focus groups involving AIMS students and alumni, as well as data obtained through surveys of these groups. Additionally, the report features a bibliometric analysis of the research output, a comparative examination of three distinct African higher education research models, and insights gleaned from a collaborative learning workshop held on August 11, 2023, involving GAC, IDRC, and AIMS stakeholders.

Key findings

- The AIMS MS4CR program stands out as one of the rare initiatives offering training and research in mathematical sciences applied to climate change. The program's theory of change resonates with African priorities in higher education and research, although it cannot address all the diverse needs on the continent due to its scale and available resources. Nevertheless, the program has yielded significant results with the means at its disposal.

- Recognizing the interdisciplinary nature of climate change challenges, the MS4CR program complements other initiatives in the landscape, such as the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) and its Master Research Program on Informatics for Climate Change (MRP-INFORMCC) in Burkina Faso.

- AIMS' adaptability and student-centered pedagogical approach provide a substantial advantage over traditional university programs.

- The program has elevated the research capacities of African scientists in the fields of climate and mathematical sciences. It has also played a pivotal role in fostering gender diversity within climate research by actively involving female researchers.

- To date, the program has successfully educated over 200 young African scientists at the tertiary level, equipping them with the knowledge necessary to comprehend the intricacies of climate change challenges and enabling them to generate high-quality forecasts of climate change impacts. Additionally, it has made a notable contribution to the expansion of the pool of experienced African scientists involved in climate science research and publication, with a specific emphasis on promoting the inclusion of women. However, it's worth noting that while the program's impact has been significant, cohort sizes may not suffice to address the wide-ranging demands of diverse climate resilience areas.

- Program implementation initially faced challenges that caused delays in scheduled activities, but most activities were eventually executed as planned, with a specific extension for the PhD program to 2024 due to research program implementation delays. Key achievements are detailed in subsequent sections of this report.

- The program has heightened AIMS' visibility within the higher education and research landscape, leading to invitations for AIMS to participate in and contribute scientifically through its researchers to significant climate change discussions in Africa and globally.

- While AIMS alumni are progressing in careers related to climate sciences, the full extent of their contributions to African economic, political, and educational progress may become more evident in about five years. The short-term nature of the intervention makes it challenging to gauge continental-level impacts.
- The program's achievements during the COVID-19 pandemic are attributed to AIMS' adept program management, IDRC's responsiveness, and the growing recognition of climate change's importance by policymakers. Weaknesses include a heavy reliance on external funding, dependence on a few major donors, and a cost-intensive operating model combining a residential format for students with a centralized management system through a secretariat. AIMS is addressing financial challenges through a new network structure and strategic repositioning of its centers.

Conclusions

In conclusion, the AIMS MS4CR program aimed to increase the participation of African mathematicians in addressing climate change issues through training, research, and strengthening AIMS' centers. It achieved partial success by expanding access to postgraduate opportunities and streamlining operations, aligning well with African development priorities.

The program successfully equipped over 200 young African scientists to contribute to climate change solutions, although gender balance targets were often unmet. Cohort sizes may not create a noticeable regional impact, and there's tension between research breadth and critical mass.

Efficiency was satisfactory, but the residential model and centralized management structure drove costs. Sustainability has improved with a new strategic plan, but the decentralized model's advantages remain unclear. Challenges include the need for enhanced research coordination and alignment with stakeholder needs.

Approaches from ICCA, WASCAL, and ACDI can inform AIMS' functioning and impact, including specialized training programs, collaborative networks, transdisciplinary approaches, practical training, diverse funding sources, industry collaboration, adaptability, global network building, university leadership support, and clear strategic planning. These practices can enhance AIMS' effectiveness in addressing climate change and mathematical sciences in Africa.

Recommendations

Based on the conclusions drawn from the evaluation, the following recommendations have been developed regarding AIMS' renewed programming in postgraduate training and research in mathematics and climate science in Africa, as well as organizational improvements specific to AIMS:

Recommendation 1: Explore opportunities for expanding Master's and Research Master's Programs in Climate Science with a continental impact.

Recommendation 2: Boost AIMS' visibility and strengthen partnerships on Climate Science

Recommendation 3: Focus AIMS research on local needs in specific research domains in Climate Science

Recommendation 4. Strengthen the Integration of education and research with Industry for enhanced climate resilience

Recommendation 5. Harness the results and lessons learned from MS4CR to enhance its impact and inform programming in this area

Recommendation 6. Advance financial sustainability and revenue diversification across AIMS centers

1   Introduction

This report presents the findings of the End-of Programme evaluation of the AIMS MS4CR. As per the agreement between IDRC/GAC and the AIMS Secretariat, this external evaluation (hereafter referred to as "the EE") was commissioned to inform future programming in the area of postgraduate training and research in mathematics and climate science in Africa and to provide recommendations for the **evolution of AIMS as an organisation.**

As such, the evaluation presents summative elements since past achievements were collected and assessed, as well as formative and forward-looking elements. The evaluation covers the full period of the programme implementation.

Overall, the evaluation aims to assess:

- How the programme has performed.
- How AIMS training has evolved.
- How the programme links to regional development priorities
- How appropriate the AIMS model is for advancing higher education and research in mathematical sciences on the African continent,
- Provide recommendations regarding **programming** in the area of postgraduate training and research in mathematics and climate science in Africa and for and **organizational matters specific to AIMS**.

This final report is based on data collected through a thorough analysis of the literature and documentation made available to the consultants, scoping interviews with IDRC/AIMS secretariat and selected interviews with stakeholders, a field visit in Kigali from 26th to 30th of June, focus group discussions and survey with AIMS students and Alumni and benchmark studies for three selected institutes in sub-Saharan Africa. Findings and recommendations were discussed and fine-tuned after a learning workshop with MS4CR stakeholders and additional investigations.

The report is set out in four sections as follows:

Following this introduction in chapter 1, chapter 2 presents the methodological approach to this end-of programme evaluation. In chapter 3, we present the findings of the evaluation in terms of an overall assessment of each of the evaluation criteria (Relevance, Effectiveness, Efficiency, Sustainability) and their related evaluation questions. Chapter 4 provides conclusions, as well as recommendations that address the main objectives, and are intended to provide input for a future programming in the realm of climate change and higher education and research in Africa and for AIMS as an organisation.

Finally, the overview of the contextual background regarding climate change in Higher Education in Africa, the general description of the MS4CR programme and supplementary materials are provided in appendix.

2 The external evaluation

2.1 Purpose and objectives

The evaluation is expected to provide rigorous information and insights on the impacts of the MS4CR programme. The evaluation aims to inform future programming in the area of postgraduate training and research in mathematics and climate science in Africa.

The evaluation examined:

- **How the programme has performed**, looking at achieved results, key drivers and obstacles to success, gender equality aspects of the programme.

- **How AIMS training has evolved**, including the introduction of a climate change resilience component to the mathematical content and pedagogy, and a greater focus on virtual teaching in the context of the COVID-19 pandemic, and the effects of these changes, for instance, by understanding the levels of skills gained by the students in mathematical sciences in nexus to climate change resilience and in addition, understanding the evolution of nature of support or change in format of programme activities during covid19 to further enhance recommendations for future actions.

- **How the programme links to regional development priorities as well as the African Union's Science, Technology and Innovation Strategy for Africa** (STISA-2024).

- Finally, **how appropriate the AIMS model is for advancing higher education and research in mathematical sciences on the African continent**, including application of mathematical sciences in climate change stream and notably identify its strengths and weaknesses and sustainability against comparable interventions in Africa.

In that sense, the evaluation is formative and forward looking. The prospective objectives of the evaluation are notably to:

- Make recommendations regarding **programming** in the area of postgraduate training and research in mathematics and climate science in Africa, namely in the context of capacity-strengthening, research for development, and climate action objectives.

- Make recommendations for the **evolution of AIMS as an organization**, based on key challenges and opportunities identified, a scan of the relevant landscape, and the AIMS 10-year Strategic Plan.

2.2 Evaluation approach

Our approach to conduct this evaluation is presented in the sections below. The methodology considered the needs of the users of the evaluation to inform key choices and prioritisation.

2.2.1 Prioritising a collaborative and utilisation-focused approach.

The core of the utilisation-focused approach revolves around asking two key questions at the beginning of the evaluation. Firstly, who is going to use the evaluation? And secondly, what needs to be done to make the evaluation as useful for them as possible?[1,2] This approach presents requirements that must be considered in the design of the evaluation[3]. With these

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[1] Michael Patton (2013) *Utilisation-Focused Evaluation Checklist* accessed on 28.1.22 from https://wmich.edu/sites/default/files/attachments/u350/2014/UFE_checklist_2013.pdf

[2] INTRAC (2017) *Utilisation-Focused Evaluation* accessed on 28.1.22 from https://www.intrac.org/wpcms/wp-content/uploads/2017/01/Utilisation-focused-evaluation.pdf

[3] Ibid

requirements in mind, we have ensured that the principles of participation, learning, and adopting a practical mind-set are embedded in our methodology: indeed stakeholders were consulted at early stage to refine expectations and design the evaluation framework (inception); then to provide their views on the programme relevance and performance (data collection); some were engaged during workshops to validate findings and prepare recommendations (virtual); and finally they shall be exposed to conclusions and recommendations for fine tuning and adoption (finalisation at institutional and programme level). Additionally, we ensure to present analysis, interpretation, judgement, and recommendations in a way that users participate actively, can comment and appropriate, but also to allow dissemination of significant findings to expand influence. We ensure that results and recommendations from the evaluation are practical, operational, and grounded in the reality of MS4CR's objectives and activities to facilitate their take-up.

2.2.2 *A theory-based evaluation relying on a contribution analysis.*

Contribution analyses provide a rigorous approach to assess the effectiveness and impacts of an intervention. This approach is appropriate for a formative evaluation, since it focuses on measuring the outcomes of an intervention, in addition to assessment of the process through which the intervention has produced its effects and tests the assumptions that underpin its design. A "**theory of change**" developed during the MTE (see appendix B 4) to explain the MS4CR intervention logic and conduct necessary analyses. We ensured that it allowed us to draw out the expected outcomes and impacts at the programmatic and institutional/government level, alongside the relevant assumptions to be tested in the draft final report.

2.2.3 *Capitalising on existing data & evidence and noting that most of the evaluation questions is of qualitative nature.*

The **MS4CR programme already had various sets of data**, gathered from multiple sources (e.g., existing evaluations, annual surveys to students, ongoing bibliometrics activities, database etc.), and data collected in a Monitoring Evaluation and Learning (MEL) framework. The EE has built on this and complemented it with interviews and surveys data.

2.2.4 *Addressing the mainstreaming of gender equality and inclusivity.*

Gender equality and inclusivity, is a transversal theme in this evaluation and we took an approach of collecting data throughout the evaluation, guided by specific criteria and questions we have devised to look at these issues throughout a programme cycle (as we have done for the evaluation of the Science Granting Councils Initiative/IDRC[4]).

2.3   Evaluation framework

The evaluation framework focused on the OECD-DAC evaluation criteria of **relevance, efficiency, effectiveness, and sustainability.** To assess MS4CR against these criteria, we tested the hypotheses and assumptions that underpin its theory of change to assess their validity in view of the results achieved in this Final Report.

The questions intended to inform lesson learning and recommendations are gathered in the last section of the framework. This evaluation framework was reviewed and refined during the inception phase, based on the initial review of documentation, engagement with stakeholders

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[4] https://idl-bnc-idrc.dspacedirect.org/handle/10625/61785

and data available from the MEL system. Additions to the initial questions in ToR are marked **in green**.

Table 1 Evaluation matrix

Evaluation criteria	Evaluation questions and sub-questions	indicators	Tools
Relevance	Q1. To what extent was the MS4CR programme relevant to the development priorities of Africa, specifically in terms of higher education and research in climate science?	• Evidence of alignment to Africa's climate development priorities in climate space • Research output use/collaborations created with government and role of centres in climate resilience development. • New partnerships formed/focus and priority alignment to institutional needs/research needs. • Number of/New skills/human capital developed in climate resilience and relevance of expertise in climate sciences	• Desk analysis of Africa's needs and strategies related to climate change. • Analysis of the intervention logic itself • Interviews with internal and external stakeholders
	Q2. To what extent did the programme contribute to regional development objectives and a regional science, technology and innovation agenda? **Notably in increasing the contribution of African mathematical scientists/researchers (men and women) in finding solutions to CC challenges?**	• Evidence of regional collaboration between researchers/institutions • Nature and geographic coverage of the project including research and AIMs scholars • Number of research outputs/targets and use/citations/conference presentations/feed into policy briefs	• Desk analysis of researchers and alumni contributions to the field (academic, private sector, research) • Interviews with internal and external stakeholders • Data analysis
	Q3. To what extent was the programme able to adapt and respond appropriately to emerging challenges, needs and priorities of beneficiaries **(students, private sector, public sector, research sector)?**	• No of consultations done with the beneficiaries/institutions • Evidence of stakeholder engagement • Evidence entailing records of challenges and actions taken to address them • Evidence of solutions and outcome in streamlining challenges	• Review of TOC • Interviews • Focused group discussion • Desk review
	Q4. Does the AIMS model respond to gaps in higher education and research in mathematical science?	• Evidence of existing research gaps in the centres/institutions/state of climate research in pre-AIMs intervention • Evidence of no of researchers/students before AIMs and post AIMS interventions • No. Of research output in climate science/resilience in pre and post AIMS. • Gender approach adopted in the programme	• Review of TOC • Data analysis • Interviews • Benchmarks
	Q5. Does the AIMS pedagogical approach provide a significant advantage with respect to traditional university programmes, namely in terms of, inter alia,	• Evidence of the adoption of pedagogical approach in target institutions • Comparative performance of AIMs students/researchers to traditional research programmes	• Interviews • Stakeholder engagement • Data analysis • Benchmarks

Evaluation criteria	Evaluation questions and sub-questions	indicators	Tools
AIMS	analytical rigour, critical thinking and leadership skills?	• Perception from AIMS students on learning outcomes. • Perception from faculty in other universities	• Bibliometric analysis
	Q.6 What are areas (e.g., related to climate science) where AIMS could potentially have an impact in the future?	• Evidence of areas that recorded high interest from students/researchers • Areas most researched/more partnerships developed, • Evidence of future changes in institutional/regional priorities in climate change space/most urgent climate issues in Africa/government priorities for research. • Evidence of existing gaps identified during programme implementation	• Interviews • Desk research • Stakeholder engagement
Effectiveness	Q7. Were programme activities delivered as planned? Were they rolled out successfully and as intended? What key factors influenced the achievement or non-achievement of the objectives of the MS4CR programme? How adequate were the M&E mechanisms in responding to challenges, opportunities, etc.?	• Evidence on project timeline/existing plan • Evidence of executed project activities achieved deliverables • Responses recorded for the programme call/no of grants/awardees/how many completed the programme? • Existence of M&E tools/was there established M&E team and coherence to the programme • Evidence/No of reporting sessions/channels provided by the programme • Perception from the management team	• Review of programme report • Stakeholder engagement • Review of M&E framework
	Q8. What impact did the programme have on its target beneficiaries? Is there any evidence that AIMS alumni will contribute to the further economic, political and educational advancement of the African continent?	• No of graduates/ACE centres, researchers. • No of research outputs • Lessons learnt/skills gained from internships • No of partnerships created during or after AIMS programme • Case studies of ACE alumni tracking, evidence on current activities in post AIMs programme • Perception from the stakeholders	• Surveys/Interviews • Case studies • Stakeholder engagement
	Q9. To what extent has the programme been able to provide postgraduate opportunities for AIMS Alumni? What could be done differently to enhance postgraduate opportunities?	• No of postgraduates from the programme • Evidence on continuation to post graduate studies after AIMs i.e. from internships/fellowships	• Focused dialogue • Interviews • Programme report analysis • Data analysis
Efficiency	Q10. Was the programme implemented in the most cost-efficient means possible?	• Budget variance; the actual and forecasted budget • Review of grants allocation procedures, timing, allocations, use and reporting.	• Project financial report/expenditure report/audit reports from the institutions/centres • Interviews

Evaluation criteria	Evaluation questions and sub-questions	indicators	Tools
	Q11. Did the use of funds for the MS4CR programme demonstrate value for money in terms of contributions to programme objectives and to the long-term sustainability of AIMS?	• No of research output/vs intended • No of beneficiaries/gender, youth inclusion in the programme • Evidence of partnerships created due to Aims programme • Evidence of alignment of the results to the initial programme objectives	• Document review, • Report screening and data analysis
	Q12. What are the strengths and weaknesses of the AIMS model, and does it enable cost-efficient, responsive, and timely programme delivery?	• SWOT analysis of AIMS model • Comparison points with other higher education and research models	• Document review • Interviews • Benchmarks
Sustainability	Q13. How and to what extent are AIMS students, alumni, donors, and governments promoting the sustainability of AIMS' activities after the end of the programme?	• Evidence of the partner institutions developing long term investments in the activities/pedagogy supported by AIMS • Evidence of students/Researchers graduating from the programme continuing to advance their work in climate resilience in Africa • Evidence of government/external party collaboration/initiative with the centers/or with researchers to advance climate resilience research in Africa	• Document review, • Interviews, • Focus discussion groups
	Q14. How and to what extent has the financial stability of AIMS been improved? How successful has AIMS been in securing funding? How diversified are the sources of funding secured by AIMS? How can the organization's financial stability (sustainability) be improved?	• Evidence from financial resource streams of the programme, • Evidence of additional financial sourcing streams by the centers/researchers or partner institutions. • Evidence of governance restructuring and external audits positive appraisals • Evidence of adequacy between the 5-year strategic plan, activities planned and financial commitments from donors	• Scoping programme documents • Interviews (donors, AIMS management)

2.4   Data collection strategy

The data collection phase consisted of a series of interviews with selected project stakeholders (37 interviews with programme stakeholders, one focus group discussion with MS4CR alumni); an online survey for students and alumni (112 respondents), and analysis of three (3) other higher education models in Africa related to climate change.

2.4.1   Desk review

An extensive documentation review was carried out during the evaluation period, and diverse documentation was consulted, including:

- Continental documents/strategies on mathematics, climate change and higher education.
- MS4CR programme documents (intervention logic, Performance Measurement Framework, implementation status and results reports, procurement plans, financial statements…).
- Previous evaluations (notably the MTE[5] which has been conducted by Technopolis).
- Auditing documents.
- The database of master's students, alumni, and other beneficiaries (research chairs and grantees, women fellows, interns).
- Other document provided during the interviews.

Full bibliography reviewed is in Appendix K. Background analysis is presented in Appendix A and AIMS MS4CR Theory of Change and outputs are presented in Appendix B.

2.4.2   Field visit to AIMS Rwanda/ AIMS Secretariat

The field visit to AIMS Rwanda and the Secretariat took place from 26 to 30 June 2023. The evaluation team leader committed to carry out in-depth consultation with key beneficiaries of the MS4CR Programme, key internal stakeholders at AIMS Rwanda and AIMS secretariat and external stakeholders. Notably, we conducted 15 interviews with AIMS executive Team, Senior Management, Academic Directors and relevant staff, AIMS MS4CR lecturers and tutors, AIMS Research Staff, AIMS MS4CR Research Chairs and grantees, 5 interviews with key partners of AIMS in Kigali, including employers of the interns funded by the programme and other private sector, government, education sector representative, and 1 focus group with AIMS master's students.

In total, 15 interviews and 1 focus group discussion were carried out during the mission to Kigali, some of them remotely, due to their absence from the country during the field mission. **The interview and focus group guides can be found in Appendix F and H respectively.** Details of the interviews conducted and the breakdown of the respondents by category are presented in Appendix G.

It should also be noted that the field mission coincided with major structural changes in the AIMS network and major events in central Rwanda, which limited the availability of relevant stakeholders for this evaluation. Indeed, we learned some time before our mission that the AIMS Secretariat had been dissolved and most of the people contacted to schedule interviews had already left Rwanda or were not necessarily available to answer questions related to their previous positions. Furthermore, we observed upon arrival that the graduation ceremony for

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[5] https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/55740/IDL-55740.pdf

the outgoing cohort of master graduates of AIMS Rwanda was scheduled for June 27th, which explained the lack of response from certain stakeholders of the centre level.

2.4.3   Interviews and focus groups (remote)

Several interviews and a focus group discussion were planned to be conducted remotely with the internal stakeholders across all 4 other AIMS centres administrating the programme, including centre management team, lecturers and tutors, interns, graduates, alumni, and the respective private sector, government, academia partners. Interviews were also planned with the IDRC and GAC as funding sponsor and other key informant stakeholders, not necessarily related to AIMS but with significant knowledge and invaluable experience in the realm of climate change and resilience and mathematical sciences. **The interview and focus group guides can be found in Appendix F and H respectively.** A total of 37 interviews were carried out with a wide range of stakeholders. The breakdown of respondents in each category is provided in **Appendix G**.

2.4.4   Survey of AIMS MS4CR students (current and alumni)

The evaluation aimed to assess and document the perceptions and experiences of the programme's direct beneficiaries. The purpose of the survey was to gain the input of the AIMS MS4CR students (current and alumni) on the effectiveness, impact, sustainability, recommendations as well as satisfaction on the master's level training programme and the Internship programme.

Survey questions were presented to the client after which the survey was programmed in our survey tool (Survey Monkey). **The survey questionnaire can be found in Appendix I.** The survey was launched on July 11th with the aim to gather information regarding the perceptions and experiences of MS4CR Programme direct beneficiaries, AIMS MS4CR student's alumni, interns, and research master students[6].

The survey remained accessible for about four weeks. After the first week, a reminder was sent to the target group. To increase the survey response rate, the survey link was circulated through the alumni network, AIMS Industry Initiative and the academic departments of the centres with which we interacted throughout the hybrid interview campaigns. A total of 112 students and alumni have been reached by the survey and 51 of them completed the questionnaire. The survey was closed on August 4th. **Survey results are presented in Appendix C**.

2.4.5   Brief bibliometric analysis of research produced.

We conducted a bibliometric analysis on the research published under the research programme (Research chairs, small research grants and Climate Science Fellowship for women) and the publications steaming from AIMS (alumni, interns) and related to climate change. The analysis was produced on the basis on the one conducted during the mid-term evaluation (which addressed 54 publications) and supplemented with research findings that have been published after 2021 until June 2023. A list of publications, which is part of the indicators collected by the programme, was also used. As a result, we now have a list of 110 publications published by MS4CR beneficiaries, including WICCS, small grantees, Research chairs and post doc and AIMS alumni, that is 29 more than the result obtained at the MTE[7] conducted in 2017.

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[6] Our proposed methodological approach to capture the perceptions and experiences of MS4CR Programme direct beneficiaries is (i) to survey AIMS students (current, alumni, interns) who are most numerous populations and (ii) to interview all the research grantees, chairs and women fellows who constitute a less numerous populations.

[7] https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/55740/IDL-55740.pdf

An overview of the research outputs produced by AIMS is shown is the table below.

Table 2 Breakdown of publications by AIMS.

Category of MS4CR	Number of publications
Chair Programme	20
PhD Programme	2
Small Research Grants	12
WiCCS	16
AIMS Alumni	60
Total	**110**

Source: Programme data and Scopus

A total of 50 publications were published over the programme implementation by the research component (chair programme, PhD programme, Small Research Grants, WiCCS) and 60 by AIMS alumni (please refer to table 2 above). Subsequent analysis and data triangulation were conducted to further disaggregate the publications classified under alumni category to further unpack if interns or students from the previous cohorts of the MS4CR climate science stream have contributed to the publications. **The list of publications and subsequent analysis is provided in Appendix D**.

2.4.6   *Other higher education and research model analysis*

As stated in the inception report, we conducted an analysis on other higher education and research institutions, initiatives, and programmes (ICCA[8], ACDI[9], WASCAL[10]) to identify the most effective practices, designs, and models that have contributed to their success. Additionally, a crucial aim of this series of analyses was to identify and understand the challenges encountered by these programmes/initiatives, in order to extract valuable insights that will inform the evaluation process and shape the recommendations upon its completion. The analysis process involved a comprehensive desk research, data collection, along with conducting interviews with representatives from each of the institution/initiative/programme. The interview questionnaire is to be found in Appendix J. From the list of initiatives/ centres suggested at the inception phase, we retained 4 of them:

- The Africa Centres of Excellence (ACE) initiative of the Word Bank Group: 2 west African Centres specialised Mathematics, Computer Science, and ICT (ACE MITIC in Senegal) and Mathematical Sciences, Computer Science and Applications (ACE SMIA in Benin)

- The Western and Southern African Science Service Centre for Change and Adaptive Land Management (WASCAL and SASSCAL): these centres are similar regarding the operating model, funding scheme and sponsorship. We focused on the WASCAL master's in computer science and Climate Change.

- The Institute for Climate Change and Adaptation at the University of Nairobi (ICCA)

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[8] https://icca.uonbi.ac.ke/basic-page/philosophy-rational-objectives

[9] https://acdi.uct.ac.za/education

[10] https://wascal.org/

- The University of Cape Town African Climate and Development Initiative (ACDI)

The initiatives/centres selected for analysis are focused on training students in climate change theme like the AIMS MS4CR programme. They also give a broader geographical representation from East (ICCA), West (WASCAL) and South (ACDI) of Africa. Three benchmark studies, documented by desk reviews and in-depth interviews with the programmes stakeholders have been completed. **The analysis results are to be found in Appendix E**.

3   Responses to the evaluation questions

3.1   Relevance

Q1. To what extent was the MS4CR programme relevant to the development priorities of Africa, specifically in terms of higher education and research in climate science?

The overall MS4CR programme objective is to improve climate change resilience in Africa through higher education and research was and remain relevant to the development priorities of Africa.

- African development priorities in Africa are to develop and implement both climate-smart and climate-resilient development strategies, which involve research, innovation, new technologies and skills development. Higher education and research are a both prerequisite and fundamental drivers to tackling climate change. However, being one of the most vulnerable continents to the impacts of climate change, Africa, faces an information gap between climate impacts that are experienced on the ground and that are recorded and published in scientific literature. This problematic lack of research can be attributed to a relative lack of long-term climate observation infrastructures, funding, capacity, technology, and human resources in Africa. **Appendix A.1** develops these elements in detail. Additionally, overall higher learning and research institutions in Africa are limited by resources and public financing. **Appendix A.2. and A.3.** develop these elements in detail.

- Research in climate science has evolved since 2010, as it has now become a priority in the development agenda and policies of African countries. African Governments are considering overall climate change as a raising concern. Climate science has become central to their policies to mitigate and adapt to climate change. The Climate for Development (ClimateDev-Africa) Programme[11] was created in 2010 under the auspices of African Union Commission (AUC) to align development of climate research for development including enhancing participation in climate negotiations. At continental level, in 2015, to the favour of the Assessment of Millennium development goals MDGs, the Economic Commission for Africa and Global Climate Observing Systems recognised the impacts of climate change and the challenges it posed for the attainment of MDGs by 2015. Climate has significant importance in the African Union Agenda 2063. To this date, 117 African research organizations are engaging in Pan-African led climate research. Research institutions (African Centres of Excellence[12] funded by the World Bank, WASCAL etc..) have recently developed trainings for PhD students and research chairs on Climate. Local and international funding available to address the climate change challenges have become more important but yet are quite low in comparison to other continents. Hence there is still a gap to fill in order to meet an ever-growing demand of climate research in

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[11] https://www.climdev-africa.org/

[12] https://ace.aau.org/about-ace-impact/

Africa for policy interventions on the continent. **Appendix A.4.** present these elements in detail.

- Predicting and understanding the impacts of climate change involves the use of sophisticated, quantitative mathematic models of chemical, physical and biological processes, including the integrated assessment models used for IPCC reports. Additionally, STEM disciplines provide the foundation for pursuing resilient, climate-smart technological opportunities. **Appendix A.5.** present these elements in detail.

AIMS MS4CR programme is one of the rare programmes proposing mathematical sciences training and research applied to climate change. MS4CR theory of change is relevant to African continent priorities in higher education and research in mathematical science applied to climate change (see the whole theory of change in Appendix B).

Q2. To what extent did the programme contribute to regional development objectives and a regional science, technology and innovation agenda? Notably in increasing the contribution of African mathematical scientists/researchers (men and women) in finding solutions to Climate Change challenges?

Given the significant needs and challenges in the field of science, technology, and innovation TI, as well as the continent's development objectives, **it would be ambitious to precisely quantify the contribution of the AIMS MS4CR programme** to achieving these goals. However, the MS4CR has contributed to raise interest and awareness among young scientists in climate change issues and increase the number and contribution of mathematical science graduates **needed to finding solutions to the climate-change related challenges in Africa.**

- AIMS contributes to regional development objectives and regional STI agenda by training cohorts of climate scientists, with a specific and unique angle: mathematics applied to climate change (biomathematics, climate dynamics and modelling, computing/programming). Researchers were trained on different thematic topics across the continent such as tropical diseases, drought and climate variability, mathematic models of physical climatic parameters, biodiversity response and policy implications. Almost 200 beneficiaries, including 185 graduates, women researchers, post doc and PhD candidates have been working on climate change related issues on the continent.

- Interview with stakeholders indicate that about three of the AIMS alumni are now researchers actively contributing to the IPCC modelling of climatic system in the continent as lead/contributing authors; that research outputs have been useful for policy makers informing climate policies and development of the Nationally Determined Contributions in accordance with the Paris Agreement.

However, trained cohorts are not large enough to make a significant difference in so very diverse fields of climate resilience as these tackled by the AIMS students. So far AIMS MS4CR has given priority to purposely leaving many topics open for learning and researching. However, the MTE had already recommended a concentration, which appears still to be the right way forward as called for by external stakeholders. Additionally, components which address the relevance of the research conducted to national government absorptive capacities and industry needs is still underdeveloped.

Q3. To what extent was the programme able to adapt and respond appropriately to emerging challenges, needs and priorities of beneficiaries (students, private sector, public sector, research sector)?

In the realm of climate change and resilience, the diversity of climate-related activities, challenges and initiatives that have occurred on the continent during the implementation

period reflects the urgency of the topic and the overall relevance of the programme[13]. It further emphasizes that the challenges, needs, and priorities vary based on beneficiaries, who do not uniformly experience the impacts of climate change with equal intensity. It is therefore challenging to provide a definite answer regarding the programme's ability to effectively adjust and respond to the evolving needs, challenges, and priorities of its beneficiaries given the evidence collected.

At a global level, the only major event that could have led to a shift in needs and priorities of beneficiaries was the Covid-19 pandemic. The programme was able to adapt to the pandemic for the main pillars, namely the training, research, WiCCS, internship programmes and the consolidation.

The agile nature of AIMS and the flexibility of MS4CR programme design gave enough room for adaptability to a shift in needs of priorities of the direct beneficiaries, in the majority of the countries where the programme was delivered operates. However, the evidence gathered throughout the assignment does not allow for extrapolation outside the AIMS area of influence, nor for all components of the programme.

- For the students (training and internship component): the programme is providing a good learning opportunity and skills that are practical to tackle real world issues, especially pertaining to climate change and its challenges. The internship component allowed knowledge transfer and industrial skills gain. Additionally, the AIMS model and innovative pedagogical approach provided the graduates with the skills necessary to excel in applying mathematical tools to climate change issues, especially for people who needed them both prior to and during their training. It is important to recall that due to the diversity of backgrounds, students start the academic year with varying levels of knowledge and skills, and some courses are also taught according to the level and interests expressed by students. MS4CR has also provided the resources and capabilities needed to continue the learning during the pandemic and easily adapted to the change in mode occasioned by the restrictions, including hybrid mode for internships.

- For the researchers (PhD and research master students), the timelines were adjusted to consider the impacts of Covid -19 and other challenges to fit into their needs and priorities. In spite of the challenges, the researchers gained practical expertise on how to use scientific tools including provided research facilities such as laboratories in addition to quality teaching.

- Research sector: there are growing challenges in climate science, and it is imperative to increase the number of climate science experts on the continent. AIMS MS4CR has contributed to this objective by building the capacity of young African scientists in addressing key climate change issues relevant for the development priorities and emerging issues of the continent. MS4CR has trained around 200 experts in mathematical modelling of climate able to understand the key challenges posed by the impacts of climate change in Africa and to make predictions about the future to inform decision-making. As indicated in the State of the Climate in Africa 2021 report[14], it is crucial to improve climate services provision in Africa as to date, only four countries can provide forecasting or warning services

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[13] A review of the WMO reports on the state of Climate in Africa https://public.wmo.int/en/media/press-release/state-of-climate-africa-highlights-water-stress-and-hazards#:~:text="Temperature%20increase%2C%20heat%20waves%2C,Nations%20Sustainable%20Development%20Goals%20(SDGs)

[14] https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate/Africa

at a full/advanced capacity level.[15] The MS4CR graduates and researchers possess the necessary skills to contribute to the climate services provision. The research programme was designed without a specific central thread, giving sufficient freedom and flexibility to adapt and address the most pressing issues perceived by the researchers and global scientific community.

- Public sector: the emerging need that is addressed by the programme is the provision of critical mass of graduates able to understand climate change and resilience issue and provide information for policy actions. To date, a total of 200 young scientists have been trained to use mathematical tools for climate change related challenges, which appears to be limited compared to the existing knowledge and skills gaps. And none is employed by a government partner.

- There is also a concern regarding the ability of the public sector at national level to understand the impacts and design policy intervention for adaptation and mitigation. In this respect, the adaptability or relevance of the MS4CR programme depends on the willingness or the readiness of the partner countries, especially policy makers, to draw research output into emerging policy windows. In most cases, there is a disconnection between academia and policy makers about the urgency to act on climate change issues through training. But for the more advanced ones, the alignment is more obvious. For example, in Rwanda, the research chair is involved in a training programme for public and private sector employees on specific topics related to climate change and resilience. In other countries, the placement topics are in fact subjects of major importance for governments that do not have the capacity to address these concerns. Admittedly, most of them are too broad to be covered in a six-month internship, but they do exist, and the internship programme provides a response to the current needs and challenges of partner governments and institutions.

- From the interviews and document review, the public sector engagement towards the programme and AIMS in general has improved, as governments in partner countries are substantially increase their funding to AIMS, as compared to an average of 40% of their pledge contribution in the previous years. A new commitment has been signed with the government of Senegal to increase their funding and in Cameroun, the new agreement set to double the previous amount of their contribution. Rwanda and Ghana governments are offering in kind contribution (land) and funding to build new infrastructures for the centres. However, there is limited evidence that the research stream has included a lot the governments and public sector stakeholders, not that the research topics were demand driven and based on public sector needs assessments. Most of the climate related job opportunities for the programme alumni were recorded for the non-for-profit sector and private or university research institutes.

- Private sector: similarly, the challenges and needs of the private sector are mainly addressed through the internship component where needs are expressed in the form of research topics. The curriculum of the master training is designed to address some private sector needs as some consultations with industry partners are conducted prior to the finalization of the curriculum, according to the interviews conducted with key informant stakeholders. However, there is still room for improvement as few partnerships were formalized with the industry and the efforts of consultations with key private sector and other organisations were not monitored to serve as evidence. In addition, there is no record of AIMS MS4CR being engaged with an African private sector company focusing in the

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[15] https://public.wmo.int/en/media/press-release/state-of-climate-africa-highlights-water-stress-and-hazards#:~:text="Temperature%20increase%2C%20heat%20waves%2C,Nations%20Sustainable%20Development%20Goals%20(SDGs)

area of climate change, highlighting the challenges of engaging with them at the institutional level.

In a broader perspective, there is limited evidence that the programme was able to capture any emerging challenges, needs and priorities of the public, private and research sectors in Africa. To do so, it is necessary to have a foothold in the highest spheres of influence and decision-making in the specific field, develop a strong stakeholder engagement strategy and participate in high level conferences to interact with experts and gain insights into emerging concerns. AIMS newcomer status in climate science arena and pandemic-induced delays have hindered its ability to quickly respond to emerging needs and priorities.

Q4. Does the AIMS model respond to gaps in higher education and research in mathematical science?

The literature on higher education and research in mathematical science has highlighted several gaps, which are more acute in the context of African countries. They span from disparities in gender and inclusion, limited access to learning resources (materials and educational facilities) to skills gap in the industry, lack of practical applications and lack of interdisciplinary integration[16]. Other gaps include quality of teaching across all levels, and insufficient teacher professional development opportunities, shortages of educators, outdated curriculum and pedagogical approach, socio-economic and geographic inequalities, a notable lack of internal research capacity and disconnection from areas of contemporary interests[17]. In this landscape, AIMS, created in 2003, is one of the first initiatives on the continent aiming to bridge some of these gaps. With the World Bank's African Centre of Excellence programme[18] started in 2014, many higher education institutions in Africa have begun to address the challenges in higher education and research in Africa. This initiative addresses particularly the development of training and research capacities, higher-level skills and innovative research, gender inclusion, development of partnerships with universities and industries and facilitation of access to the job market to the graduates, in key development priority in the continent including STEM and climate change. In the area of mathematical sciences, the World Bank African centres of excellence identified are ACETEL, CAPIC, ENSEA, MITIC, SMIA[19] and ACE DS[20]. Another centre in Rwanda, ACE ITLMS in the University of Rwanda, college of Education, is addressing the issue of Quality of Education, aiming to improve the quality of mathematics and science education.[21]

AIMS model is contributing to some extent, to bridging some of these gaps, including the gender disparity, resources, quality of teaching, interdisciplinary integration.

- Regarding gender disparity, and socioeconomic and geographical inequalities, AIMS has continuously addressed mainstreaming of gender in all its programmes including climate researcher. Women researchers are engaged through the women fellows' programme, in the master's programme and other post doc research activities. Indeed, a quota policy for female representation is in force across the network. An additional analysis indicates different nationalities are represented in the students within the AIMS programme, as students are recruited from all over the continent and from diverse economic backgrounds. The presence of AIMS in several African countries encourages diversity, even if this is

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[16] https://www.un.org/osaa/sites/www.un.org.osaa/files/un_brand_report_web_august_2020_v36928.pdf

[17] https://www.mathunion.org/fileadmin/CDC/cdc-uploads/CDC_MENAO/Africa_Report.pdf

[18] The Africa Higher Education Centers of Excellence: A Pathway towards Sustainable Development (worldbank.org)

[19] https://ace-partner.org/dstn/en/centres/

[20] https://ace2.iucea.org/index.php/2016-09-15-07-45-41/applied-statistics

[21] https://ace2.iucea.org/index.php/2016-09-15-07-45-41/quality-of-education

constrained by the capacity of the centres and the disparity in the level and quality of teaching in the different countries. Moreover, AIMS is engaged in a programme aiming to improve the learning outcomes in mathematics and STEM for secondary school students, with a particular focus on girls and increasing the understanding of gender-sensitive teaching methods and inclusion. The aim of these initiatives is to help create a pool for graduates in mathematical sciences and STEM with a focus on gender, as it is a growing concern for the continent.

- Resources and quality of teaching: Compared to traditional university teaching, AIMS offers active learning in mathematical sciences where graduates are expected to understand and challenge what they have learned. They are also equipped with scientific computing skills and advanced analytical tools which gives them a comparative advantage in terms of research skills and employment readiness as opposed to graduates from traditional mathematical education. The resulting environment for learning of AIMS, the teaching model, the multicultural environment provides a unique exposure to students. AIMS offers unique training programmes, and the teaching is diversified, and addresses subjects that other universities do not offer or cover. Compared to traditional university teaching, AIMS offers active learning in mathematical sciences where graduates are expected to understand and challenge what they have learned. They are also equipped with scientific computing skills and advanced analytical tools which gives them a comparative advantage in terms of research skills and employment readiness as opposed to graduates from traditional mathematical education.

- In terms of interdisciplinary integration, AIMS, through climate change research and scientists training at the graduate level in the MS4CR programme, brings mathematicians to address climate change issues. This mathematical science excellence for modelling climate change angle is providing practical applications of mathematical knowledge to providing responses to real world issues and connection to areas of contemporary interests, to a larger pool of young scientists. Climate change research needs a multidisciplinary approach and from our investigations, AIMS MS4CR is the first African institution/ programme that offered to tackle climate change issues under the prism of mathematical science, at the graduate level, responding to the urge in training good methodologists in predictions and forecast. This approach provides a broader base of mathematicians capable of applying their knowledge to climate change challenges and a pool of qualified researchers.

AIMS is dedicated to addressing certain gaps to the best of its capabilities, but due to the extensive nature of these needs, these endeavors might not receive the recognition they deserve. There should be more initiatives of this kind to have a significant impact in increasing the number of scientists working on these issues. Existing and more recent initiatives identified are the Master Research Programme on Informatics for Climate Change (MRP-INFORMCC), started in 2020, in Burkina Faso, under the WASCAL programme funded by the German Ministry of education and research (See Appendix E).

Q5. Does the AIMS pedagogical approach provide a significant advantage with respect to traditional university programmes, namely in terms of, inter alia, analytical rigour, critical thinking, and leadership skills?

The AIMS pedagogical approach appears to provide a significant advantage with respect to traditional university programmes. This finding is rooted in the perceptions of AIMS alumni and other university faculty in Rwanda and Cameroun and other key informant stakeholders who have experienced alternative pedagogical approach in both capacities (students and lecturers).

- Interviews with AIMS alumni indicate a high appreciation of the pedagogy. The structured master's programme is evidenced to include **high level of practicality, engagement with the industry and contributing to the contemporary research** needs in Africa.

- AIMS model of teaching is focused on the student experience. The surrounding environment, composed by tutors available 24/7 and lecturers in immersion in the student's environment, offers a unique leaning experience in terms of support system[22].

- Interviewees indicated that the pedagogical approach at AIMS develops more leadership in learners compared to other masters' programmes at partner universities. Discussion and exchange sessions with leading experts in their respective fields stimulate students and give them a platform to express their leadership skills. Students also participate in various conferences and seminars organised by the AIMS network, which enables them to meet and interact with high-level **international and leading experts in their respective fields** and provides networking opportunities, which are not necessarily available at all traditional HEIs.

- The process of conducting research and developing thesis at AIMS is evidenced to be more rigorous in analytical approach with up to three to four review sessions to strengthen students research capacity, in addition to developing numerous mini projects in almost every training module during coursework.

- AIMS is also **an agile organization**, which adapts the content and delivery format of its training courses in line with scientific advances in the field, demand, and the requirements of the job market. This flexibility provides a significant advantage with respect to traditional university programmes, who are faced with the rigid internal structures of their institutions, which makes curriculum and programme reform difficult. They are also subject to financial, material, human and technical resources constraints, which prevent them from enhancing their pedagogical approaches.

- There are other initiatives on the continent in the field of mathematical sciences and/or climate change (at master's level) that are quite similar to the AIMS model, except for the teaching and learning environment. These include the World Bank's African Centre of Excellence (ACE) programme, WASCAL, ICCA and ACDI. Students enrolled in these programmes evolve in a more stimulating environment compared with the masters' programmes traditionally offered at the host universities, with courses offered by lecturers from their own countries or partner universities, more learning resources (facilities, up to date libraries, internet, bursaries), etc.

- The AIMS offer is more diversified compared to other traditional masters' programmes and is not limited solely to the institutional partnerships formed by the scientific collaboration networks. Volunteer lecturers are selected from a pool of leading local and international scientists, recognized for their teaching abilities. The curricula are not rigid, and the lecturers can customize their courses for the benefit of students. In other initiatives, the teaching staff is drawn exclusively from national universities (hosts) and is limited to bilateral or multilateral partnerships agreements signed.

- The residential model of AIMS also allows far greater contact time between lecturers and students, offering a great academic support even during evenings[23]. The teaching model is also structured around discussion sessions, aiming at building critical thinking whereas in

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[22] https://global.uchicago.edu/sites/default/files/2019-03/AIMS%20Structured%20Masters_curriculum.pdf

[23] https://global.uchicago.edu/sites/default/files/2019-03/AIMS%20Structured%20Masters_curriculum.pdf

the other initiatives, typical approaches rely on regular lecture courses[24]. Regarding ACDI, it has the advantage of having a large and diversified network of associate researchers. However, it only offers a single master's degree focusing on climate change, which also follows the host university's procedures. it must be acknowledged, however, that in terms of research capacity in the realm of climate change, South Africa's higher education and research ecosystem is one of the most advanced on the continent.

- AIMS centres are embedded in the education ecosystem through partnerships with local universities in the host countries. In practice, selected lecturers from local universities at AIMS centres are involved in course delivery, and the MS4CR programme PhD candidates are registered and affiliated with local universities. The level of collaboration with local universities varies by centre and the institutional framework of the host country. AIMS centres are embedded in the education ecosystem through partnerships with local universities in the host countries. AIMS South Africa is affiliated with Stellenbosch University. In Cameroon for instance, there is close collaboration between AIMs and the university of Buea, to which it is attached, in accordance with the HE regulations. Diplomas awarded are signed by the university of Buea. We have little information on formal partnerships with other universities. In research, scientific collaboration between institutions seems limited or non-existent. This observation can be extended to the centre in Senegal, which was recommended in 2020[25], to sign partnership agreements with national universities to ensure that its courses are firmly rooted in the national higher education system. Overall, the evaluators note that AIMS is not deeply integrated into the higher education ecosystems and seems to rely heavily on the leadership of the centre presidents, with little formalization through strategic partnerships at the institutional level.

Q6. What are areas (e.g., related to climate science) where AIMS could potentially have an impact in the future?

AIMS could potentially have an impact in the future in the following areas:

- Climate information services: as AIMS is focusing on applying mathematical tools to resolve climate change and resilience issues, climate information services could be an important area of impact. Collecting and analysing climate information requires skills and knowledge that are available and developed within the AIMS network (research chair in climate change and resilience) and could provide to AIMS a significant advantage. AIMS is equipped to provide the range of different information that decision makers will need in relation to climate change impacts.

- Exploring the impacts of climate change on agriculture in Africa: this appears to be a key area of impact for AIMS in the future. More than half of the internships granted have taken place within organisations whose areas of focus is agriculture and climate change. In the specific context of AIMS, it can become an important area of specialization as mathematics brings an important value to agricultural development, by providing the analytical insights that can contribute to sustainable practices, increased yields, and improved resource management. Indeed, mathematics constitutes a valuable tool in various aspects of agriculture, including and not limited to: Crop Planning and Management, Precision Agriculture, Weather Prediction and Risk Management, Yield Prediction and Resource Allocation, which can be key areas of interest pertaining to the

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[24] https://wascal.org/master-research-programme-on-informatics-for-climate-change/

[25] https://anaqsup.sn/index.php/sites/default/files/2021-05/rapport_externe_master_en_sciences_maths_aims.pdf

challenges of climate change. This position is also substantiated by the fact that the majority of the consequences and complexities stemming from climate change exert both direct and indirect influences on the realms of agriculture and food security[26]. This will entail strengthening and increasing AIMS' research activities and raises the question of funding.

- The interface between climate change and its challenges on to key development sectors in Africa, including health and food security, as well as the Interface between climate science, health, data science, machine learning and artificial intelligence: these tools and their applications are mastered at AIMS. For most African countries, the repercussions of climate change are felt in terms of disruption of the agricultural crop cycle, drought, landslides, floods, health, etc., and researchers and students alike have shown an interest in looking into these urgent issues.

3.2   Effectiveness

Q7 & Q8. Were programme activities delivered as planned? Were they rolled out successfully and as intended? What key factors influenced the achievement or non-achievement of the objectives of the MS4CR programme? How adequate were the M&E mechanisms in responding to challenges, opportunities, etc.?

Activities under the MS4CR programme were divided into five pillars: research programme, masters' programme, internships, climate science fellowship for women, and consolidation of AIMS network. The interviews and the programme monitoring, and evaluation reports clearly indicated that most of the programme activities were rolled out as planned and as intended. However, the pace at which the activities were rolled out was a bit slow and not all activities were completed as originally scheduled.

The interviews and data analysis highlighted the following challenges and achievements:

- **Research programme**:
  - At the beginning, it was difficult to know how to recruit and find researchers per year for a grant: matching grants and people who need them was quite time consuming (which is not specific to AIMS but to most research programmes). It was particularly difficult given the thematic focus of the programme, for a relatively new institution in the realm of climate science research which caused delays in programme delivery. It was also difficult to establish timelines for grants based on the availability of researchers.

  - Moreover, the unpredicted covid19 crisis and its implications and family related issues with the students affected the effective delivery of the programme and the achievement of the objectives. The programme was granted an extension to June 2023 to allow the completion of research activities that lagged and a new timeline of December 2024 for completion of PhDs. All changes in the programme delivery were nevertheless discussed and agreed with IDRC.

  - At the date of this assessment, the key outcomes, compiled from March 2023 interim technical progress report are the following (detailed overview of the key immediate outcomes are provided in **Appendix B):**
    - Climate science research and grants for one research chair and 2 resident researchers, supported by 41 (against the target of 45) postgraduate researchers (13 PhD candidates, 11 postdoctoral fellows and 17 research masters) and 19 small research grants (against the target of 16).

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[26] The State of the Climate in Africa 2021

- **Masters' programme**:
  - The climate science stream was to be offered at AIMS Rwanda and AIMS Tanzania within the ten-month structured AIMS master's programme, composed of both functional courses and a three-month applied research project. Other AIMS centres (Cameroon, Ghana, Senegal) were to offer elective courses in climate science to introduce the students to how mathematical sciences can be applied to climate change-related issues. However, during programme implementation, modifications were brought to the programme: AIMS Tanzania did not offer the climate science stream (as the centre faced financial difficulties and was eventually closed) but AIMS Cameroon and Senegal did so from September 2020. Only AIMS Ghana, Cameroon and Senegal offered the elective courses.
  - At the date of this assessment, the key outcomes, compiled from March 2023 interim technical progress report are the following (detailed overview of the key immediate outcomes are provided in **Appendix B):**
    ◦ 168 graduates (64 F, 104 M), climate science stream against a programme target of 174.

- **Internship programme**:
  - At the date of this assessment, the key outcomes, compiled from March 2023 interim technical progress report are the following (detailed overview of the key immediate outcomes are provided in **Appendix B):**
    ◦ Internships for 142 AIMS students or alumni in climate change science field.
    ◦ 12 secured collaborations with host institutions/industry partnerships against a target of 15.

- **Climate Science Fellowship for Women**:
  - At the date of this assessment, the key outcomes, compiled from March 2023 interim technical progress report are the following (detailed overview of the key immediate outcomes are provided in **Appendix B):**
    ◦ Climate science fellowships for 21 women researchers (against the target of 20), and funding to enable young women and girls to access opportunities such as STEM camps.

- **Consolidation of AIMS network**:
  - The objective of the consolidation of the AIMS network was to ensure it operates in a more coordinated and sustainable manner, by enhancing key internal systems including M&E.
  - At the date of this assessment, the key outcomes, compiled from interviews and March 2023 interim technical progress report are the following (detailed overview of the key immediate outcomes are provided in **Appendix B):**
    ◦ The M&E mechanisms include the in-house and external outsourced services. There is a department in charge of M&E, and there is also evaluation conducted at the students' level (beneficiaries and trainees) (Masters, PhD, post Doc, women fellows, and small grantees). The MERL rules required by IDRC were adequately followed. The semi-annual reporting system has helped to provide a more focused reporting between the centres and the secretariat and the donors.
    ◦ Regarding the adequacy of those M&E mechanisms, the AIMS Secretariat convened a comprehensive and network-wide in-person workshop at Rwanda on 22-24 November 2022, to discuss and align the M&E framework with its 10-year strategic plan and refine the short-term action plans for its decade long strategic

plan to ensure effective and successful implementation of the strategy. In general, the workshop generated three outcomes: a detailed workshop report, an M&E framework, as well as the 2022/2023 work plan.

- The analysis of the data collected highlights that AIMS made some good efforts in the design of model and implementation approach. Most interviewees attributed the successes of the programme to these key factors:

  - The agility/flexibility of AIMS as an institution, skills, experience, and knowledge of the people running the programme and leading the centres. As well as increasing the programme management unit in 2020 and availability of digital tools and facilities at AIMS to support students.

  - Setting up an effective recruitment strategy / marketing the centres to other African universities.

  - Digital tools and facilities at AIMS to support students learning;

  - Another key success factor is the responsiveness and openness of IDRC regarding to the challenges encountered during implementation.

  - The increasing awareness of climate change importance for policy makers by key government partners, including the government of Rwanda was instrumental to the programme success.

  - The calibre of the people recruited for the research chair was also mentioned as a key factor in the programme's success because it has helped to attract top young researchers to AIMS who have helped to train the master's students.

Q9. What impact did the programme have on its target beneficiaries? Is there any evidence that AIMS alumni will contribute to the further economic, political, and educational advancement of the African continent?

- As presented above, the MS4CR programme has built the capacity of more than 200 young African scientists at tertiary level to understand the challenges of climate change and to produce high quality forecasts of the impacts of climate change. It has also contributed to increasing the number of experienced African scientists, including women, working, and publishing in the realm of climate science.

- Thanks to AIMS MS4CR programme, there is an increasing recognition and visibility of African women in the mathematical sciences and climate change ecosystem. Given the growing recognition that climate change has gender-differentiated effects, it is important to place the gender dimension at the centre of reflections on the issue and to encourage more and more African women researchers to take an interest in the problem of climate change. According to the programme progress reports, a total of 234 African women climate scientists played an active role at the Gender Summit-Africa, compared to 20 as targeted at the programme design.

- In terms of contribution to climate-change related challenges in Africa, the programme beneficiaries under the research stream have published around 74 peer reviews publications out of which 42 are referenced in high quality scientific publications database. Other papers have been produced and submitted to journals and are in the review process which could take months before they are published.

- A total of 40 alumni were offered PhD and other postgraduates' opportunities in fields related to climate change or are actively engaged in professional positions in climate change related fields.

- AIMS alumni are progressing in their careers in academia and other relevant industries in the area of climate sciences but there is little evidence yet to assess their contribution to the **further economic, political and educational advancement of the African continent as these type of impact impacts may** require more time to materialize. As the continent is also constrained by opportunities challenges, it is less likely that such a contribution can be noticeable at the continental level.

- With regards to the AIMS network, this is the first time the institute has a thematic focus as its regular master is general. This dimension also aims to support the sustainable development of the continent and has increased the visibility of the institute in the higher education / research institutions landscape. AIMS was invited for the first time to contribute to the production of the report on the state of climate of Africa (2023) in Accra.

- Rwanda Environment Management Authority (REMA) is organising a World Climate Research Programme (WCRP) Open Science Conference (OSC) 2023 with AIMS as co-host. This conference is held every ten years, and for the first time in Africa. It will bring together the climate, environment, and related communities to discuss the latest developments in climate science and explore the transformative actions urgently needed to ensure a sustainable future, it will culminate with the "Kigali Declaration" – a conference statement that will be submitted to the 28th Conference of the Parties (COP28). In conjunction with the OSC, WCRP is also conducting a dedicated two-day Symposium for Early and Mid-Career Researchers (EMCRs), hosted by AIMS, to brainstorm on the connections between climate science and society.[27] This was made possible due to the growing recognition of the leading role of AIMS Research chair on climate science and resilience in the ecosystem of climate science in Africa.

- Additional impact of the programme include:
  - Growing networking opportunities.
  - Improved ranking of local / university partners.

Q10. To what extent has the programme been able to provide postgraduate opportunities for AIMS Alumni? What could be done differently to enhance postgraduate opportunities?

- Several alumni have been able to secure postgraduates opportunities due to the network of AIMS and the exposure they got with the lecturers and academic partners. It is also noteworthy to mention that the programme has equipped the graduates with technical and research skills needed for other postgraduate opportunities. AIMS recorded a total of 23 alumni pursuing further climate science related studies, including 13 MS4CR alumni (2 from the optional climate science stream). It is noteworthy to mention that some of the postgraduate opportunities listed are within the MS4CR programme itself, with students completing the structured master's degree followed by the research master while non MS4CR alumni were granted MS4CR PhD scholarships.

- For the research stream, the opportunities happened in the form of academic research positions (sometimes within MS4CR), teaching positions in partner universities and career advancements within academia. It would be overly simplistic to credit AIMS alone for the professional growth of these researchers, as the institute actively seeks out and nurtures the best talents from the very beginning, however it is contributing to their advancement. Dr Nana Klutse 's promotion from WiCCS fellow to resident researcher of the AIMS climate chair can testify the contribution, as well as the transitioning of Dr. Emmanuel Dufourq from

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[27] Opportunities for EMCR - WCRP OSC 2023 (wcrp-osc2023.org)

Postdoc to Junior Research Chair at AIMS South Africa. These outcomes are not tracked and monitored in the project M&E framework, rendering it difficult to analyse the outcomes under different perspectives, including gender.

- However, there is limited evidence of the existence of specific AIMS initiatives to facilitate access to postgraduate opportunities to the alumni at the institutional level, except the following:
  - AIMS ensures a continuous communication with alumni and shares opportunities with alumni, including internships and postgraduate opportunities, invitations to events and conferences post AIMS, etc. The Internship programme has placed 142 students and alumni providing learning opportunities in climate change across the continent. And alumni also have subsequent opportunities due to the networking events and activities.
  - AIMS also provides guidance about CV writing skills, cover letter, and how to build leadership skills.
- To enhance postgraduate opportunities, the investigations highlight a need to spend more time in internships to engage with students and to do specific applications of the solutions in the internship programme phase. The current four-month period (as per the MOU) is considered very limited to learning.
- It is also mentioned that students that get to do further studies abroad divert into new fields or different thematic areas according to the needs of donors.
- AIMS can get more funding by aligning to the donor needs and balancing this with the internal needs/objectives.
- And finally, triangulation of the information gathered shows that there are very few opportunities in the field of climate change in Africa for young graduates to enter the job market. Only 16 climate change jobs related opportunities for graduates have been recorded, including 10 positions held by MS4CR masters' graduates. 11 are happening in Africa (international NGO, university based and private research institutes, no government jobs) and 6 of these opportunities are offered in the field of research and academia.
- AIMS needs to step up its efforts to forge partnerships and actively market its training programmes and graduates to the industry. Most of the partnerships have been established with institutions based in Rwanda, while AIMS recruits graduates from a variety of backgrounds. Embeddedness and partnering in the local ecosystems in the centre's countries will be pivotal in increasing opportunities for the graduates. Hence, there is a need to enhance the capacity of centres in fostering and forging more partnerships in the national, regional and global ecosystems.

3.3 Efficiency

Q11. Was the programme implemented in the most cost-efficient means possible? What were the obstacles or on the opposite the drivers to cost efficiency? What could have been done differently?

According to key internal stakeholders, **within the context of AIMS', the programme was deemed cost efficient**, especially for the **training**, **research**, and **internship components**.

- Due to Covid-19 and the programme reprofiling during implementation, notably the reallocation of the funding dedicated to open a new centre in francophone Africa, it was possible to make some savings on some activities and double the number of graduates in climate science stream. AIMS relies on external teaching staff and does not bear the cost of having permanent teaching staff. From the AIMS centres perspective, the programme was value for money. However, from some beneficiaries of the research programme, the

weighing allocated to some components has led to inefficiency. More could have been achieved by increasing the research chair team[28]

- In the realm of scholarship funded programmes and higher education institutions in Africa, **the AIMS residential model is costly**, as indicated in the 10-year strategic plan, which states that switching to a non-residential model will induce a reduction of 50% of training cost per student. However, we do not have enough evidence to assess whether removing the residential approach would lower the quality of AIMS products or reduce accessibility of the programme. Without prejudice to its volunteer model, switching to a more traditional model like the other universities with a permanent staff could be a good way forward, only if AIMS succeeds in becoming firmly integrated into the continent's higher education and research systems.

  Furthermore, as we do not have information on the operating costs of the ACDI or ICCA models, a comparison of the models in terms of efficiency remains hypothetical. However, there is no doubt that a model involving the provision of lectures and faculty exchange in partnership agreements with several universities could offer an advantage in terms of operating costs over having internal high-quality permanent staff. These alternatives models are embedded within national universities and the cost of these permanent staff is borne by the host universities.

  Again, signed partnerships agreements with national, regional, and international universities involving faculty exchange and cooperative research would have enhance the cost efficiency of the programme delivery.

- The consolidation component of the MS4CR programme received a significant portion of the budget (almost 40%) and contributed to strengthening internal systems at AIMS. However, evaluators observe that the programme could have been more cost-efficient if a portion of this budget was reallocated to other relevant activities (training, internship, and research components) and the relevance of some entities, particularly the Secretariat was questioned. Recent restructuring of the AIMS network, driven by decisive actions and the implementation of KPMG audit recommendations, has highlighted that the Secretariat is no longer pertinent. While stakeholders initially viewed Secretariat staff as crucial for overseeing programme implementation, centralizing key functions, and ensuring harmonization across centres, the Mid-Term Evaluation (MTE) recommended a thorough internal analysis of centralization versus decentralization. With notable transformations occurring at the centre level and their increasing capacity to deliver key outputs and coordinate core functional activities of the AIMS network, the importance of the Secretariat diminished in the eyes of key internal stakeholders.

Q12. What are the strengths and weaknesses of the AIMS model, and does it enable cost-efficient, responsive, and timely programme delivery?

The strengths of the AIMS model lie in the nature of the organization and the flexibility of AIMS approach.

- AIMS can provide and deliver customized programmes, based on the needs of the targeted beneficiaries in an agile manner.

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[28] More WiCCS positions compared to postdoc positions, while the postdoc were full time staff doing research and involved in training activities and the WiCCS partially involved with limited interaction with the training component. This has led to several postdocs' positions being abruptly interrupted or terminated due to funding constraints.

- Gender and inclusion considerations are embedded in the values and culture of AIMS network (diverse nationalities and promotion of women in science)

- AIMS was able to secure substantial funding from host governments, development partners and foundations to support cost-efficient delivery.

- Another key strength of AIMS is its reputation for performance based on past achievements. The quality of training offered at AMS seems higher than the one offered by traditional universities.

- The network of AIMS is a strength.

Regarding the weaknesses, the higher dependency on external funding and reliance on few major donors is a major area of concern at AIMS. The AIMS organizational model was also an important weakness and furthermore, the residential model of AIMS is expensive.

- Most of the deliverables were happening at the centres level while the former Secretariat, was disconnected from the operations but was driving the costs. Staff at the secretariat appeared to be less knowledgeable than the centre's staff.

- AIMS is struggling to establish partnerships with the industry, including private and not for profit sector, and academia, and to market its graduates. In the realm of climate sciences, it is more noticeable as only a small proportion of graduates was able to find employment opportunities. The choices were limited, and graduates had to create their own career path. There is a need to improve marketing of AIMS products and better branding to secure corporate and university partnerships. Only 12 partnerships out of 24 reported under the programme were formalized with a signed MoU. The low level of engagement with the industry is also an area of weakness.

- AIMS is a learning organization with regards to research management and research support. Lack of good research support can hinder results.

- The interviews also highlighted the "condensed programme" as a weakness: students do not necessarily have the required background to go directly into some PhD programme, and also to undertake some courses so it's a really challenging learning involvement for students.

However, the new structure of the AIMS network and the strategic repositioning undertaken is deemed to be addressing the main weaknesses areas.

3.4   Sustainability

Q13. How and to what extent are AIMS students, alumni, donors, and governments promoting the sustainability of AIMS' activities after the end of the programme?

- AIMS is a relatively young higher education institution on the continent, totalling less than 20 years of existence. As a result, it might be difficult to expect that AIMS students and alumni network can substantially contribute already to the sustainability of the activities of the centres and the activities after some programmes ended. Especially for the MS4CR programme that have been launched quite recently. Attempts have been made and as reported in the MTE, alumni cannot contribute financially to the sustainability of the network.

- With regards to the publications in the field of climate science produced by AIMS alumni and beneficiaries of the MS4CR research programmes, there are good prospects for their ability to contribute actively to the future. More than 42 Scopus referenced publications in the realm of climate science and change were published by the research stream after three years of activity, and 110 in total. However, in comparison with the 671 publications of the University of Cape Town and the 485 by ACDI members over the period 2021-2017,

and the 250+ publications sponsored by the WASCAL since its inception, AIMS is not very prolific. To its credit, AIMS has a limited research staff.

- The Government of Rwanda has financially invested in the programme and its representatives participate in AIMS events. However, there is a need to strengthen the relationship with governments and identifying donors who could fund specific programmes- to diversify the streams. Governments don't have the resources to sustain this kind of programme. They are ambassadors for AIMS. This return may be tangible in 10 years' time because the graduates are still young.

- The contribution and increasing recognition of AIMS at the continental level can also be seen as a way of promoting the sustainability of AIMS activities after the end of the programme. The MS4CR research chair has been appointed as lead author of one chapter of the Intergovernmental Panel on Climate Change (IPCC) 2021 report, with several postdoctoral staff and WiCCS grantees as contributing authors as well, under AIMS affiliation. In the field of climate change, contributing to IPCC assessment reports is a significant indicator of a researcher's influence on global climate policy. The opportunities to increase visibility are also arising with joint collaborations in hosting scientific events.

Q14. How and to what extent has the financial stability of AIMS been improved? How successful has AIMS been in securing funding? How diversified are the sources of funding secured by AIMS? How can the organization's financial stability (sustainability) be improved?

- Over the period of programme implementation, several efforts have been undertaken to improve the financial stability. According to the Follow Up Summary Report of 2022 by KPMG all recommendations made in relating to grants management were addressed. Sources of fundings were diversified in the last 3 to 4 years. Commitments of partners governments have improved over the years, adding more stability to this stream of funding. As indicated in question 4 above, their pledge contribution as increased and are settled on time, compared to previous years. In 2020/21, 25% of AIMS' total budget was provided by host country governments[29]. There is a promise of increasing government contribution in Senegal and in Cameroun, the new agreements set to double the previous amount of their contribution. Rwanda and Ghana governments are offering in kind contribution (land) and funding to build new infrastructures for the centres.

- AIMS is developing a new stream of additional revenue with added value services, including workshops and events hosting, short courses, and training of professionals from public and private sector institutions. The amount of income is minimal in relation to the network required budget, but it can be improved.

- AIMS is undergoing restructuring, and the financial stability and sustainability has been in question. The new structure entails switching to a more decentralized model, since the secretariat was very expensive, and the centres will have more power to work efficiently. This is expected to improve the financial stability. The objective of the new plan is to achieve the self-sufficiency of a minimum of three centres within a span of nine years, thereby enabling their contribution towards ensuring the overall sustainability of the entire network.

- The new financial sustainability plan entails the offering of fee-paying structured masters and undergraduates' programmes alongside fully funded programmes model. Centres also mentioned the necessity of hiring permanent staff. The fee-paying model is implemented in southern and eastern Africa (ACDI and ICCA) and seems to be attractive and bringing revenue to the centres. A balanced model combining scholarship-based

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[29] AIMS financial sustainability plan Version 1.2

model and fee paying should be reconciling the imperatives of giving equal opportunities to students from disadvantages background to access graduate education and generating revenues to the centres while increasing number of scientists trained per year.

There is still room for improvement in communication and marketing of AIMS products to secure additional corporate partnership.

One strategy is to open on the graduate programme in Ghana as a pilot, which should be fee paying. The strategy is also about diversifying the sources of funding in the long term by renewing grants with major donors such as Mastercard foundation, as well as securing new donors like the Bill and Melinda Gates Foundation[30]which has recently joined the funding partners.

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[30] Cf Financial sustainability plan version 1.2

4   Conclusions and recommendations

4.1   Conclusions

The primary goal of the AIMS MS4CR program was to augment the involvement of African mathematical scientists in addressing climate change-related issues in Africa through training, internships, and research. Simultaneously, it aimed to reinforce AIMS' operations across the continent, strengthening its existing centers.

In practice, the AIMS MS4CR program has partially succeeded in bolstering the contribution and representation of African mathematical scientists, including women, in tackling climate change challenges within Africa. It has achieved this primarily by expanding access to postgraduate opportunities for young African mathematicians and scientists. Additionally, the program has streamlined AIMS' operations at both individual centers and the network level, enhancing its positioning within local and regional ecosystems as a key player in climate change research in Africa.

The AIMS MS4CR program aligns closely with Africa's development priorities, both at the national and international levels. It has successfully equipped over 200 young African scientists at the tertiary level, positioning them to actively contribute to the resolution of climate change challenges. Given that many African nations struggle with limited technical and scientific research capabilities, climate change and its associated challenges remain prominent development concerns. Thus, nurturing researchers with expertise in climate resilience and training climate scientists is pivotal for enhancing technical and research capabilities across the continent.

The evaluation indicates a growing interest among aspiring mathematicians in the field of climate science, particularly in areas where mathematical tools and knowledge can be applied effectively.

In terms of effectiveness, most program activities were executed as planned, despite disruptions caused by the COVID-19 pandemic. The program managed to achieve nearly all expected outcomes within the scheduled timeframe, even necessitating a no-cost extension. However, despite a clear commitment to gender balance, the program often fell short of reaching its gender-related targets across various activities. Furthermore, the evaluation noted that the cohort sizes might be too small to create a noticeable regional impact. A tension was also observed between the broad spectrum of researched topics and the need to generate critical mass in specific domains to drive significant change.

The program's efficiency was considered satisfactory, with the management teams of the centers confirming that many activities and results were achieved within the specified budget. However, the AIMS residential model, coupled with the centralized management structure, was identified as a cost driver.

In terms of sustainability, the AIMS model has exhibited relatively low sustainability, but it has shown improvement in recent years, notably with the implementation of the new strategic plan and the financial sustainability plan. The findings suggest that the new strategy will focus on enhancing the financial stability of AIMS centers. However, there is limited evidence to determine the significant advantages of the decentralized model over the previous model.

While the program succeeded in meeting a majority of its targets, several challenges were identified. Enhanced coordination of research efforts and topics is essential to achieve substantial impact within specific domains of climate change. Additionally, research must be aligned with the needs and absorptive capacities of both governmental and private sector stakeholders.

From the information provided about the Institute for Climate Change Adaptation (ICCA) of the University of Nairobi, the Western African Science Service Centre for Change and Adaptive Land Management (WASCAL), and the Africa Climate Development Initiative (ACDI) at the University of Cape Town, several approaches and best practices can be applied to enhance the functioning and impact of the African Institute for Mathematical Sciences (AIMS). Here's what can be learned in terms of approach for AIMS:

- Specialized training programs: AIMS can consider specializing in particular fields of mathematics or scientific disciplines to address specific needs on the continent. Just as ICCA focuses on climate science and adaptation, AIMS could develop specialized programs in areas of high relevance to Africa.

- Collaborative networks: Establishing collaborative networks like AIMS' involvement with the African Research Universities Alliance (ARUA) Centre of Excellence can enhance research and capacity building. AIMS could seek strategic partnerships and collaborations with other academic institutions, research centers, and organizations working on similar objectives.

- Transdisciplinary approach: A transdisciplinary approach, like that employed by WASCAL, can help AIMS offer training and research that address complex challenges effectively. AIMS could encourage collaboration across different fields and promote interdisciplinary projects.

- Practical training: Offering practical training components, internships, and fieldwork, as seen in ACDI and WASCAL, can enhance students' real-world problem-solving skills. AIMS could provide opportunities for hands-on experience and research projects.

- Financial sustainability: AIMS could explore multiple funding sources, such as school fees, research grants, and partnerships with organizations, to ensure financial sustainability. A diverse funding model can support long-term growth and development.

- Industry collaboration: AIMS could work to establish collaborations with industry partners to bridge the gap between academia and the private sector. This can provide students with valuable exposure to real-world challenges and job opportunities.

- Adaptability and curriculum review: AIMS could be prepared to adapt and update its curriculum and programs in response to evolving circumstances and needs. Regular curriculum reviews and flexibility in course offerings can keep the institution relevant.

- Global network building: Building a strong global network, as demonstrated by ACDI, can lead to more extensive collaborations and partnerships. AIMS could seek to establish relationships with universities, research centers, and organizations worldwide to enhance its international presence and impact.

- Support from university leadership: Having strong support from university leadership, as seen with ACDI, can help AIMS secure resources and commitment from the host institution. AIMS should work closely with its parent university to ensure the backing necessary for its initiatives.

- Clear strategic planning: AIMS could have a clear strategic plan in place, outlining its objectives, financial flows, and priorities. This can help guide its growth and development over time.

Subsequently, we offer recommendations for future programming, providing stakeholders with insights into ways to improve the design, implementation, and overall outcomes of similar initiatives in the future.

4.2 Recommendations to AIMS

As AIMS decided to continue offering Master and Doctoral activities in climate science, the following recommendations were elaborated:

Recommendation 1: Explore opportunities for expanding Master's and Research Master's Programs in Climate Science with a continental impact.

AIMS has chosen to continue the initiatives previously funded by the MS4CR program, particularly in the areas of Master's and Doctoral programs. However, the evaluation has highlighted that the number of beneficiaries trained through the MS4CR master and research programs is relatively low, considering the continent's substantial needs.

Therefore, it is recommended that AIMS collaborates with universities to identify opportunities for scaling up these programs. Drawing from AIMS' experience, higher education institutions can learn from challenges, lessons, and best practices to establish their own programs. Specifically, the following actions are suggested:

- Expand the number of individuals trained while maintaining the program's inclusive nature. This can be achieved by potentially establishing a comprehensive master's program in mathematics and climate sciences in one or two centers, while other centers continue with their specialized streams.
- Explore potential synergies with the AI/data science streams
- Enhance the visibility of AIMS' contributions in the field of climate resilience to facilitate expansion and create a network of stakeholders.
- Foster collaboration with other universities, taking into account their capacities and resources, using an interdisciplinary approach to address diverse educational needs, given the complexity of teaching climate change.
- Promote inclusivity, diversity, and gender equity through targeted initiatives and fellowships. Empower young girls and women to pursue education in science and climate science.

Recommendation 2: Boost AIMS' visibility and strengthen partnerships on Climate Science

The evaluation has identified challenges in recruiting students who align with the grant requirements, especially considering the thematic focus of the MS4CR program. Similarly, the evaluation has highlighted challenges in establishing corporate and industry partnerships outside Rwanda, where the former Secretariat was located. To address this issue, AIMS can enhance the visibility of its initiatives across Africa, attracting suitable students for climate science streams, as well as for new program streams, but also establishing new partnerships.

Specifically, the following steps can be taken:

- Create a comprehensive communication plan that targets relevant platforms and stakeholders across the continent.
- Expand communication channels and go beyond traditional recruitment methods like AIMS websites and peer/alumni networks. Leverage the power of social media and engage with regional and national media.
- Foster collaboration with educational institutions. Collaborate with national schools and universities sharing similar priorities, such as STEM and climate resilience. Utilize their networks and alumni connections.
- Increase participation in industry events to boost the program's reputation, foster multi-stakeholder partnerships, and attract more beneficiaries.

- Explore the option of hiring marketing professionals to support regional marketing efforts and generate more interest in the program, its objectives, and outcomes.
- Strengthen the capabilities of teams, particularly center staff, to effectively manage the responsibility of cultivating and sustaining partnerships.
- Create tailored strategies for attracting partners at the center level.

Recommendation 3: Focus AIMS research on local needs in specific research domains in Climate Science

The evaluation has highlighted the broad thematic focus of the MS4CR program, suggesting that it may miss opportunities to address specific research needs and challenges related to policymaking and investments.

To address this, it is advisable to concentrate AIMS research activities in Climate Science on specific research domains within specific centers. This can be achieved through the following actions:

- Implement customized training courses and specializations that go beyond the broad theme of mathematical sciences for climate resilience. These should be based on context and ecosystem analysis to ensure that the program caters to local needs. This approach allows students, interns, and postgraduates to leverage practical opportunities within the local ecosystem in line with their training.
- Create climate science streams within selected centers, with a specific focus on areas such as AI, machine learning, and data science.
- Enhance the capacity of lecturers, who act as intermediary beneficiaries, to ensure the effective delivery of tailored training courses.
- Draw from the experiences of past and current research-oriented programs that have successfully delivered context-specific interventions across the continent. These programs aim at capacity building to mitigate the impacts of climate change, safeguard socio-economic development, and reduce disruption. An illustrative example is the Future Climate for Africa (FCFA) program, which was a £25 million initiative funded by the UK Foreign, Commonwealth and Development Office (FCDO) from 2015 to 2022. The FCFA program focused on generating climate science specifically tailored to Africa and pioneered the use of improved medium- to long-term climate change information in development projects.

Recommendation 4. Strengthen the Integration of education and research with Industry for enhanced climate resilience

Currently, the utilization of climate knowledge across the continent falls short of its potential, with the most vulnerable populations yet to fully benefit from recent scientific and technological advancements. To yield more tangible outcomes, there is a pressing need to adopt more cohesive strategies that leverage climate resilience education as a catalyst for effective adaptation and mitigation measures, especially in regions where the economy heavily depends on climate-dependent activities, such as agriculture.

To enhance the design and delivery of the thematic training program, the following specific interventions can be considered:

- Incorporate experts from critical industries and government representatives into the program board. This participatory approach not only enriches the curriculum but also serves as a valuable advocacy tool, particularly if cost-effective methods are employed.

- Strengthen the alignment between course design and the requirements of industries, as well as the climate-related socio-economic challenges specific to the local context.

- Foster stronger stakeholder engagement mechanisms throughout the research project cycle to amplify the program's impact. This can be achieved through the establishment of steering committees, which play a pivotal role in identifying research areas and driving the utilization of research results.

- Forge connections with other initiatives that present market and industry opportunities for students, interns, and post-graduates specializing in climate change adaptation and mitigation. By doing so, you can create a symbiotic relationship that benefits all stakeholders.

- Align the timing of internships with the innovation cycle to facilitate the completion of internship projects that can lead to more concrete outputs. This synchronization not only enhances the educational experience but also contributes to the continuity of the program.

- Consider establishing strategic partnerships with existing "climate service centers" or create one to reinforce operational capabilities in generating and delivering up-to-date climate information and prediction products for climate services. The demand for more accurate short- and long-term predictions and projections, ranging from regional to local scales, is growing. However, there remains limited access to usable data and product inputs crucial for generating climate services and products at the national level. This initiative can bridge this gap and enhance the effectiveness of climate services in supporting climate adaptation and risk management.

Recommendation 5. Harness the results and lessons learned from MS4CR to enhance its impact and inform programming in this area

To broaden the impact of the MS4CR program and to inspire both other institutions engaged in climate science and AIMS' other thematic streams, it is crucial to:

- Systematically collect and document the lessons learned from MS4CR and other thematic streams.

- Compile these valuable insights into practical toolboxes.

- Make these toolboxes readily available for transfer to any interested institution. This proactive approach ensures that the wisdom gained from AIMS activities, especially the MS4CR program, continues to benefit a broader community and fosters a lasting legacy for the organization.

Recommendation 6. Advance financial sustainability and revenue diversification across AIMS centers

The evaluation has underscored the importance of fortifying the AIMS network and enhancing its financial stability and sustainability. To achieve these objectives, it is imperative for AIMS to:

- Pursue a funding diversification strategy tailored to the unique needs of each center.

- Conduct a comprehensive economic analysis encompassing various scenarios, including the comparison of permanent staff with the current model, and explore the synergy of fee-based education alongside scholarship programs.

- Investigate additional funding mechanisms and operational models, drawing inspiration from successful models like ACDI, which encompasses both individual and institutional memberships.

Appendix A   Climate change and the African continent

A.1   The Burden of Climate Change in Africa

Africa is one of the most vulnerable[31] **continents** to the impacts of climate change, including climate variability and extremes[32]. Climate impacts in the form of increasing temperatures, rising sea levels, changing precipitation patterns and more frequent extreme weather events such as droughts and floods will increasingly threaten Africans' livelihoods and security. These impacts are likely to be felt in the form of water crises, food insecurity, infectious diseases, and direct loss of human lives[33]. Sea-level rise will endanger coastal cities, particularly those close to important river deltas such as the Niger and Nile Delta regions. Agriculture is extremely sensitive to changes in temperatures and rainfall, and these changes will impact food security and access to food on the continent. Climate-sensitive diseases including malaria and cholera are also projected to spread to regions where they are not currently present as a result of warming temperatures.

Figure 1 Global climate change vulnerability index
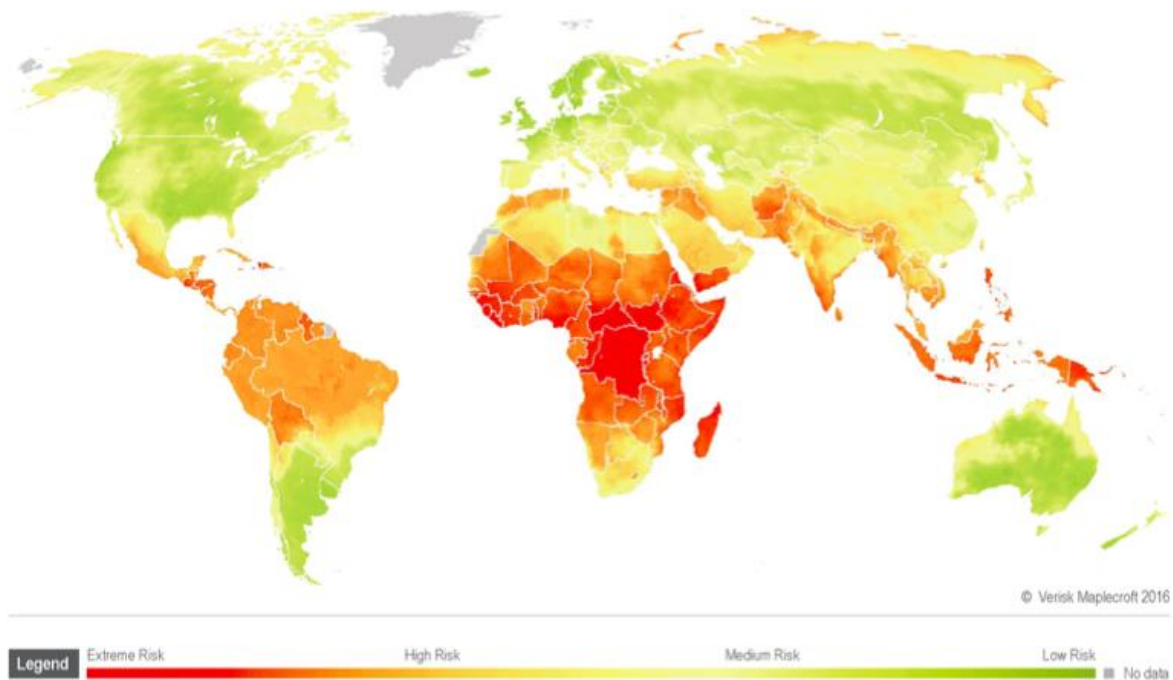
Source: Verisk Maplecroft, 2016.

Across the continent, there is a strong economic dependence on climate-related activities, resulting in a heightened vulnerability of important economic sectors and substantial economic impacts on the line. This climate vulnerability is aggravated by other compounding developmental factors, such as weak economies and institutions, complex and poorly developed governance structures, limited access to capital, and endemic poverty. These

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[31] Vulnerability is defined as the "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes" (IPCC, 2001. Third Assessment Report).

[32] IPCC, 2014. Fifth Assessment Report.

[33] State of the Climate in Africa, World Meteorological Organisation, WMO No 1253, 2019

factors combined have in turn weakened Africa's adaptive capacity and resilience in the face of projected climate impacts.

The African Union's (AU) African Climate Change strategy confirms that Africa "will bear the greatest brunt and suffer the worst devastating effects" of climate change. Forecasts from climate modelling indicate that Africa is the most vulnerable region for the impacts of climate change under all climate scenarios for average global warming above 1.5 degrees Celsius.[34] According to the AU, the expected impacts of climate change in Africa include the following:

	Agriculture and food security: Prolonged droughts, flooding and loss of arable land due to desertification and soil erosion are reducing agricultural yields and causing crop failure and loss of livestock, endangering rural and pastoralist populations, as well as urban food security.
	Health: Climate change induced natural disasters and scarcity in safe drinking water due to droughts leading to spread of communicable diseases in Africa, exacerbated by poor sanitation.
	Forced migration: Droughts and floods have led to forced/induced displacements in many parts of Africa. Extreme weather conditions and shifts in climate and degradation of ecosystems threaten livelihoods and erode human security, causing forced migration and population displacement. It can then also threaten political and economic security and lead to conflicts as people struggle for access to basic resources.
	Energy: Extreme weather events damage energy infrastructure, such as hydropower generation and electricity transmission. Climate change exacerbates deforestation, which in turn contributes further to GHG emissions.

Source: Treated by Technopolis Group, 2020

Whilst knowledge of African climate trends and vulnerability has increased over the past decade, there is still a blind spot in terms of data, particularly when compared to data available in Europe and North America. This lack of climate data and scientific studies on the subject means that there is a large degree of uncertainty regarding projected climate impacts in Africa, particularly when predicting impacts in a country, sub-region or at the local level[35]. In turn, this uncertainty constrains governments' decision-making to reduce vulnerability, build resilience, and plan and implement adaptation strategies.

This information gap has led to a widening dichotomy between climate impacts that are experienced on the ground in Africa and climate impacts that are recorded and published in scientific literature. Major reports such as the Intergovernmental Panel on Climate Change (IPCC) assessments, for example, present more information regarding impacts in developed countries than for less-developed countries.

This problematic lack of research can be attributed to several causes, some of which are structural or historical in nature. Climate data is based on long-term observations of weather patterns, where there is a relative lack of long-term climate observation infrastructure in Africa[36]. This factor is compounded by a lack of funding, capacity, technology, and human resources for African scientists and researchers to undertake and monitor front-line research and publish their findings. African researchers are generally excluded from access to critical

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34 https://www.afdb.org/en/cop25/climate-change-africa

35 The Science of Climate Change in Africa: Impacts and Adaptation, Gordon Conawy,

36 IPCC, 2014.

data recorded by national meteorological institutions because of the high costs involved, which hinders their ability to research climate impacts[37].

In general, African governments do not invest substantially in research, meaning that most research is either donor-driven or conducted by external consultants[38]. Because of this, research is rarely mainstreamed into national development policy or based on national priorities, as it more likely would be if it were undertaken by national researchers. Consequently, African theories, perspectives and experiences are inadequately represented in climate research on the continent.

A.2   African policies on Climate Change

African leaders are faced with the challenge of developing and implementing both climate-smart and climate-resilient development strategies. These strategies need to address the implications of ongoing and anticipated changes in climate while also shifting to cleaner energy sources and avoid locking-in to the technologies of yesterday. In this regard, the AU has put forth the African Climate Change Strategy to provide regional economic communities, member countries and other stakeholders with strategic guidance to address climate change challenges. The African Development Bank (AfDB) has developed a Pilot Programme for Climate Resilience (PPCR) to demonstrate ways in which developing countries can make climate risk and resilience a part of their core development planning, while building on the National Adaptation Programmes of Action[39].

A major component of African strategies to address climate change involves research, innovation and new technologies. The African Union and the European Union set out a roadmap for a Research & Innovation Partnership on Climate Change and Sustainable Energy in 2017. The UNFCCC and, in particular, the Green Climate Fund provide a mechanism by which African countries can gain facilitated access to technologies developed elsewhere. At the same time, regional and local technological development is necessary, **together with associated skills development**. Based on the African Union climate strategy, technology transfer has been stressed on both adaptation (with technologies related to dealing with impacts of desertification, drought-resistant crop varieties and early-warning systems) and mitigation aspects (technologies related to low-carbon sustainable development)[40].

At the national level, many African countries have also been driving diverse policies to enhance adaptation and mitigation, as well as build up capacities internally to solve the challenges faced. Some of such strategies include: National Plan of Adaptations to Climate Change of Togo; National Policy on Climate Change for Namibia; National Adaptation Strategy and Plan of Action of Climate Change for Nigeria; Mauritania's National Adaptation Programme of Action to Climate Change (NAPA); Rwanda Green Growth and Climate Resilience-National strategy for climate change and low carbon development; Guinea-Bissau National programme of action of adaptation to climate changes; Benin's Low carbon and climate change resilient development strategy 2016–2025.

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[37] Nordling, L. 2019. "Scientists Struggle to Access Africa's Historical Climate Data," *Nature*, 574: 605-606.

[38] United Nations University. Research Uptake: Strengthening Climate Change Research in Africa. https://www.wider.unu.edu/research-uptake/strengthening-climate-change-research-africa

[39] https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/climate-investment-funds-cif/strategic-climate-fund/pilot-program-for-climate-resilience-ppcr

[40] African Strategy on Climate Change, African Union, May 2014

A.3   Higher Education and Climate Change.

Higher education institutions play a profound role in providing science-based solutions for climate change and related externalities. Over time, climate sciences curricula inclusion in education system and research programmes have led to increased scientific information and awareness of climate change impacts including scientific evidence on climate change events. In particular, universities and research institutes across the world host various research programmes on climate change backed with national, regional and international funding crosscutting PhD, masters, and fellowships. Through research and advocacy, the higher learning institutions continue to be central to both climate mitigation and adaptation globally. In addition, HEIs have far reaching role in teaching, building knowledge, and disseminating scientific knowledge on climate change in conferences and through various communities of practice. For example, in July 2019, led by the Alliance for Sustainability Leadership in Education, a network of 7,000 HEIs across 6 continents declared climate emergency committing to undertake three-point action plan with their students:

- Committing to carbon neutrality by 2030 and 2050.
- Mobilizing resources for climate research and skills development.
- Increasing in the curricula climate and sustainability education

Locally led research work on exposure to food insecurity, loss of water resources, infrastructures, and loss of livelihoods on negatively impacted communities in these regions is a significant step to bridge research and actions in addressing climate change. Demand for research output is growing in Africa especially those geared towards climate change adaptability. Although the research capacities of African scholars are still limited, efforts are being made to improve on climate change research in African higher learning institutions.

At all levels, there limited participation and capacities of global south higher institutions in climate change education and research. Even at high level institutional and research platforms, opportunities to participate vary across the globe, and this is even observed at IPCC level with affiliated researchers from different institutions globally. Currently IPCC consists of 278 experts from 65 countries assessing areas such as energy, transport, buildings, industry, agriculture. This is composed of 36 coordinating authors. 41% of the authors are from developing countries and 59% from developed. 29% are women and 71% are men. These experts have ties to the higher learning and research institutions[41].

Higher learning institutions in Africa are limited by resources and public financing to fulfil their commitment to the national climate agenda. McCowan 2020[42], further argues that the fact that university departments may have different priorities may also limit promotion of climate innovations. African HEIs have continuously grown interest in climate change space, focused on teaching and learning, building knowledge and values that promote climate resilience. Through different models such as policy training, environmental clubs, outreach, poetry, art, mathematics as adopted by AIMs. These efforts are further enhanced by the growing need for interdisciplinary approach and inclusivity in climate science education and research.

A.4   Research and climate change

Lack of diversity in climate science research is a significant limitation to innovating solutions for climate change in Africa. In the publication of 100 most influential climate papers by Reuters for instance, only five were Africans, representing 1% of climate papers.

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[41] https://archive.ipcc.ch/report/authors/report.authors.php?q=37&p=

[42] https://www.researchgate.net/figure/University-modalities-Source-McCowan-2020_fig1_369395726

Figure 2 100 most cited climate research papers between 2016-2020

Authors by continent (%)
Top 100 climate papers
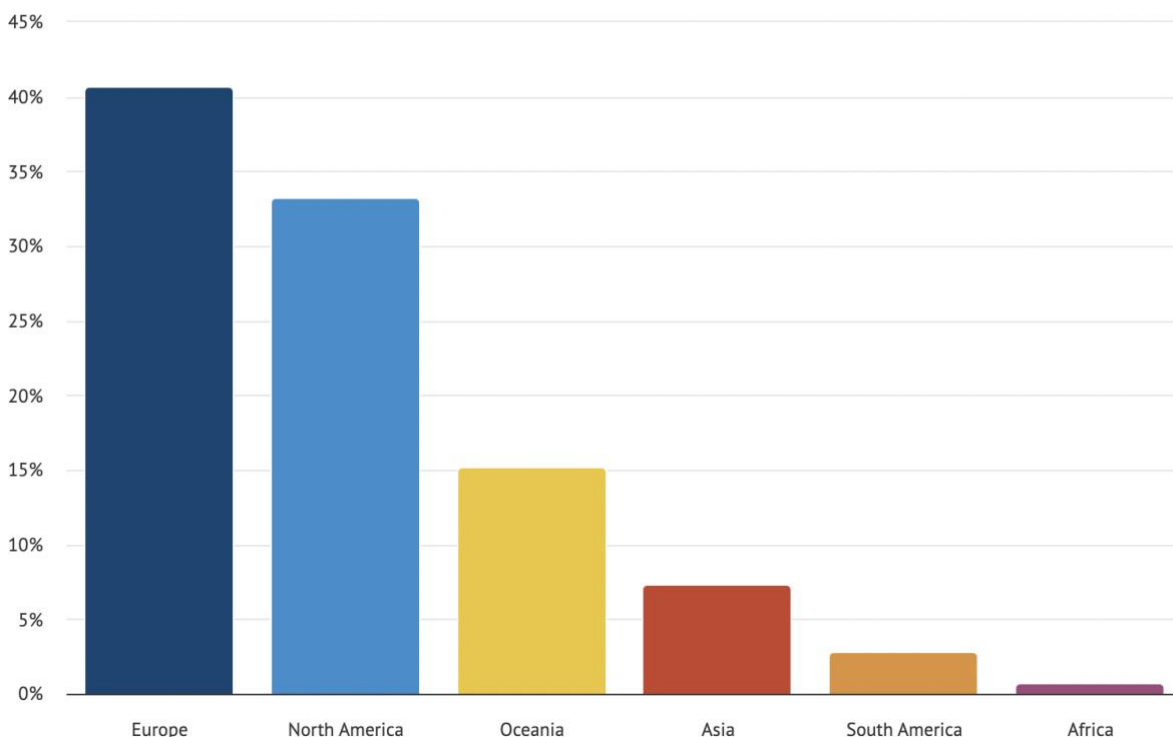
Source: Carbon Brief, 2021.

The researchers in the global south encounter challenges as the field of research to drive potential solutions in the climate field remain. In addition, gender representation in climate research also remains disproportionate. A survey of 1000 topmost influential climate researchers by Reuters in 2021 indicates that just 122(12.2%) were female. This could impact the needs of some vulnerable communities in the society as research output presents the voices of these communities. When climate researchers originate from these parts of the society, besides backing of scientific evidence there is an understanding of socio-cultural dynamics of these regions thus appropriate climate resilience actions. When these gaps exist it becomes, a sure limitation to action to address needs such as gender responsive climate action. In addition, out the 1000 most influential researchers surveyed just 1% were based in Africa while 75% affiliated to EU and American institutions[43].

Due to this disparity, efforts are being made to engage the African based researchers to increase engagement in quality publication in climate change. This is a key driver to adjust on the research driven solutions for climate change in the continent. Bridging this gap (lack of representation) could lead to innovative solutions to the climate challenges which are different in these regions. Programme such as Carnegie's Africa Programme[44] is working towards tracking engagement of Pan-African led climate research and as of November 2021, there were 117 African research organizations covering five thematic areas. (See the figure below, 'other' represents multiple workstream or peer reviewer, or policy-oriented work.)

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[43]

[44] https://carnegieendowment.org/2021/11/01/elevating-african-voices-in-climate-research-pub-85682

Figure 3 African Organizations working on climate related research.
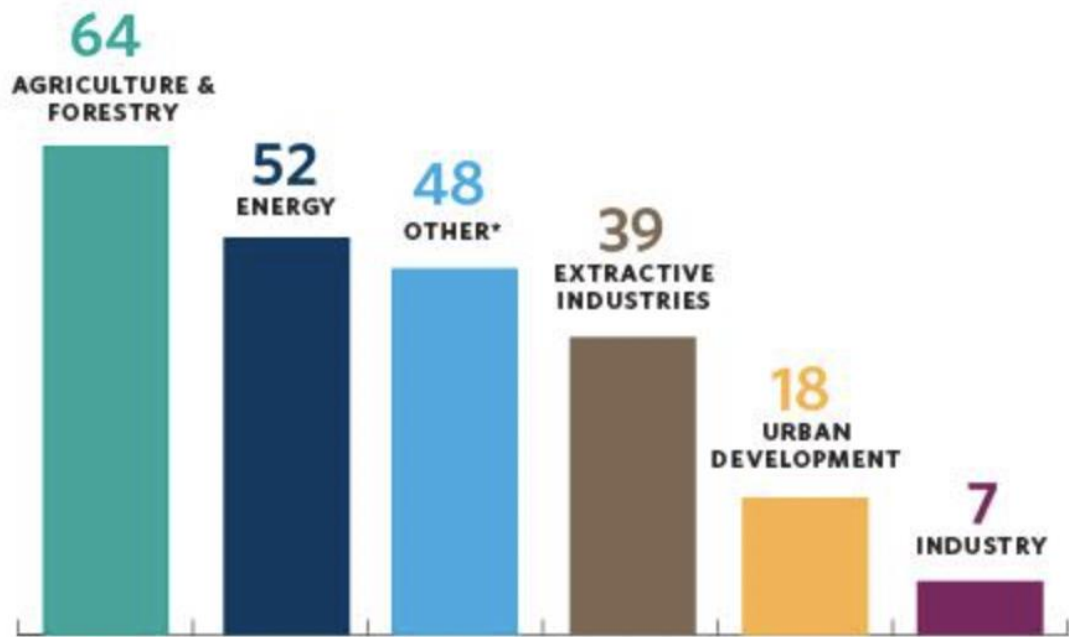
Source: Carnegie Africa Programme, 2023.

The above data concurs with the research conducted by the University of Sussex of tracking finance flow for climate research. Sampling 1,000 climate research funded projects (USD 2.2bilion), the results indicated that climate adaptation attracted 36% of fundings between 1990-2020, climate mitigation, energy system attracted a funding of 28%, transport and mobility 13% and geoengineering 12 % with industry coming last at 11%[45].

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[45] https://www.sussex.ac.uk/broadcast/read/57937

Figure 4 Funding for climate research in Africa and World
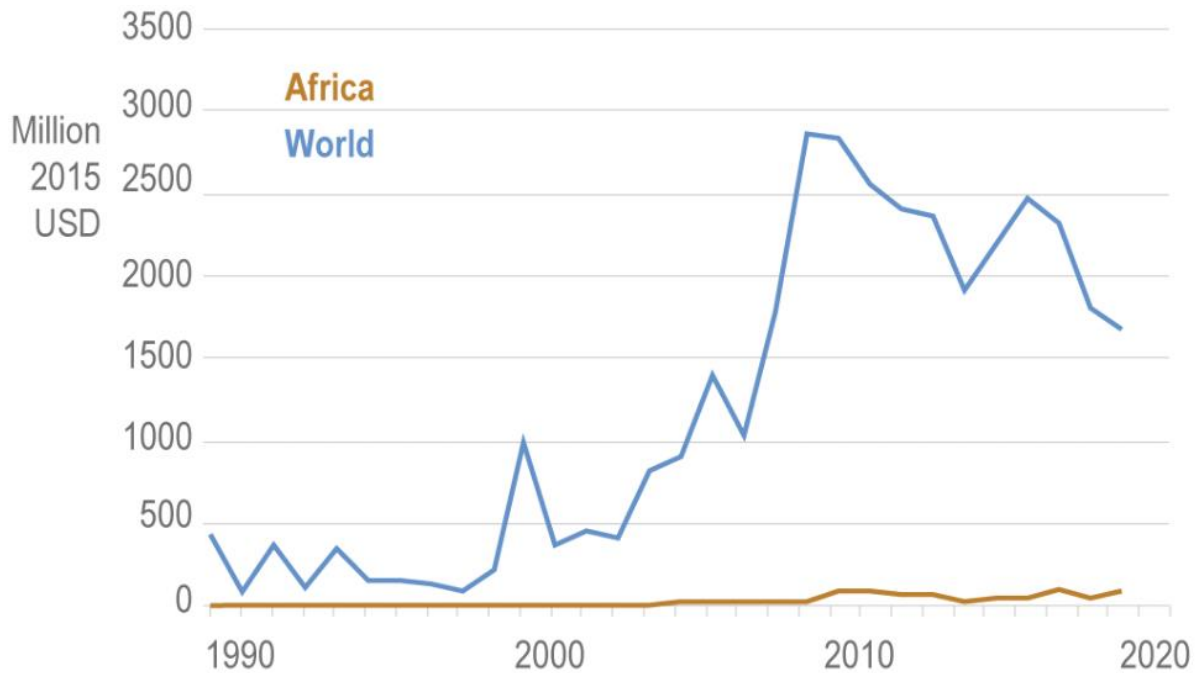
Source: IPCC, 2020

In addition, **between 1990-2020 Africa received just 3.8% of global climate change research funding** with just 1% reaching the African leaning institutions as Europe and North America received a total of 79% of research finding in climate research[46].

Higher learning institutions are better positioned to bridge the gap in information with in-depth understanding of the local community's needs. Role of research institutions was reiterated in COP27 in Egypt as this could fill the data gaps existing from the content for planning for both resilience, adaptation, and mitigation of climate change.

The United Nations Economic Commission for Africa (ECA) has recommended investing in a network for **Centres of Excellence in Science and Technology in the continent that can build a workforce to provide innovative solutions to climate change through research and development**.

Accordingly, research centres and education centres of excellence have recently been established specialising on climate change, including but not limited to: the African Centre of Excellence for Climate Smart Agriculture and Biodiversity Conservation (ACESABC); the ARUA Centre of Excellence in Climate and Development (ARUA-CD); the African Climate and Development Initiative (ACDI) at the University of Cape Town; the Institute for Climate Change Adaptation (ICCA) at the University of Nairobi; The Institute for Environment and Sanitation Studies at the University of Ghana, etc.

In parallel, the ECA established the Climate Research for Development in Africa (CR4D) initiative, to create "a multi-institutional and multi-stakeholder collaborative platform that mobilizes expertise and resources to facilitate use-inspired climate science research that

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[46] https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-9/

informs climate change policy and sustainable development planning in Africa"[47]. The intention is to develop Regional Climate Research Partnerships that involve diverse expertise from the natural, biophysical and social sciences to design research that translates into appropriate and actionable information for policy and sustainable development planning.

A.5 Mathematical sciences and Climate Change

Responses to mitigation and adaptation challenges must be based on the best available scientific knowledge[48] and much of this knowledge and potential lies in the field of science, technology, engineering and mathematics (STEM). First, predicting and understanding the impacts of climate change involves the use of sophisticated, quantitative mathematic models of chemical, physical and biological processes, including the integrated assessment models used for IPCC reports. Indeed, sufficient expertise in this area is required in order to participate on an equal basis in international negotiations (e.g. UNFCCC). Furthermore, it is important to ensure that such modelling efforts reflect sufficient and proportionate attention to the African region, in terms of the robustness of data and mechanisms modelled and geographical granularity. Second, STEM disciplines provide the foundation for pursuing resilient, climate-smart technological opportunities.

Climate change provides mathematical scientists with a broad range of challenging research problems whose solutions could have a large societal impact[49]. The figure below shows some of the dimensions in which mathematics for climate science can be engaged.

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[47] https://www.uneca.org/cr4d

[48] As recognised for example the jointly funded AU-EU Research & Innovation Partnership on Climate Change and Sustainable Energy (CCSE).

[49] Mathematics of Climate change A new discipline for uncertain century, Dana Mackenzie MSRI, 2007

A.6   Trends in Higher Education and Research in Mathematical Sciences

Africa's priorities for an effective higher education relies on the capability to design and implement education system that offers foundation to sustainable social economic development. Higher education in Africa has evolved in the last five years on basis of funding, research capacities, infrastructures and impacts to the global sustainable development goals. Importantly, this evolution has been notable for both in teaching and learning of mathematical sciences and climate sciences in Africa in especially in the wake of covid19. Key developments include:

Enrolment in tertiary institutions in Africa, especially Sub-Saharan Africa remains below global average.

Figure 5 enrolment rates in tertiary education across the globe
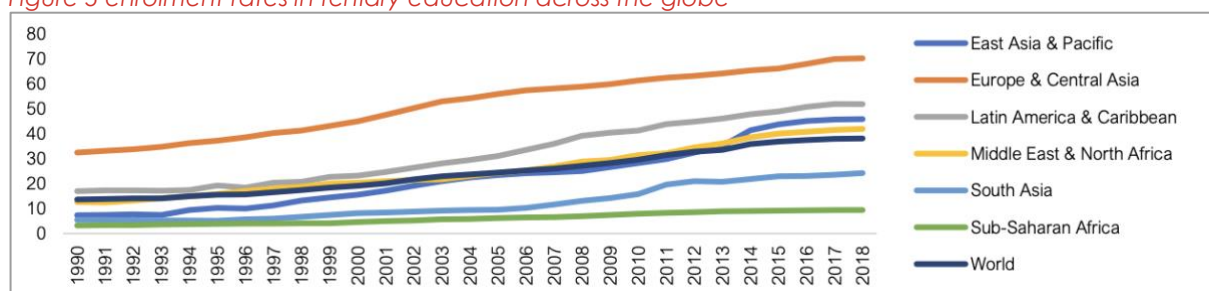
Source: UNESCO Institute of Statistics

While education systems in Africa has generally improved, these developments are majorly recorded in primary and secondary education, with consistently slow improvements in higher education. Free primary and secondary education have attained 80% of enrolment, however only 7% are getting enrolment in higher learning institutions with sub-Saharan Africa at 3%[50](2018). In 2019 enrolment in tertiary institutions in Africa alone recorded 9.4% compared to global average of 38%. In 2020 tertiary enrolment rates were 10%[51].

Government expenditure on research remains low: While in average the African government spent about 5% of the GDP on education (although second highest than any region in the world), the actual expenditure in research and innovation remains low just at 0.3% against the African Union declaration of 1% of their GDP annually. In terms of the allocation expenditure, government spends 21% on tertiary education, compared to 43% on primary education and 27% on secondary education[52]. Additionally, these expenditures do not adequately address the needed investments in the education system including higher education, research and development. Africa's expenditure on research and innovation also lags behind the global average of 1.7% in 2019.

Emergence of centres of excellence in higher learning institutions. Since 2011, there has been emergence of the knowledge centres of excellence in Africa facilitating research both at regional and national levels. This has significantly increased the research output partnering within the continent and also with research institutions in Europe, Asia and North America. The World Bank through the Africa Higher Education Centres of Excellence Programme[53] (2014-2020) supported over 14,000 masters and PhD students in STEM and also expanding capabilities for teaching, learning , access and sustainability. This included trainings in Applied mathematics offered in ACE centre Benin and training in ACE centre Senegal offering training

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[50] https://thedocs.worldbank.org/en/doc/908af3404023a2c31ef34853bba4fe60-0200022022/original/One-Africa-TE-and-COVID-19-11102021.pdf

[51] https://data.worldbank.org/indicator/SE.TER.ENRR?locations=ZG

[52] https://thedocs.worldbank.org/en/doc/908af3404023a2c31ef34853bba4fe60-0200022022/original/One-Africa-TE-and-COVID-19-11102021.pdf

[53] https://www.worldbank.org/en/results/2020/10/14/building-centers-of-excellence-in-africa-to-address-regional-development-challenges

in Mathematics and ICT. For this reason and other interventions by the European Commission, USAID and other development Agencies, the research output in Africa grew by 43% between 2012 and 2016, and prospects are even getting better in terms of publications. Additional funding of these research centres were through the Pan African University Alliances.

Research on mathematical knowledge in Africa is growing but productive use remains limited. Studies conducted covering the period 2014-2021[54] on the practicality of mathematical research in Africa illustrates growth in mathematical knowledge in Africa. However, a gap is still existing in the differentiation of the students' learning outcome and developing a practice from area from the training. Evidently, in the context of transfer of mathematical knowledge there is high emphasis for what trainers know and very low knowledge transfer to learners which leaves a question to whether the current teaching approaches are appropriate in training mathematicians. This link further translates to missing industrial applicability of the knowledge gained in the mathematical sciences, thus need to strengthen productive use of mathematical knowledge. In addition, there is need to assess the pedagogy applied for teaching, including conceptualising mathematical knowledge into a specified field, which imperatively should differentiate knowledge for teaching and practice-based teaching. Notably, the instruments and standards used in mathematical learning to larger extent do not contextualise Africa.

Digital learning and impacts of Covid19 on higher learning institutions: Covid19 pandemic tested the resilience of education system as well as research capacities defining the ability of higher learning institutions in medical research and participation in development of vaccines locally. Evidently, limited nexus of research in health in higher learning institutions remained limited in Africa.

Due to the social distance rules remote platforms emerged as key platforms to teaching in colleges and universities. Regions that had greater advancement in digital technologies transitioned rapidly to the techno-pedagogical models for their entire programmes. A significant divide in access to learning opportunities and access to digital infrastructure was exposed by Covid19.

Higher education research also faces challenges. While efforts have been made to address these shortcomings the following still remain to be solved:

Research as a driver of economic development. For Africa to meet the development needs Higher learning institutions must develop the needed research capacities, technical expertise, and strengthen the contribution to the salient areas of development of Africa. This includes practical solutions to the challenges such as climate change, governance, innovation, science, and technology. Transfer of research output or solution from research institutions outside the continent for example may not exactly provide solutions to the challenges facing African society. Mathematical sciences are central to this intervention.

Higher education plays an important role in socio-economic development. Besides providing human capital development through skills transfer and training, it is an important contributor in enhancement of this factor of production. In facilitating meeting of market demands higher learning institutions, also provide robust research capacities, and produce innovations that are valuable commercially for economic growth. Quality education significantly improves the human development index and a key pillar to the GNI score which defines the quality of life and how well being of people in society[55]. Additionally, Samuelson and Northaus, bases economic growth (stability of economic systems[56]) on four key elements and education is central to this: the quantity and quality of its labor force; the abundance of its land and other natural resources; the stock of accumulated capital; and lastly, the technological change and innovation that allow greater output to be produced with the same inputs. To strengthen economic outputs and sustain economic growth in Africa including industrial output, research, innovation and technological advancements, there is need to invest in higher education to achieve higher results in the quality of labour force.

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[54] https://ajoted.org/index.php/ajoted/article/view/10/30

[55] https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

[56] https://www.bu.edu/eci/files/2020/04/Chapter-2_Sample-Chapter.pdf

Sustainable financing of higher education systems. There is need to break from high reliance on the traditional funding models to diversify the sources of financing higher education. Over the last five years, reliance on government for funding remains one of the shortcomings of many public research institutions. In addition, some countries rely heavily on foreign funding for national budgets. With economies constrained with public debts, the situation remains volatile, and many majorities of research institution find it difficult to build research programmes. Further, there is limited opportunity to respond to the development needs as donor funds are linked to donor demands. Frequent strikes by lecturers lasting up to a year also paralyses learning in the African countries.

Lagging infrastructure: This includes the physical and digital infrastructure to improve learning that matches the market needs in the 21st century. The pedagogy created at the beginning of the industrial evolution may not meet the current market needs as Africa needs to pace up for the fourth industrial revolution[57]. Global economies are changing and key education models such as education technologies are changing across the globe. New skills set connecting to changing market needs are needed to adjust the current teaching approaches. In addition, overcrowding of students in the higher learning institutions in Africa makes it difficult for the research staff to teach effectively thus impacting considerable the quality of teaching, research and learning. Research applicability in areas such as agriculture and climate change remain limited.

Weak links with the private sector and international markets: Shifts in linking economic gains from higher learning institutions especially through research remains limited compared to other regions and is significantly needed. In case studies of higher learning institutions in UK indicate a contribution of about 3% of the GDP annually and 940,000 jobs, Canadian 55billion and Australian 25 billion annually. Technological advancements developed by universities in the USA contributed about 591billion to the GDP between 1996-2015[58] alone. Whereas in Africa due to the missing link of teaching and industry needs (87%) of private sector CEOs in Africa remains concerned of the availability of key skills in the workforce. In the year 2040, Africa work force will be 1.1billion surpassing Asia and Europe.

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[57] https://www.technopolis-group.com/africas-fourth-industrial-revolution/

[58] https://digitalmarketinginstitute.com/blog/what-is-the-importance-of-higher-education-on-the-economy

Appendix B Presentation of MS4CR Programme at AIMS

Established in 2003 in Cape Town, South Africa, the African Institute for Mathematical Sciences – Next Einstein (AIMS-NEI) is a pan-African network of centres of excellence offering postgraduate education, research, and public engagement for the development of Science, Technology, Engineering and Mathematics (STEM) in Africa. AIMS-NEI recruits Africa's most talented university graduates to pursue a one-year fully funded master's in mathematical sciences in a highly interactive and culturally diverse learning environment. AIMS-NEI attracts world-class lecturers and research fellows on a volunteer basis to further improve the learning experience for students. Building on the success of its first centre in South Africa, AIMS launched the Next Einstein Initiative (NEI) in 2008 to scale up and roll out the AIMS-NEI model across the continent. Six additional centres were established in Senegal (2011), Ghana (2012), Cameroon (2013), Tanzania (opened in 2014 but closed since 2020), and Rwanda (2016). As of December 2020, over 2,200 students (33% women) from 43 African countries had graduated from AIMS post-graduate programmes of whom 54 were graduates of the MS4CR programme.

The AIMS Mathematical Sciences for Climate Change Resilience (MS4CR) Programme is a CAD $20 million initiative funded through Canada's International Development Research Centre (IDRC). The objectives of the MS4CR programme are (i) to increase the contribution of African mathematical scientists in finding solutions to climate change-related challenges in Africa through training, internships, and research and (ii) to support the consolidation of AIMS' operations across the continent through strengthening existing AIMS centres. The programme was originally to be implemented over five years (2017/2018 – 2021/2022). A time extension to the research component was agreed in 2020 for an additional year - to permit completion of planned activities postponed due to delays in hiring of the Research Chair. This component will thus end in June 2023.

The partnership between AIMS-NEI and IDRC extends beyond the MS4CR programme. The initial contribution by IDRC and GAC (CA$ 20 million in 2010 and CA$ 2 million in 2013) laid the foundation for AIMS to grow into the Pan-African network it is today. AIMS is also involved in a number of IDRC projects as subgrantee. Other joint activities/collaboration include the GAC-funded Skills for Employability Programme at AIMS Senegal since 2016. Note that GAC also provided CA$2.5M in short term funding to cover core costs in support to AIMS' cost savings and deficit reduction plan.

The MS4CR programme is composed of **five pillars**:

- **Master's Programme**: the climate science stream was to be offered at AIMS Rwanda and AIMS Tanzania within the ten-month structured AIMS Master's programme, composed of both functional courses and a three-month applied research project. Other AIMS centres (Cameroon, Ghana, Senegal and South Africa) were to offer elective courses in climate science in order to introduce the students to how mathematical sciences can be applied to climate change-related issues. However, in the course of programme implementation, modifications were brought to the programme: AIMS Tanzania did not offer the climate science stream (as the centre faced financial difficulties and was eventually closed) but AIMS Cameroon and Senegal did so from September 2020. Only AIMS Ghana, Cameroon and Senegal offered the elective courses.

- **Internship Programme**: seeks to place students and alumni in internships with relevant industry partners. It also seeks to build sustainable partnerships with industry partners across and beyond Africa. In addition, some students can obtain industry experience through

Mitacs "Global Links Programme[59]," which involves spending six-to-eight weeks in a research or internship placement in the fields of sustainable development, engineering or renewable energy.

- **Research Programme**: provides i) research scholarships for Masters, PhD students and Post-Docs; ii) Research chairs involving resident researchers, Post-docs, PhD and Masters students; iii) Small research grants to researchers (USD 10,000 per project); iv) Research Fellowships for women (up to USD 35,000 for an innovative research project in climate change at an African host institution) and mobility grants; v) Sponsorship to Next Einstein Fellows (NEF) for NEF Global Gatherings and promotion of thought leadership in climate science through the participation of researchers to climate science panels and other pre-events organised by NEF Global Gathering.

- **Climate Science Fellowship for Women**: dedicated activities including i) Women fellowships; ii) Mobility grants for women researchers to facilitate their participation in climate science-related opportunities; iii) Publications to profile leading African women climate scientists; iv) AIMS Women in Science Climate Change Speaker Series; v) Gender Summit; vi) Other outreach activities to encourage girls to pursue further studies in mathematical sciences and climate change.

- **Consolidation of AIMS network**: concerning the MS4CR, hiring an MS4CR programme manager; concerning the overall AIMS network, opening of a new AIMS centre in Francophone Africa, enhancing key internal systems (including finance, human resources, communications, fundraising, IT, gender equality, M&E and procurement).

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[59] Mitacs Globalink Research Internship is a competitive initiative for international undergraduates. From May to October of each year, top-ranked applicants participate in a 12-week research internship under the supervision of Canadian university faculty members in a variety of academic disciplines, from science, engineering, and mathematics to the humanities and social sciences.

Figure 6 Draft Theory of Change MS4CR Programme

ULTIMATE OUTCOME	**1000** Improved climate change resilience in Africa

INTERMEDIATE OUTCOMES	**1100** Increased contribution of African mathematical scientists (women and men) in finding solutions to climate-change related challenges in Africa.	**1200** Strengthened operations of AIMS centres

H2: AIMS students, alumni, and researchers (women, men) demonstrate high skills in climate science, which are suited to employment requirements.
H3: Women are aware of the career opportunity to study and work in the field of mathematical science for climate resilience.

IMMEDIATE OUTCOMES

1110 Increased access for African students (women and men) to post-graduate education in mathematical sciences with a focus on climate change	**1120** Increased research by African mathematical scientists (women and men) in the field of climate science	**1130** Increased capacity of AIMS alumni (women and men) to work in climate change fields within industry, governments and non-governmental organizations.	**1140** Increased capacity for African women to participate in research in climate change fields	**1150** Increased visibility of African women in the field of mathematical sciences and climate change	**1160** Increased interest of African girls in mathematical sciences and climate change	**1210** Sustained capacity of AIMS centres to deliver high standards of training in advanced mathematical sciences	**1220** Strengthened institutional capacity of the AIMS Network

H4: High quality responsive courses tailored to the need of the labour market.
H5: African Students are attracted to study at AIMS and join the climate science stream.
H6: Mathematical researchers are interested into research in climate science.
H7: There is a conducive environment for research in climate science in partner universities.
H8: There is equity in career and research opportunities for women and men.
H9: The delivery of gender responsive curricula/activities and opportunities for women changes perceptions and behaviour in male and female beneficiaries.
H10: Employment and internships opportunities are available in climate science in Africa.
H11: Employers (public, private) are willing to participate in the programme.
H12: Stakeholders are committed and engaged to support the evolution of the MS4CR Programme.
H13: Staff are well equipped to support the delivery of the programme.
H14: Well-functioning systems and operations at AIMS.

OUTPUTS

1111 A Climate Science Stream at	**1121** AIMS Research Chair and Resident Researchers in Climate Science	**1131** A successful internship programme is created to	**1141** A climate science fellowship programme	**1151** Publications to profile leading African women climate	**1161** Girls are targeted and encouraged to pursue further studies in	**1211** African graduate students (women and men) are trained in	**1221** Key internal systems (including finance, human resources, communications,

AIMS Rwanda, AIMS Senegal, AIMS Cameroon, and AIMS Ghana are created **1112** A climate science course option is offered at AIMS Ghana and AIMS Cameroun	programme is created **1122** AIMS Research Scholarships in climate science is created for Master's, PhD and Post-doc students working under the AIMS Research Chair in Climate Science **1123** The Next Einstein Forum promotes climate change research (by women and men) **1124** Small research grants programme in climate science is created	secure placements for AIMS alumni (women and men) in industry, governments and non-governmental organizations in the field of climate change	for women is created **1142** Mobility grants are provided to women researchers to facilitate participation in climate science-related opportunities	scientists are produced **1152** AIMS Women in Science (AIMSWIS) Climate Change Speaker Series is created **1153** Gender Summit- Africa is delivered	mathematical sciences and climate change	advanced mathematical sciences at the post-graduate level.	fundraising, IT, gender equality, M&E and procurement) are strengthened **1222** Additional programme staff are hired to support AIMS Network

ACTIVITIES

1111.1 Design the curriculum for the Climate Science Stream at AIMS-Rwanda, Senegal, Ghana, and Cameroon **1111.2** Recruit lecturers with expertise in climate change **1111.3** Recruit students into climate	**1121.1** Launch call to recruit Research Chair and Resident Researchers in Climate Science **1121.2** Recruit Research Chair and Resident Researchers in Climate Science **1122.1** Launch calls to provide AIMS Research Scholarships in climate science to Master's, PhD and Post-doc students (women and men) working under the AIMS Research Chair in Climate Science	**1131.1** Develop partnerships with industry, government and non-governmental organizations in the field of climate change **1131.2** Train AIMS students in transferable skills for the workplace prior to their internship placements **1131.3** Follow up with interns	**1141.1** Design climate science fellowship programme for women **1141.2** Launch call for applications to select climate science fellows **1142.1** Identify early-career women scientists	**1151.1** Identify leading African women climate scientists within the AIMS network to profile **1151.2** Launch a call to identify leading African women climate scientists outside of the AIMS network to profile **1152.1** Design AIMS Women in Science (AIMSWIS) Climate	**1161.1** Organize public outreach events aimed to inspire girls and boys to pursue further studies in mathematical sciences and climate change	**1211.1** Recruit African graduate students (women and men) to AIMS centres **1211.2** Provide students with AIMS bursaries towards the study of mathematical sciences	**1231.1** Review and update AIMS key internal systems **1231.2** Clarify roles and responsibilities of AIMS departments and staff **1231.3** Train AIMS staff on internal policies and procedures **1231.4** Network consolidation (advancement, communication, governance, capital assets)

science stream **1112.1** Recruit lecturers to offer climate science course options at AIMS Ghana and Cameroon	**1123.1** Identify and connect with existing communities of practice on climate science **1123.2** Launch calls to recruit Next Einstein Forum fellows in climate science (for women and men) **1123.3** Recruit Next Einstein Forum Fellows in climate science **1123.4** Organize panel in fields related to climate science at Next Einstein Forum Global Gathering **1123.5** Reach-out to expert to organize pre-events in fields related to climate science at Next Einstein Forum Global Gathering **1124.1** Launch call for small research grants in climate science (women and men)	and host organizations during and after internships to gather feedback on the strengths and weakness of the placement in order to further improve the internship programme going forward	requiring mobility grants to facilitate participation in climate science-related opportunities	Change Speaker series **1152.2** Recruit experts to deliver Speaker series **1153.1** Design Gender Summit-Africa			**1231.5** Peer review of AIMS centres **1232.1** Recruit MS4CR programme manager **1232.2** Consolidate Secretariat staff

Source: MS4CR Programme Logic Model, AIMS (April 2020), Adapted by Technopolis (February 2021)

Table 3 Achievement of the master's level training Programme - Outputs

Activity	Baseline	Initial targets[60]	Revised targets (2017)[61]	Midterm status (Dec.2020)[62]	Final status (August 2023)	Achievement rate[63][64]	Gender ratio[65]
Climate Science Stream *(number of offerings)*	0	• 3 (AIMS Rwanda) • 3 (AIMS Tanzania	• 4 (AIMS Rwanda) • 2 (AIMS Cameroon) • 2 (AIMS Ghana) • 2 (AIMS Senegal)	• 2 (AIMS Rwanda)	• 6 (AIMS Rwanda, AIMS Ghana, AIMS Senegal, AIMS Cameroon	• 75%	
Climate Science Stream *(graduates)*	0	• 88 graduates (34% F)	• 174 graduates (30% F)	• 54 (38M, 16F)	• 168(64F,104M)	• 96%	38%
Climate Science course options *(offerings) i.e. electives?*	0	• 5 centres (Cameroon, Ghana, Senegal, South Africa, new centre in francophone country)	• 2 centres (AIMS Cameroon, AIMS Ghana)	• 2 centres	• 3 centres (AIMS Ghana, AIMS Senegal, AIMS Cameroon)	• 150%	
Climate Science course options *(graduates)*	0	• 105 graduates	• 20 (10 per centre)	• 61 (41M, 20F)	• 139(49W, 90M)	• 143%	64%

Source: AIMS MS4CR Performance Management Framework (Dec. 2020) and 7th Technical report and AIMS MS4CR Performance Management Framework (Dec. 2020) and 11th Technical report and 11th MS4CR Interim PMF (Dec. 2022).

[60] From implementation plan, June 2017

[61] From implementation plan, June 2017

[62] From Performance Measurement Framework, July 2021

[63] Key: Red – Achievement rate < 50%, Orange – Achievement rate > =50%, Green – Achievement rate >=100%.

[64] Achievement rate is calculated against revised target.

[65] Key: Red – Gender ratio < Target threshold (30%), Green – Gender ratio >= Target threshold (30%).

Table 4 Achievement of the Research Programme – Outputs

Activity	Baseline	Initial target	Revised target	Midterm status (Dec.2020)	Final status (August 2023)	Achievement rate	Gender ratio
Research scholarships	0	• Total: 50	• Total: 45	• Total: 30 • (24M, 6F)	• 43(29M,14F)	• 95%	• 32%
Research masters	0	• 20 Masters	• Masters: 18	• Masters:11 (9M, 2F)	• 17[66](4F, 13M)	• 100%	• 22%
PhD students	0	• 14 PhDs	• PhD: 12	• PhD: 12 (9M, 3F)	• 13(7M, 6F)	• 108%	• 46%
Post-Docs	0	• 16 post-Docs	• Post-doc: 15(4W,8M)[67]	• Post-doc: 7 (6M, 1F)	• 12(8M,4F)	• 80%	• 33%
Research chairs	0	• 3 chairs	• 1 Research Chair • 2 Resident Researchers	• 1 research chair • 3 resident researchers • (1M, 2F)	• 1(M)research chair • 2(F) Resident researchers	• 100% • 67%	• 66%
Small research grants	0	• 16 grantees	• 4 calls for proposal (1 per year) • 19 grantees	• 2 calls launched • 10(6M, 4F)	19(7F,12M)	• 100%	• 36%
Climate science Fellowship for women	0	• 20 grantees	• 4 calls for proposal (1 per year)	• 3 calls launched	• 21 grantees awarded • 4 calls launched	• 100%	
			• 21 fellows	• 6 fellows	• 21fellows	• 100%	
Mobility grants for women	0	• 10 grants awarded	10 grants awarded	6 grants awarded	• 11grants awarded	• 110%	
Climate science Fellowship for women	0	• 20 grantees	4 calls for proposal (1 per year)	3 calls launched	• 21 grantees awarded • 4 calls launched	• 100%	
			• 21 fellows	• 6 fellows	• 21fellows	• 100%	

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[66] One male master's student withdrew from the programme on personal grounds, 17 have completed.

[67] One post doc candidate withdrew from the programme

Activity	Baseline	Initial target	Revised target	Midterm status (Dec.2020)	Final status (August 2023)	Achievement rate	Gender ratio
NEF Fellows in field related to climate science (women and men)	0	• 8 fellows • 10 panellists in NEF Global Gatherings • 40 participants supported to attend pre-events	• 5 fellows supported	• 5 fellows	• 5 fellows	• 100%	
			• 10 panellists in NEF Global Gatherings	• 22 panellists in NEF Global Gatherings	• 22 panellists in NEF Global gatherings	• 220%	
			• 40 participants supported to attend pre-events	• 22 participants supported to attend pre-events[68]	• 22 participations supported to attend per-events	• 55%	
			• 15 Alumni supported to attend NEF GG	• 14 Alumni supported to attend NEF GG	• 14(2F,12M) Alumni supported to attend NEF	• 93%	• 14%

Source AIMS MS4CR Performance Management Framework (Dec. 2020) and 7th Technical report, and AIMS MS4CR Performance Management Framework (Dec. 2020) and 11th Technical report and 11th MS4CR Interim PMF(Dec.2022)

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[68] The exact number of NEF Fellows who featured in the virtual NEF GG, 2020, from 8-10 December 2020 not included because not yet available.

Table 5 Achievement of the WiCCs programme - Outputs

Activity	Baseline	Initial target[69]	Revised target[70]	Midterm status (Dec.2020)	Final status (August 2023)	Achievement rate[71][72]
Fellowship for women	0	• 20 grantees	• 4 calls for proposal (1 per year)	• 3 calls launched	• 4 calls launched • 21 grantees, awarded	• 100%
			• 21 grantees	• 6 fellows	• 21 grantees, awarded • 21 fellows	• 100%
Mobility grants	0	• 10 grants awarded	• 10 grants awarded	• 6 grants awarded	• 11 grantees awarded	• 110%
Publications profiling African women climate science scientists	0	• 4 issues of the publication	• 4 issues of the publication	• 2 issues of the publication	• 3 issues of the publication	• 75%
			• 60 women researchers profiled (15 per issue)	• 30 women researchers profiled	• 51 women researchers profiled	• 85%
AIMS Women in Science Climate Change Speaker Series (AIMSWIS)	0	• 24 series organised	• 15 series organised (3 per centre)	• 2 series organised	• 7 series organised (4 AIMS South Africa, 1 Ghana, and Cameroon)	• 70%
			• 600 attendees (30 per event)	• 122 attendees (45F, 77M)	• 460 attendees (187F, 273M)	• 76%
Gender summit	0		• 2 Gender summits organised	• 2 Gender summits organised	• 2 Gender summits organised	• 100%
			• 750 women scientists attendees	• 276 women scientists attendees	• 276 women African women scientists	• 37%
Other outreach activities	0		• 4 outreach activities	• 3 outreach activities organised	• 5 outreach activities (due to covid outreach events were	• 125%

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[69] From implementation plan, June 2017

[70] From PFM, February 2021

[71] Key: Key: Red – Achievement rate < 50%, Orange – Achievement rate > =50%, Green – Achievement rate >=100%.

[72] Achievement rate is calculated against revised target.

Activity	Baseline	Initial target[69]	Revised target[70]	Midterm status (Dec.2020)	Final status (August 2023)	Achievement rate[71][72]
					temporarily on hold)	

Table 6 Achievement of the master's level training Programme - Outputs

Activity	Baseline	Target[73]	Midterm status (Dec.2020)	Final status (August 2023)	Achievement rate[74]	Gender ratio[75]
Internships provided	0	• 100 (30% F) • Revised target 167	• 62 (38M, 24F)	• 174(75F,99M)	104%	43%
Organisations hosting interns	0	• 15	• 7	• 26	173%	
Internship partnerships formalised with organisations	0	• 15	• 11	• 26	173%	

Table 7 Achievement of the Consolidation Programme - Outputs

Functions	Actions
Governance	**AIMS International Governing Board Charter** (operational principles) was approved by the Board in February 2021. The following changes have been introduced: - Replace practice of silent approval with more practical and prudent approval practice - Include calendar of board activities - Make provision for annual general meeting - Introduce annual evaluation of the board and its committees - CEO expenses must be pre-approved by the Board or AFC and AFC must take a stock of CEO expenses on a quarterly basis - Appointments: CEO must be appointed by the Board; appointments of CFO, CSO, CAO and Centre Presidents must be pre-approved by the Board; and appointment of International Auditor must be done by a committee, including all members of the AFD

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[73] From Performance Measurement Framework, February 2021

[74] Key: Green- Above 100%, Orange – Above 50%, Red – Below 50%.

[75] Key: Green- Above 30%, Red – Below 30%.

	Expansion of the AIMS International Governing Board, making it more effective. A new Board member was added, Mr. Charles Boamah, Ex- senior Vice President and Chief Financial Officer of the African Development Bank. He is now the Chair of the re-established Audit and Finance Committee. Board is expected to add two more members towards the later part of 2021. AIMS started undertaking a profound **restructuring and reorganization process** to ensure more streamlined operations and increased efficiency and effectiveness, and contracted KPMG to conduct an internal audit to assess the existing structure, operations, and policies. **Revised organisational structure of the Board**, to reduce PCEO span of control, align with strategy, and eliminate role ambiguity. All policy chapters were revised in February 2021 to include: - All requests initiated by CEO and all exceptions to the policy must be pre-approved by AFC - Delegation of authorities must be pre-approved - Reference to the position titles is changed, e.g., PCEO to CEO, VPO-CFO to CFO, etc., - Non-compliance and repercussions are clearly defined in each policy chapter **AIMS 2021-2026 Strategic Framework** designed early 2021. Further actions taken based on the 2022 review included: - Approval of the roles of AIMS College of Professors Committee. - Approval of the updated Board Charter passed on 17th November 2022. - Approval of the Board Evaluation to be conducted once a year and results documented for future references.
Finance	A total of **11 new finance policies** were finalized and approved by the AIMS International Governing Board in July 2019. These are: Accounting and Financial Reporting; Financial Management and Authorization; Budget and Resources Allocation; Banking and Cash Management; Investment; Reserves; Borrowings; Audit and Compliance; Grants and Project Management; Information Technology; and Information and Records Management. **ACCPAC** (financial system) was upgraded to support timely closure of books of accounts and to enable system-based reconciliation of inter-company accounts between the entities. The AIMS International Governing Board includes a schedule of activities to be undertaken by the **Audit and Finance Committee** of the Board. **Financial reports vetting process** was put in place: the Chief Finance Officer now vets financial reports to donors before their submission. An online platform was created to help streamline centre-level planning and reporting. **Financial statements** of all entities are regularly audited including the consolidated financial statements of the network. AIMS is in the process of **hiring an internal auditor** towards improving due diligence and offering financial oversight. A section was added on mapping Stellenbosch University Accounting coding structure with AIMS accounting structure.
Human resources and hiring of programme staff	December 2018, **a dedicated MS4CR programme Manager** was hired. In 2019, **a Director for Programme Delivery and Reporting** was hired. In the first half of 2020, AIMS laid off nine employees and dismissed four employees due to misconduct. In the second half of 2020, hiring took place for a: **Chief Academic Officer** of the AIMS Network; **Global Network & Centre President**, AIMS Cameroon; **Chief Scientific Officer** for the AIMS Global Network, replacement of **AIMS Global Network CEO**; Secretariat based **Director of HR** December 2020, Employee Handbook was converted into HR policy manual with specific policy chapters: - Recruitment, selection and staff on-boarding

	- Staff welfare and remuneration
	- Pay administration
	- Performance management
	- Training and development
	- Staff conduct
	- Organisational structure and reporting relationships
	- Working hours, and accountability hours worked
	- Compensation with equitable grading and salary structure
	- Organisational culture and audit
	- Code of conduct and professional Ethics
	- Conflict of interest
	- Disciplinary procedures
	- Termination of employment
	HR information system launched April 2021.
Communication and IT	The **AIMS SharePoint platform** was established June 2020, providing an online collaborative platform for AIMS staff to share and manage information and knowledge. It is intended to promote collaboration across the network by sharing financial/procurement documents, policies/guidelines/procedures/templates, academic materials/reports etc. AIMS intend to hire a **software developer**, that will support the setup of the electronic climate science information service and facilitate converting research results into public goods.
Procurement	AIMS adopted a **new procurement manual**, setting out the procedures, processes and guidelines for the procurement of goods and services across the network, aiming at greater efficiency and effectiveness in service delivery. The following are enforced: - All purchases between USD 15,000 and USD 150,000 must be jointly approved by the CEO and CFO and verification by Internal Auditor - In case of higher value purchases, no formal or informal commitments should ever be made without the approval of the AFC - Legal review of contracts above USD 150 K - Internal Auditor must review all purchases above USD 150K before it is sent to AFC for approval - Provision for pre-qualification exercise to identify competent service provider **Training on the new procurement process** was delivered on several occasions to staff. Based on the assessment conducted by KMPG in 2022 submitted February 2023, AIMS has reinforced the following to address the gaps in procurement: - AIMS has constituted a tender committee of three members, one from the finance, a representative from management, and logistics/requesting department. - Operations manager mandated with procurement responsibilities and ensuring compliance with the procurement policy. However, ERP system has not been modelled, due to financial constraints, and there still a risk of fraudulent procurement conducted procurement to pay system.
Fundraising	**Continuous engagement with Host country governments** was carried out to obtain their financial contributions as agreed in the country MoUs. **Other options have been pursued** with Foundations, high-tech companies or social enterprises, and paid summer courses. A **High-Level Advisory Council (HiLAC)** was established at AIMS to help mobilise significant long-term funding for the network and a **Donor Committee** to provide a convening forum for AIMS' major donors.

Gender equality	**AIMS Gender Equality & Inclusion Policy and Strategy** was drafted and validated in 2020; AIMS is the process of appointing a gender officer responsible for mainstreaming gender across the network. The **position** will be placed under the CEO office according to the new organigram.
Operations and M&E mechanisms	A **Risk Management Committee** was created, and a **Risk Management Plan** was approved by the Board in July 2019. The Committee is mandated to develop a Corporate Risk Profile and a Risk Management Policy and Procedures. The Committee is also tasked with providing risk management training to AIMS employees. The Committee was expected to deliver on all aspects by June 2020. An **AIMS at a Glance** document was produced (organizational fact sheet for every AIMS entity) It includes an overview of all entities –budget, activities, list of employees, main cost elements, and status of regulatory compliances. The **AIMS Environmental Policy** was drafted by the Skills for Employability programme at AIMS Senegal, supported by Global Affairs Canada. **Grants and project Management Policy and Procedures** have been enhanced: - Donor financial reports must be approved by the Internal Auditor - Include guidelines on reallocation of resources and all reallocation of resources must be pre-approved by the AFC, both in case of restricted and unrestricted grants - For restricted Budgeted expenditures, AFC approval in advance must be obtained for over-expenditure - Donor approval should be mandatory for expenditures beyond budget, in accordance with the grant conditions **Travel policy** was introduced: - Emphasise that the travel should be the last option after exploring virtual means of meeting - All employees, irrespective of their level, must submit back to office or trip report - CEO travel must be preapproved by the AFC - CEO travel expenses must be approved by the AFC - CEO should not approve any exception to travel policy The **M&E component** will be placed under the CEO office according to the new organigram. AIMS has drafted M&E framework to track the strategic plan. This was concluded together with Annual Work Plan 2022/2023.

Source AIMS MS4CR 1st to 11th Technical reports (2017 – August 2023) and KPMG Review of AIMS policies and procedures – recommendations and Action Plan – Status Report Apr 30, 2021

Appendix C   Survey results

The survey was distributed to AIMS Mathematical Sciences for Climate Resilience (MS4CR) students in the five AIMS Centres (Senegal, Ghana, South Africa and Cameroon). It was launched on the on the 11th of July 2023 and was closed on the 4th of August 2023.

This online survey was made available through a link dedicated to collect information on the AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation. The purpose of the survey was to gain the insights from AIMS MS4CR students (current and alumnus) on the effectiveness, impact, sustainability, and recommendations. The findings of the survey by the close of data collection period are detailed below:

Survey has attracted 112 respondents. There were 51 completed responses to this survey and 61 partial responses which are defective thus not included in the analysis. This analysis will focus on survey results recorded from complete responses as of 4th August 2023.

C.1   Some information about the students

The survey attracted a total of 51 complete responses, 20 females and 31 male respondents representing 61% and 39% respectively. Thus, more male students and alumni actively participated in this survey compared to the female counterparts. The figure below shows the response rate by gender.

Figure 7 No of respondents by gender
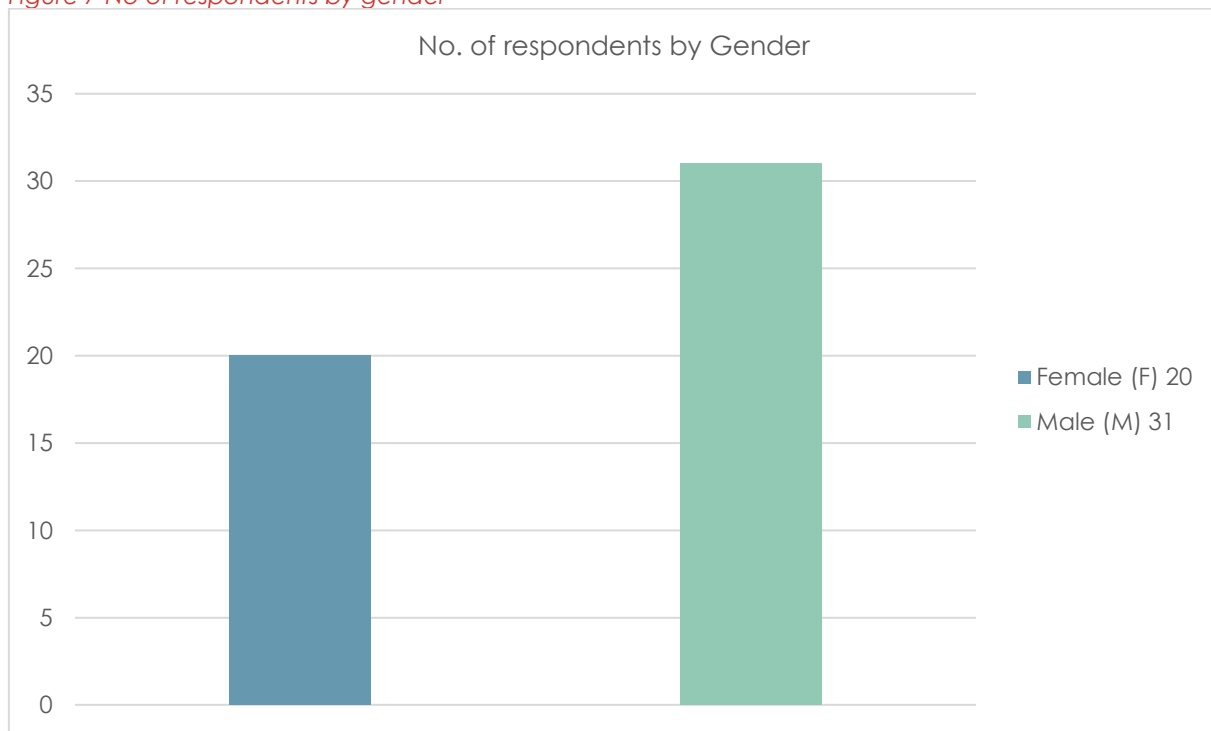
Source: Technopolis MS4CR Survey, 2023

Responses to Q2. What is your nationality?
 The entry of nationalities of the respondents is presented in table 8 below:

Table 8 Respondents by nationality

Nationality	Total	Percentage (%)
Benin	3	5.88%

Burundi	1	1.96%
Cameroon	8	15.69%
Ghana	6	11.76%
Kenya	5	9.80%
Madagascar	1	1.96%
Malawi	1	1.96%
Nigeria	1	1.96%
Rwanda	13	25.49%
Senegal	7	13.73%
Sudan	1	1.96%
Tanzania	3	5.88%
Zimbabwe	1	1.96%
Grand Total	**51**	**100%**

Source: Technopolis MS4CR Survey, 2023

Overall, the data collected reflects diversity of AIMS students and alumni due to different nationalities represented. The survey recorded a total of 13 African countries from the responses. Majority of the respondents are nationals of Rwanda at 13 out of 51(25%), Cameroon 8(15%), Senegal 7(13%) and Ghana 6(11%). The early results indicate that there is high response to AIMS presence at national levels with students in the countries where the centres are located paying high attention to join the training offered by the MS4CR programme. The figure 8 below illustrates the distribution of the students by nationality.

Q3. Are you a student or an alumni of the AIMS MS4CR Programme?

Regarding the status of the respondents, 84% of the respondents to this question are AIMS MS4CR Alumni and 16% are current students. The table below shows the results of count of respondents by category students and alumni. This indicates that the survey reached the right audience as highlighted in the inception report.

Answer(responses)	No. of respondents	Percentage
Alumni (Q3b)	43	84,31%
Current student (Q3a)	8	15,69%
Grand Total	**51**	**100,00%**

Responses for Q.4 How did you hear about AIMS MS4CR Programme? And for Q. 5 What were your motivations for applying for the AIMS MS4CR Programme?

Results of the survey indicate that 56% of respondents heard of AIMS MS4CR Programme through alumni referrals justifying the findings during the interviews. Majority of the interviewees (beneficiaries) indicated that they heard of the programme through referrals. 25% of respondents were first aware of the programme through the university website, and the main reason to apply was the desire to gain an in-depth knowledge and skills in climate resilience (82% of the respondents). 49% mentioned the financial support/scholarship whereas 39% indicating programme reputation and quality as main reason for applying the programme.

No of respondents per category

Categories (left to right):
- Alumni referral (c): ~29
- Faculty or advisor recommendation (b): ~11
- Online social media (e.g. Facebook,...): ~7
- Other: ~7
- University website (a): ~13

Legend: ■ Total
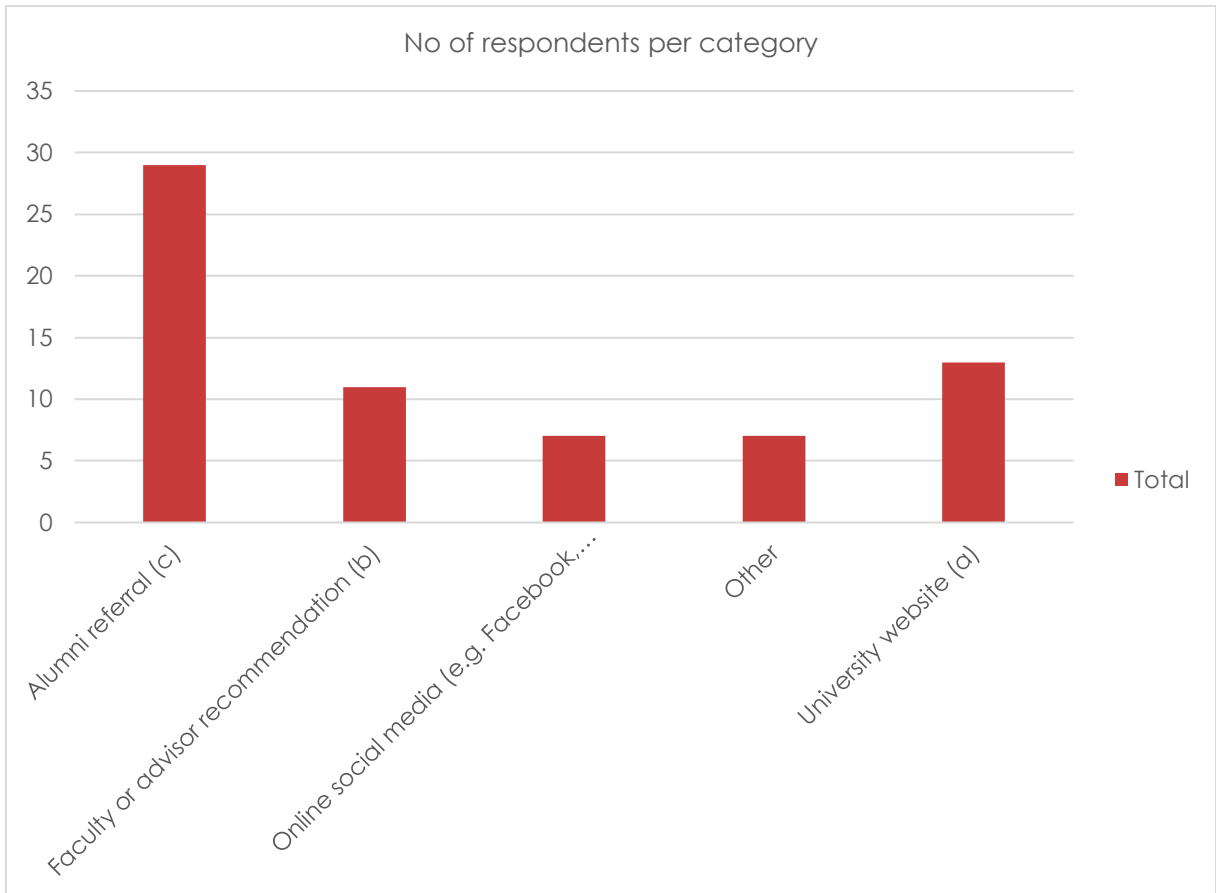
Respondents also mentioned the desire to be part of a network with exposure to opportunities in research as other reasons or motivations towards joining the programme.

No of respondents

Categories (left to right):
- Desire to gain in-depth knowledge and skills in climate resilience (a): ~42
- Financial support or scholarships available (c): ~25
- Other: ~1
- Program's reputation and quality (b): ~20

Legend: ■ Total
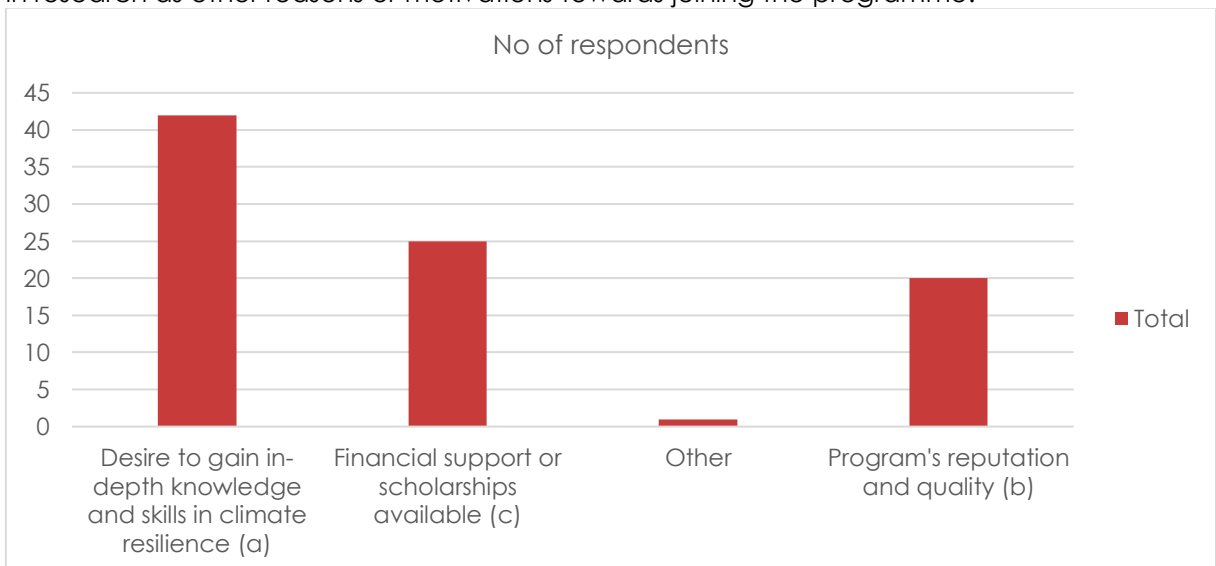
Q6. What is your career plan after completing the AIMS MS4CR Programme? (for students only)
Students were asked to share their career prospects upon completing the programme. This was a multiple-choice question that enabled recording of multiple responses. 75% of the students who responded to this question would prefer to pursue PhD after completing the MS4CR Programme while 63% would like to seek employment opportunities. Notably, all the students who responded to this survey question have clear career plan. 25% are likely to start a climate related business or organisations.

Answer(response)	No. of respondents	Percentage
Not clear about my career plan (d)	0	0
Other	0	0
Pursue further education (e.g., Ph.D. or other advanced degree) (b)	6	75%
Seek employment opportunities related to climate in a private, government or non-governmental organisation focused on climate change/resilience (a)	5	62,5%
Starting a climate-related business/organisation (c)	2	25%

Q7. What is your current position (for alumni only)?
Regarding the current position of the alumni, 42% are currently seeking employment in climate related field, 37% pursuing PhD (This indicates that AIMS students transition to further academic pursuits). This corresponds to the fact that 75% of students in Q6 above would like to continue to PhD levels. 13% of the alumni are holding positions in government or non-government organisations. About 7% are employed in private sector focused on climate resilience. Other responses included, working in areas of data science and machine learning which closely corresponds to the training offered at AIMs.

Answer(responses)	Count	Percentage
Seeking employment opportunities related to climate change/resilience (a)	18	41,86%
Currently employed in a private organisation focused on climate change/resilience (b)	3	6,98%
Working in a government or non-governmental organisation focused on climate change/resilience (c)	5	11,63%
Currently pursuing further education (e.g., Ph.D. or other advanced degree) (d)	16	37,21%
Currently launching or running a climate-related business/organisation (e)	1	2,33%
Other: (Assistant lecturer, PhD student, working in government, working in telecommunication company, working with non-governmental organisations).	6	13,95%

C.2   Effectiveness of AIMS MC4CR Programme

The responses to Q.8 In terms of providing theoretical knowledge and skills in climate resilience, how well did the programme meet your expectations? And Q9. How would you assess the level of support and guidance provided by the faculty members in the MS4CR programme?
Assessment on level of satisfaction for support indicates an excellent rating amongst 45% of the respondents, agreeing to have received or receiving needed guidance from faculty members of MS4CR Programme. 37% of respondents rate the support as good, 13% average and poor recording just 3% of the responses. The experiences of the beneficiaries reflect on the

dedication of the staff members towards the programme and its objectives as 82% of the responses recorded are above average.

How well did the programme meet your expectation?

Assesment of level of suppor/guidance received
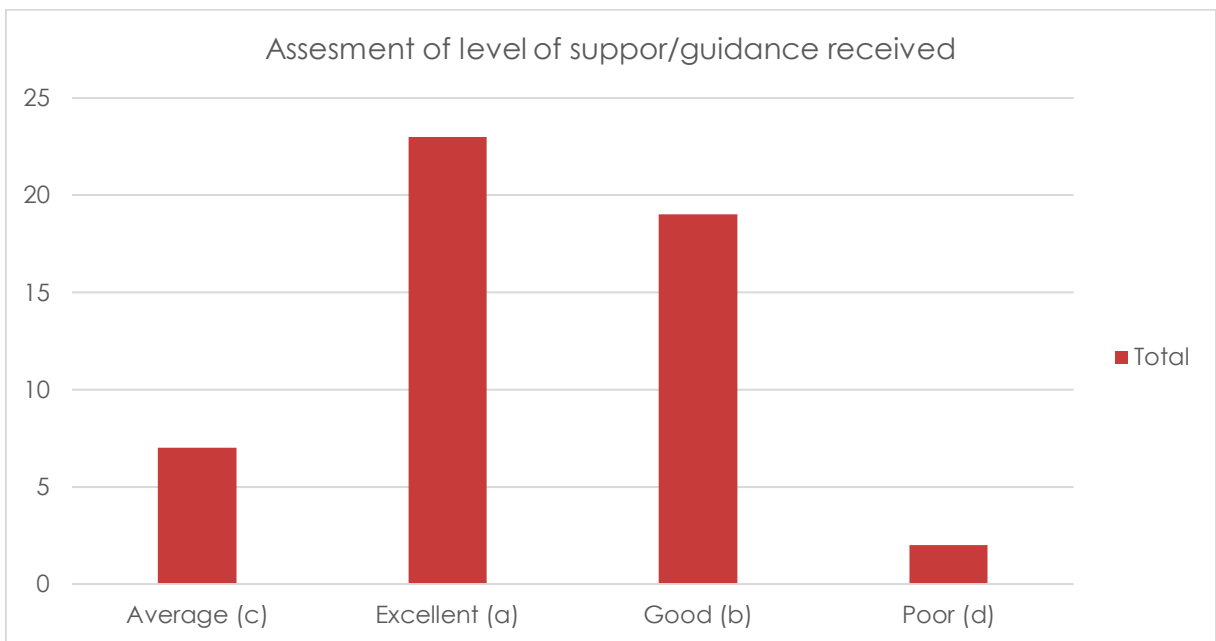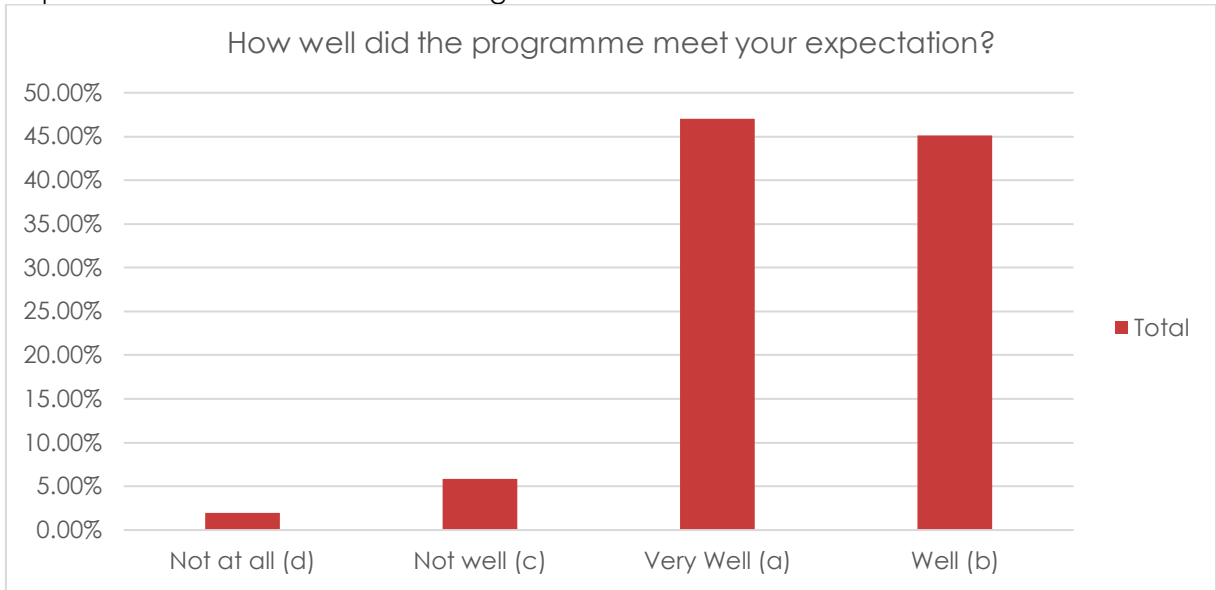
Q10. How satisfied are you with the accessibility and quality of resources and facilities (e.g., libraries, labs, research materials) for your studies?

The figure below shows the results of the survey on level of satisfaction with the quality of resources and facilitation for studies. 43% of respondents (22 out of 51) indicated they were very satisfied and 33% (17 out of 51) satisfied. However, 13% stayed neutral, 8% were dissatisfied and 1 very dissatisfied.

Figure 8 showing response to level of satisfaction with aims facilities

Level of satisfaction with qualituy of resources and faciliation for studies

Source: Technopolis MS4CR Survey, https://technopolisgroup.limequery.org/
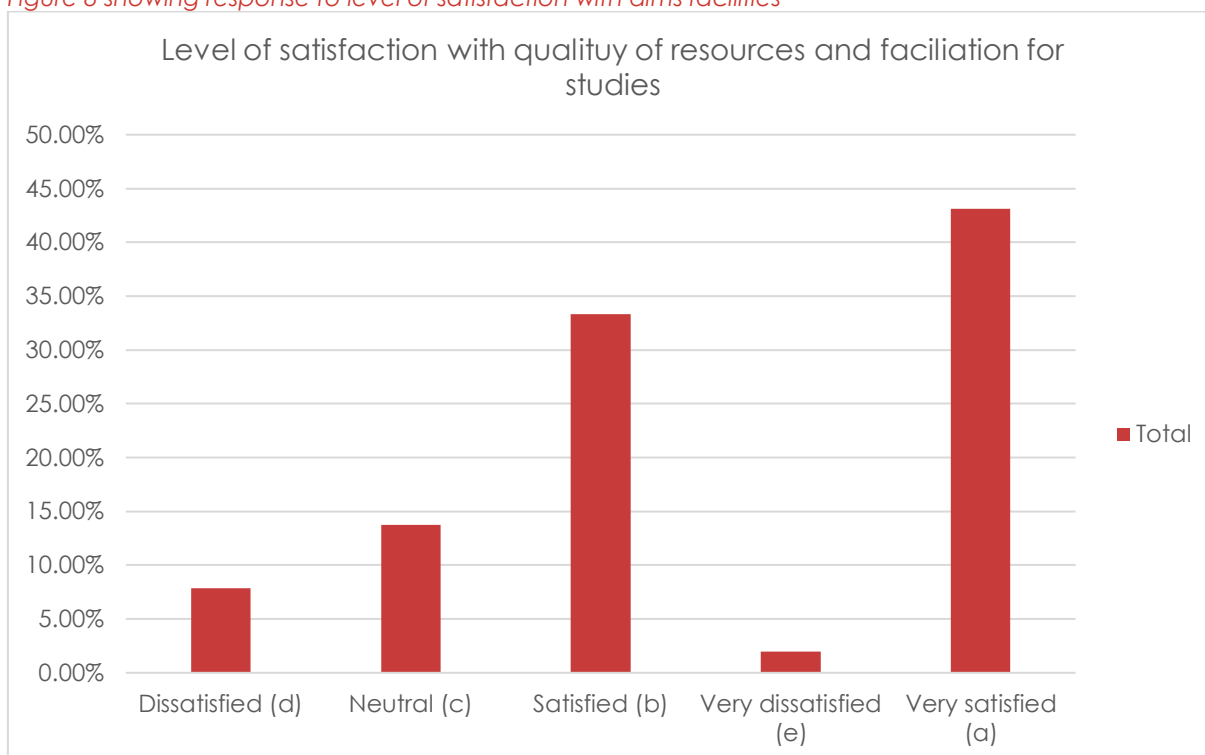
Responses to Q11. Did you have opportunities to network and collaborate with other students or professionals in the field of climate resilience during your studies?

Answer (Responses)	No of respondents	Percentage
Frequently (a)	16	31,37%
Occasionally (b)	29	56,86%
Rarely (c)	3	5,88%
No (d)	3	5,88%

The summary above represents the level of collaboration and networking opportunities present in the AIMS network. About 57% of the respondents indicated that they occasionally have opportunities to work with other professional or students in climate resilience related field. 31% frequently collaborate whereas about 6% neither rarely collaborate nor do collaborate at all. From these results and indicative responses above indicate exchange of opportunities within the AIMS network.

And Q12. Did the MS4CR programme provide you with practical experiences (e.g., fieldwork, case studies) that helped you to better understand and apply climate resilience concepts? About 56% of the respondents record that there were significant practical experiences that helped them understand the programme and in applicability of climate resilience concepts. 27%~to some extent and 15% mention the programme did not provide practical experiences.

Answer (Responses)	No of respondents	Percentage
Significantly (a)	29	56,86%
To some extent (b)	14	27,45%
Not at all (c)	8	15,69%

In terms of preparedness for the future career in the climate resilience (Q13. How well do you feel the MS4CR programme prepares you for a career in the field of climate resilience?) 55% of the respondents agree to be 'very well' prepared, 37% 'well', 6% cite the preparedness is not

well and some 3% cite the programme as not effective at all. The figure below shows the findings.

Answer (Responses)	No of respondents	Percentage
Very well (a)	28	54,90%
Well (b)	19	37,25%
Not well (c)	3	5,88%
Not at all (d)	1	1,96%
Not effective at all (a1)	0	0,00%
No answer	0	0,00%

C.3 Impact of the internship

Q14. Did you participate in an internship as part of the MS4CR programme?

Figure 9 Percentage share of students in the internship programme(Y/N)

Source: Technopolis MS4CR Survey, https://technopolisgroup.limequery.org/
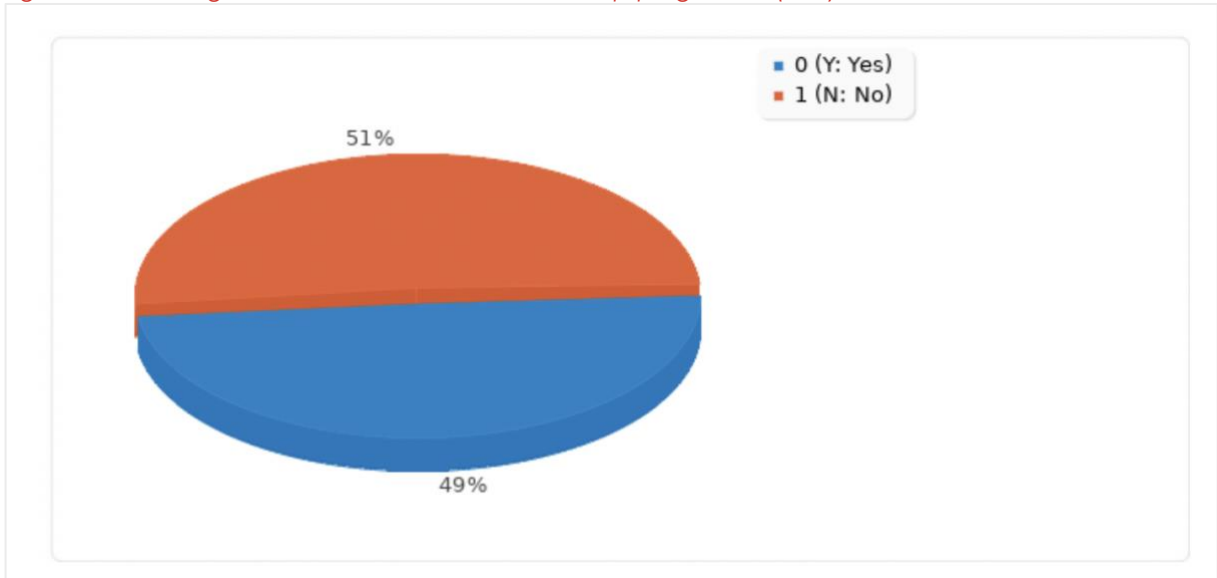
Out of the 51 respondents **nearly half 49% (25**) participated in the internship programme whereas another half 51% (26) did not take an internship programme. 92% of the internships lasted for a period of 3-6 months and another 4% lasting for more than 6 months. This also aligns with the interview findings on the duration for internship programme that averages 4 months. Figure 10 above shows the share of participation in the internship programme based on the survey results.

Q15. How long was your internship?

Answer (responses)	No of respondents	Percentage
1-3 months (a)	1	4,00%
3-6 months (b)	23	92,00%
more than 6 months (c)	1	4,00%

Grand Total	25	100,00%

Q16. How well did the internship meet your expectations in terms of enhancing your practical skills and knowledge? 64% of the respondents agree that the internship met their expectations "well" this is represented by 16 students and alumni of the 51 who participated in an internship programme. The sum of students whose expectations were met "very well and well' totals to 92% reflecting high level of satisfaction in skills and knowledge gained.

Answer	Count	Percentage
Very well (a)	7	28,00%
Well (b)	16	64,00%
Not well (c)	2	8,00%
Not at all (d)	0	0,00%

Q17. Do you believe that the internship experience contributes to your professional development and increase your employability prospects? & Q18 How satisfied are you with the internship programme overall?

Out of 25 respondent who participate in the internship programme, approximately 76% believe that the internship experience significantly contributes to both their professional development and employment prospects. The remaining 24% of the respondents decided to stay neutral.

Answer	Count	Percentage
Significantly (a)	19	76,00%
Neutral (b)	6	24,00%
Not satisfied (c)	0	0,00%

Q19. How can the internship programme be further improved to provide more meaningful and impactful experiences?

Based on Q16, 64% of participants expectations were met, a score, which is above average. This indicates that there is a good learning opportunity; knowledge transfer and industrial skills gain during the internships. However, the following recommendations were suggested on how to improve the internship experiences (Q19):

- First AIMS MS4CR to supplement the internship with training sessions and workshops on relevant industry topics, technical skills, and professional development and during the internship consider the following:

- **Real-world problem solving**: Provide interns with access to real-world climate data and challenges faced by communities or industries impacted by climate change. Engage them in projects that have practical applications and tangible outcomes. For example, focus on software applications that generate climate data analytics to translate the mathematical concepts in climate change resilience.

- **Field visits and case studies**: Arrange field visits to climate-affected regions or sites where climate resilience projects are being implemented. Case studies from these visits can be integrated into the internship programme to enrich the learning experience.

- **Publication and conference opportunities**: Support interns in preparing research papers or conference presentations based on their internship projects. Providing opportunities for dissemination can enhance their academic and professional profiles.

- **Longer-term internships**: Consider offering longer-term internships, if possible, to allow interns to delve deeper into their projects and contribute more substantially to the research. Similar recommendation was shared during interview with the internship placement organisations to match the durations with innovation cycle or periods which students can implement their projects to have impactful innovations.

- **Strengthening of supervision and evaluating intern feedback**: Regular gathering of feedback from interns about their experiences and suggestions for improvement. Use of this feedback to continuously enhance the internship programme. It is noted that some of the interns' concerns about their perspectives are being overlooked, leaving them feeling excluded from decision-making processes regarding the direction of their research. Acknowledgement and considerations of these suggestions are crucial for active participation in shaping internship experiences and research endeavours.

  In addition, providing effective supervision through follow up and improves learning. There is need to strengthen supervision from MS4CR staff in charge to closely liaise with the placement centre supervisor to coordinate learning meeting both the research needs of the student and assessing progress on key learning objectives. This includes ensuring that the placement companies or organisations are ready to onboard interns and with adequate research facilities including arrangements for field work as applicable.

- Workshops and trainings on industry specific topic. The internship programme to consider supplementing the internship with training sessions and workshops on relevant industry topics to gain more insights on emerging trends, technical skills, and professional development. This should be aimed at to create a condition for professional integration of researchers into the industry and linking professional growth in post internship.

C.4   Sustainability

Q20. Do you spread word about the MS4CR programme among your friends and colleagues? Would you recommend the AIMS Master's programme to others? And Q21. If responses a or b were selected at the previous question, please select the methods you have used to promote the MS4CR programme: (Select all that apply)?

About 57% of the respondents share regularly about MS4CR programme with friends and colleagues, whereas 41% share occasionally. 2% of the respondents do not share at all about the programme. The mode of sharing includes social media platforms such as Facebook, Twitter at 64%, participating in information sessions in universities at 48%, presentation in conferences and events at 20% and lastly other channels account for 6%, The other modes cited include sharing opportunities to others when AIMS announces them, during career talks with colleagues and outreach activities.

Answer(responses)	No of respondents	Percentage
Regularly (a)	29	56,86%
Occasionally (b)	21	41,18%
Not at all (c)	1	1,96%

Q22. Are you involved in any alumni networks or groups related to the MS4CR programme? And Q23. If responses a or b were selected at the previous question, please briefly describe your involvement and how it contributes to promoting the programme on the long run?

Involvement in alumni network
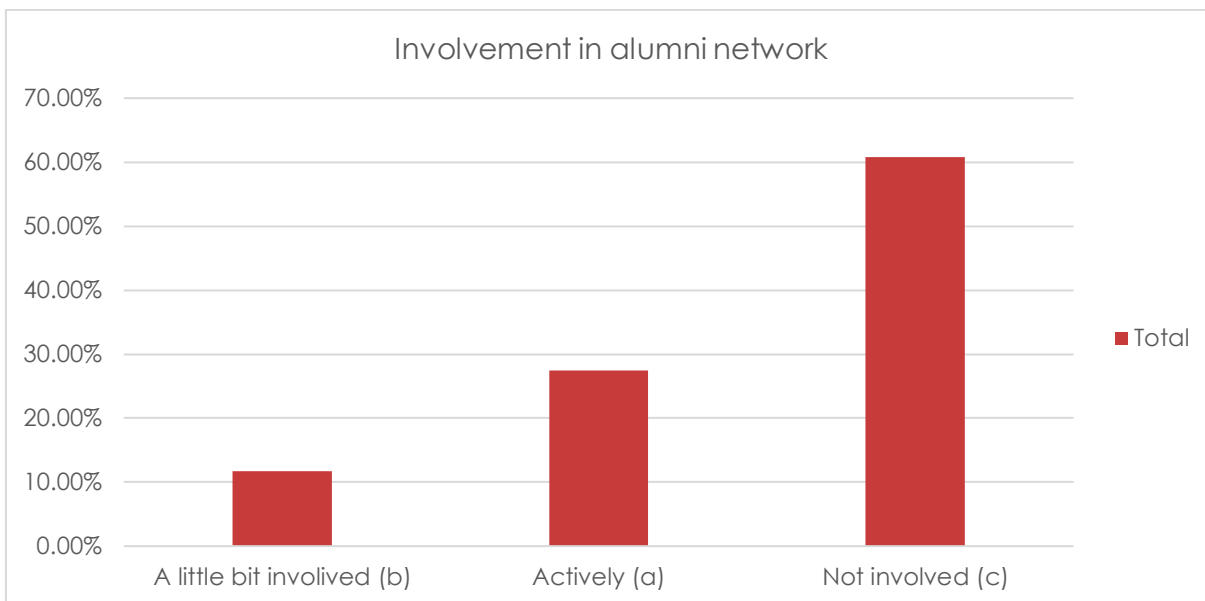
Majority of the respondents 61% (students and alumni) are not involved in the alumni network or related groups. 39% involved are mostly actively involved through(Q23); sharing about MS4CR on social media, communicating the programme details during conferences on higher education and actively participating in the MS4CR events such as workshops.

Q24. Have you collaborated with other students, professionals, or organisations to promote the AIMS MS4CR programme? And Q25. If responses a or b were selected at the previous question, please briefly describe the collaborations and partnerships you have been involved in?

Answer (Response)	No of respondents	Percentage
Significantly (a)	13	25,49%
A little bit (b)	5	9,80%
Not yet (c)	33	64,71%

The above results indicate that there is low collaboration amongst respondents (students and alumni) aimed towards promoting AIMS MS4CR programme (at 25% having made significant efforts and 10% made some efforts). Nearly 65% of the respondents have not engaged with other students or organisations to promote the programme. Below is a summary of responses on how some of the respondents have participated in promoting the programme:

- Graduates participating in the formal groups to create awareness on climate change for example Rwanda graduates created a group to keep society aware of climate knowledge.
- At the universities and educational institution events to reach target audience directly, which typically includes students and graduates who may be interested internships, research, or career in related fields.
- Encouraging and motivating the alumni to actively participate in the network events.
- Participation in the host institution workshops and actively making presentations.
- Attentively following MSC4CR communication channels and participating in events or workshops engaging alumni.

- Some respondents participated as delegates in the conferences meeting other stakeholders in higher education, a platform used to introduce the programme and its related activities.

Q26.What is the unique added value of AIMS?

Regarding the unique value of AIMS, 75% of the respondents mention international exposure as key added value of the programme with 58% citing multiple topics exposure as key (figure 12 below shows the distribution of the perception). Quality teaching is also a key value at 60% with 31 students citing it as attribute of AIMS programme. Additional values included multiple teacher exposure at 55%, multiple methods of work exposure at 43% and recognition of the institution at international level at 50%.

Figure 10 Responses on perception of AIMS value proposition

Source: Technopolis MS4CR Survey, https://technopolisgroup.limequery.org/
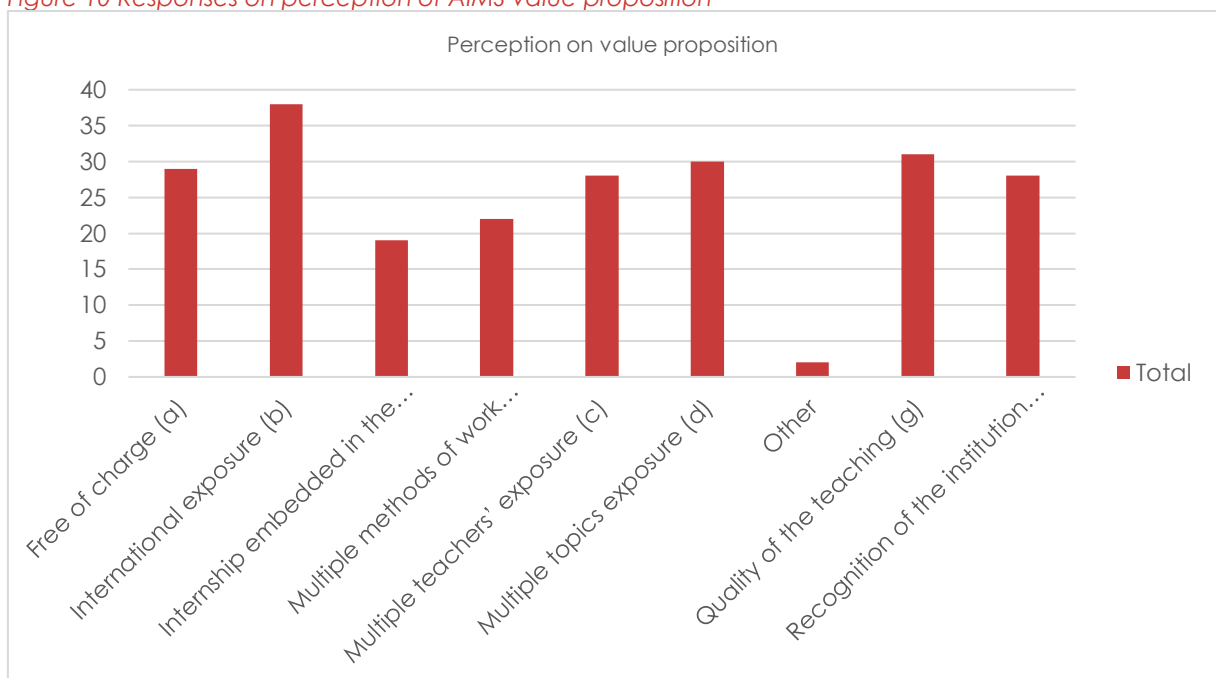
C.5   Conclusion

section allowed the respondents to provide their feedback regarding the programme. The responses received gives a reflection of the beneficiaries on different elements of the AIMS programme. The level of satisfaction from students' perspective is positive and impacts can be derived from experiences recorded in the analysis. For example, there is repeated appreciation of the training the programme has offered to young Africans to train in climate change space. Specifically, the programme has created opportunities to train young scientists in climate resilience through the scholarships and technical training through the internship. The international exposure and setting have created an environment for knowledge transfer and deep understanding of climate sciences.

Appendix D   Bibliometrics analysis

D.1   Research published under the research programme (Research chairs, small research grants and Climate Science Fellowship for women)

The database of MS4CR' publications received by AIMS during this final evaluation include 74 publications over the period from 2019 to 2023. We considered only publications referenced on Scopus. We have now a list of 50 publications referenced on Scopus.

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
1	Dr Daniel Akinyele	Small Research Grants	Evaluation of Solar PV Microgrid Deployment Sustainability in Rural Areas: A fuzzy STEEP Approach	2019	10.1109/POWERAFRICA.2019.8928904	2019 IEEE Power and Energy Society/Industrial Applications Society	Conference Paper	12	94th	3.34		20
2	Jessica N. P. Thorn	WiCCS	Catalyzing transformations to sustainability in mountain social-ecological systems	2019	10.1029/2018EF001024	Earth's Future	Article	54	96th	4.05	10.5	11
3	Nana Ama Browne Klutse	WiCCS	Recent Trends in the Daily Rainfall Regime in Southern West Africa	2019	10.3390/ATMOS10120741	Atmosphere	Article	25	90th	2.34	4.1	14
4	Nana Ama Browne Klutse	WiCCS	Identification of Potential Drought Areas in West Africa Under Climate Change and Variability	2019	10.1007/S41748-019-00133-W	Earth Systems and Environment	Review	25	75th	1.17	11.8	14
5	Dr Daniel Akinyele	Small Research Grants	Possibility of solar thermal power generation technologies in Nigeria: Challenges and policy directions	2019	10.1016/J.REF.2019.02.002	Renewable Energy Focus	Article	16	54th	0.55	8.2	20
6	Nana Ama Browne Klutse	WiCCS	Projected Change in Temperature and Precipitation over Africa from CMIP6.	2020	10.1007/S41748-020-00161-X	Earth Systems and Environment	Article	157	99th	15.91	11.8	14

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
7	Dr Dube Timothy	Small Research Grants	Remote Sensing of Invasive Lantana camara (Verbenaceae) in Semiarid Savanna Rangeland Ecosystems of South Africa.	2020	10.1016/J.R AMA.2020.0 1.003	Rangeland Ecology and Management	Article	12	83th	1.6	4.6	30
8	Dr Ayansina Ayanlade	Small Research Grants	Communicating Climate Change Impacts as Manifested in Extreme Weather: A Case of Newspapers' Reports in Nigeria.	2020	10.1007/978-3-030-36875-3_20	Climate Change Management	Book Chapter	4	78th	1.23	1.5	13
9	Nana Ama Browne Klutse	WiCCS	Projected temperature increases over northern Ghana	2020	10.1007/S42 452-020-3095-3	SN Applied Sciences	Article	16	80th	1.35	5.3	14
10	Dr Ayansina Ayanlade	Small Research Grants	Early warning climate indices for malaria and meningitis in tropical ecological zones	2020	10.1038/S41 598-020-71094-8	Scientific Reports	Article	16	67th	0.82	7.5	13
11	Dr Daniel Akinyele	Small Research Grants	Optimal planning and electricity sharing strategy of hybrid energy system for remote communities in Nigeria	2020	10.1016/J.S CIAF. 2020.E00589	Scientific African	Article	8	51th	0.44	4.3	20
12	Dr Ayansina Ayanlade	Small Research Grants	Malaria and meningitis under climate change: initial assessment of climate information service in Nigeria	2020	10.1002/MET .1953	Meteorologic al Applications	Article	5	51th	0.43	4.8	13
13	Jessica N. P. Thorn	WiCCS	Indigenous and scientific knowledge of soil regulation services, and factors effecting decision-making in the Terai Plains of Nepal	2020	10.1007/978-3-030-51051-0_3	4th EAI International Conference on Innovations and Interdisciplinar y Solutions for Underserved	Conferen ce Paper	0	24th	0		11

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
						Areas, InterSol 2020						
14	Adisa Omolola M	Small Research Grants	Bibliometric Analysis of Methods and Tools for Drought Monitoring and Prediction in Africa	2020	10.3390/su12166516	Sustainability (Switzerland)	Review	12	55th	0.49	5.8	9
15	Jessica N. P. Thorn	WiCCS	A systematic review of participatory scenario planning to envision mountain social-ecological systems futures	2020	10.5751/ES-11608-250306	Ecology and Society	Article	25	92th	3.08	6.4	11
16	Jessica N. P. Thorn	WiCCS	Indigenous uses of wild and tended plant biodiversity maintain ecosystem services in agricultural landscapes of the Terai Plains of Nepal	2020	10.1186/s13002-020-00382-4	Journal of Ethnobiology and Ethnomedicine	Article	9	88th	1.97	6.5	11
17	Jessica N. P. Thorn	WiCCS	Prospects of scenario planning for Kenya's protected ecosystems: An example of Mount Marsabit	2020	10.1016/j.crsust.2019.10.001	Current Research in Environmental Sustainability	Article	1	25th	0.07	3.7	11
18	Dr Daniel Akinyele	Small Research Grants	Review of fuel cell technologies and applications for sustainable microgrid systems	2020	10.3390/inventions5030042	Inventions	Review	75	93th	3.2	5.4	20
19	Mouhamadou Bamba Sylla	Chair Programme	A tale of two futures: contrasting scenarios of future precipitation for West Africa from an ensemble of regional climate models	2020	10.1088/1748-9326/ab7fde	Environmental Research Letters	Article	35	92th	2.68	10.1	31
20	Mouhamadou Bamba Sylla	Chair Programme	Late 21st Century Projected Changes in the Relationship between Precipitation, African Easterly Jet, and African Easterly Waves	2020	10.3390/atmos11040353	Atmosphere	Article	9	71th	0.94	4.1	31

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
21	Nana Ama Browne Klutse	Resident researcher	West African Summer Monsoon Precipitation Variability as Represented by Reanalysis Datasets	2020	10.3390/cli8 100111	Climate	Article	14	77th	1.18	5.2	14
22	Gandome Mayeul L. D. Quenum	Postdoctoral Programme	Precipitation Variability in West Africa in the Context of Global Warming and Adaptation Recommendations	2021	10.1007/978-3-030-45106-6_85	African Handbook of Climate Change Adaptation:	Article	0	24th	0		3
23	Mouhamadou Bamba Sylla	Chair Programme	Assessment of CMIP6 Performance and Projected Temperature and Precipitation Changes Over South America	2021	10.1007/s417 48-021-00233-6%23citeas	Earth Systems and Environment	Article	54	99th	10.04	11.8	31
24	Nana Ama Browne Klutse	Resident researcher	The Climatic Analysis of Summer Monsoon Extreme Precipitation Events over West Africa in CMIP6 Simulations	2021	10.1007/s417 48-021-00203-y	Earth Systems and Environment	Article	34	97th	5.68	11.8	14
25	Mouhamadou Bamba Sylla	Chair Programme	What Can We Know About Recent Past Precipitation Over Africa? Daily Characteristics of African Precipitation from a Large Ensemble of Observational Products for Model Evaluation	2021	10.1029/202 0EA001466	Earth and Space Science	Article	11	78th	1.31	5.4	31
26	Mouhamadou Bamba Sylla	Chair Programme	Robust late twenty-first century shift in the regional monsoons in RegCM-CORDEX simulations	2021	10.1007/s003 82-020-05306-2	Climate Dynamics	Article	43	98th	6.58	10.2	31
27	Mouhamadou Bamba Sylla	Chair Programme	Numerical simulation of land and sea-breeze (LSB) circulation along the Guinean Coast of West Africa	2021	10.1007/s408 08-020-00953-0	Modeling Earth Systems and Environment	Article	5	74th	1.12	5.3	31
28	Mouhamadou Bamba Sylla	Chair Programme	Current and future potential of solar and wind energy over	2021	10.1007/s003 82-020-05377-1	Climate Dynamics	Article	31	97th	4.97	10.2	31

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
			Africa using the RegCM4 CORDEX-CORE ensemble									
29	Cyrille KENNE	PhD programme	An Age-Structured Model for Tilapia Lake Virus Transmission in Freshwater with Vertical and Horizontal Transmission	2021	/article/view/212505	Bulletin of Mathematical Biology	Article	3	58th	0.53	3.9	2
30	Omolola M. Adeola	Small Research Grants	An analysis of precipitation extreme events based on the spi and edi values in the free state province, south Africa	2021	10.3390/w13213058	Water (Switzerland)	Article	3	48th	0.33	5.5	2
31	Omolola M. Adisa	Small Research Grants	Assessment of the dissimilarities of EDI and SPI measures for drought determination in South Africa	2021	10.3390/w13010082	Water (Switzerland)	Article	7	75th	1.16	5.5	9
32	Emmanuel Dufourq	Postdoctoral Programme	Automated detection of Hainan gibbon calls for passive acoustic monitoring	2021	10.1002/rse2.201	Remote Sensing in Ecology and Conservation	Article	23	95th	4.1	9.9	5
33	Thorn, J. P. R.	WiCCS	Linking model design and application for transdisciplinary approaches in social-ecological systems	2021	10.1016/j.gloenvcha.2020.102201	Global Environmental Change	Article	12	82th	1.68	16.5	12
34	Patrick Essien	Postdoctoral Programme	Long-term study on medium scale traveling ionospheric disturbances observed over the south american equatorial region	2021	10.3390/atmos12111409	Atmosphere	Article	3	57th	0.5	4.1	14
35	Mouhamadou Bamba Sylla	Chair Programme	Projected Changes in Temperature and Precipitation Over the United States, Central America, and the Caribbean in CMIP6 GCMs	2021	10.1007/s41748-021-00199-5	Earth Systems and Environment	Article	83	99th	13.57	11.8	31

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
36	Gandomè Mayeul Leger Davy Quenum	Postdoctoral Programme	Spatiotemporal changes in temperature and precipitation in West Africa. Part i: Analysis with the CMIP6 historical dataset	2021	2073-4441/13/24/3506	Water (Switzerland)	Article	9	79th	1.49	5.5	4
37	Lindani Ncube	Small Research Grants	The segmented zambezi sedimentary system from source to sink: 1. sand petrology and heavy minerals	2021	10.1086/715792	Journal of Geology	Article	6	75th	1.2	4.3	3
38	Mouhamadou Bamba Sylla Danny Parsons	PhD & Research Chair	Evaluation of Satellite-Based Air Temperature Estimates at Eight Diverse Sites in Africa	2022	10.3390/cli10070098	Climate	Article	2	63th	0.53	5.2	31
39	Francis Nkrumah	Postdoctoral & Resident Researcher	Performance of CMIP6 HighResMIP on the Representation of Onset and Cessation of Seasonal Rainfall in Southern West Africa	2022	10.3390/atmos13070999	Atmosphere	Article	2	75th	1.11	4.1	7
40	Nana Ama Browne Klutse/ Gandomè Mayeul Leger Davy Quenum	Postdoctoral & Resident Researcher	Potential of the Coupled WRF/WRF-Hydro Modeling System for Flood Forecasting in the Ouémé River (West Africa)	2022	2073-4441/14/8/1192/htm	Water (Switzerland)	Article	3	63th	0.54	5.5	13
41	Cyrille Kenne	PhD Programme	A mathematical model for tilapia lake virus transmission with waning immunity	2022	2227-7390/10/4/670	Journal of Biological Dynamics	Article	2	79th	1.38	4.8	2
42	Nana Ama Browne Klutse	Resident researcher	Modelling Cloud Cover Climatology over Tropical Climates in Ghana	2022	10.3390/atmos13081265	Atmosphere	Article	1	63th	0.55	4.1	13

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
43	Masilin Gudoshava	WiCCS	Application of real time S2S forecasts over Eastern Africa in the co-production of climate services	2022	10.1016/j.cliser.2022.100319	Climate Services	Article	0	53th	0	5.1	1
44	Patrick Essien & Nana Ama Browne Klutse	Postdoctoral & Resident Researcher	Intertropical Convergence Zone as the Possible Source Mechanism for Southward Propagating Medium-Scale Traveling Ionospheric Disturbances over South American Low-Latitude and Equatorial Region	2022	2073-4433/13/11/1836	Atmosphere	Article	1	53th	0	4.1	13
45	Mouhamadou Bamba Sylla	Research Chair	The Climatic Impact-Driver Framework for Assessment of Risk-Relevant Climate Information	2022	10.1029/2022EF002803	Earth's Future	Article	1	53th	0	10.5	31
46	Chinwoke Clara Ifeanyi-Obi	WiCCS	Promoting uptake and integration of climate smart agriculture technologies, innovations and management practices into policy and practice in Nigeria	2022	10.1108/IJCCSM-09-2021-0101	International Journal of Climate Change Strategies and Management	Article	1	61th	0.51	6.9	3
47	Mary-JaneBopape	WiCCS	Two types of ridging South Atlantic Ocean anticyclones over South Africa and the associated dynamical processes	2022	10.1016/j.atmosres.2021.105897	Atmospheric Research	Article	4	86th	2.14	9.1	12
48	Mary-JaneBopape	WiCCS	Rainfall Simulations of High-Impact Weather in South Africa with the Conformal Cubic Atmospheric Model (CCAM)	2022	10.3390/atmos13121987	Atmosphere	Article	0	24th	0	4.1	12
49	Ifeanyi-Obi Chinwoke Clara	WiCCS	Traditional Perceptions of Climate Change Phenomenon Influencing Adaptation Decisions among Women Crop Farmers in Southern Nigeria	2022	10.4314/jae.v27i2.2	Journal of Agricultural Extension	Article	0	24th	0	0.9	3

N°	Name	Programme	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact factor	h-index Scientist
50	Nakiguli Fatumah	WiCCS	Adoption of novel climate-smart farming systems for enhanced carbon stock and carbon dioxide equivalent emission reduction in cattle corridor areas of Uganda	2023	S2405-8440(23)01321-X	Heliyon	Article	0	24th	0	5.6	4

D.2 Publications steaming from AIMS (alumni, interns) and related to climate change.

Two lists of AIMS alumni publications were provided for the evaluation. One list contained 37 alumni publications relating to climate change, and the other 61 alumni publications. In the list of 37 publications, only 12 were found on Scopus. In the list of 61 alumni publications, 10 were not referenced on Scopus and 3 publications were duplicated. The total number of alumni publications supplied by AIMS for the final evaluation and referenced on Scopus is therefore 60. An analysis of publication titles and content revealed 6 of the 60 articles not related to climate change.

N°	Name	AIMS Center	Title of Publication	Year of publication	DOI	Source	Document type	Citations	Citation benchmarking	Field-Weighted Citation Impact	Journal impact Factor	h-index Scientist
1	Guy - Alain Lusilao-Zodi		A wireless sensor network for rainfall monitoring, using cellular network: A case for Namibia	2018	10.1109/GWS.2017.8300469	2017 Global Wireless Summit, GWS 2017	Conference Paper	9	92th	2.73		7
2	Andree Nenkam	AIMS Ghana	Assessment of the use of Participatory Integrated Climate Services for Agriculture (PICSA) approach by farmers to manage climate risk in Mali and Senegal	2018	10.1016/J.CLISER.2018.07.003	Climate Services	Article	39	84th	1.7	5.1	2
3	Hackman Kwame Oppong	AIMS South Africa	Exploring the temporal density of Landsat observations for cropland mapping: experiments from Egypt, Ethiopia, and South Africa	2018	10.1080/01431161.2018.1468115	International Journal of Remote Sensing	Article	7	53th	0.51	7.0	7
4	Manalebish Debalike Asfaw	AIMS Senegal	Co-existence thresholds in the dynamics of the plant–herbivore interaction with Allee effect and harvest*	2018	10.1142/S1793524518500572	International Journal of Biomathematics	Article	6	46th	0.37	3.8	3
5	Dzupire Nelson Christopher	AIMS South Africa	A poisson-gamma model for zero inflated rainfall data	2018	10.1155/2018/1012647	Journal of Probability and Statistics	Article	11	67th	0.88	0.7	4
6	Justin B. Munyakazi	AIMS South Africa	Assessing the role of climate factors on malaria transmission dynamics in South Sudan	2019	10.1016/J.MBS.2019.01.002	Mathematical Biosciences	Article	12	77th	1.28	6.9	12
7	Francis Torgbor	AIMS Ghana	An investigation of the effects of PICSA on smallholder farmers' decision-making and livelihoods	2019	10.1016/J.CLISER.2019.02.002	Climate Services	Article	24	83th	1.64	5.1	3

8	Getachew Mehabie Mulualem	AIMS South Africa	Spatio-temporal Assessment of drought in Ethiopia and the impact of recent intense droughts	2019	10.3390/RS11151828	Remote Sensing	Article	44	92th	2.77	7.9	3
9	Marc Niyongendako	AIMS South Africa	Solar Irradiance and Temperature Variability and Projected Trends Analysis in Burundi	2019	10.3390/CLI7060083	Climate	Article	15	67th	0.88	5.2	1
10	Bright Silas Edem Aboh	AIMS Senegal	Satellite imagery analysis for Land Use, Land Use Change and Forestry: A pilot study in Kigali, Rwanda	2020	10.1145/3378393.3402268	3rd ACM SIGCAS Conference on Computing and Sustainable Societies, COMPASS 2020	Conference Paper	1	41th	0.29		1
11	Manalebish Debalike Asfaw	AIMS Senegal	Effects of temperature and rainfall in plant–herbivore interactions at different altitude	2019	10.1016/J.ECOLMODEL.2019.05.011		Article	8	56th	0.58		3
12	Manalebish Debalike Asfaw	AIMS Senegal	Stochastic plant–herbivore interaction model with Allee effect*	2019	10.1007/S00285-019-01425-5		Article	3	39th	0.26		3
13	Chama Abdoulkadri	AIMS South Africa	Responses of humpback whales to a changing climate in the Southern Hemisphere: Priorities for research efforts	2020	10.1111/maec.12616	Marine Ecology	Article	7	66th	0.79	2.6	6
14	Mateyisi Jacob Mohau	AIMS South Africa	Evaluation of soil moisture from CCAM-CABLE simulation, satellite-based models estimates and satellite observations: a case study of Skukuza and Malopeni flux towers	2020	10.5194/hess-24-1587-2020	Hydrology and Earth System Sciences	Review	6	62th	0.67	9.5	4
15	El Moustaid Fadoua	AIMS South Africa	Transmission of West Nile and five other temperate mosquito-borne viruses peaks at temperatures between 23 C and 26 C	2020	10.7554/ELIFE.58511	eLife	Article	50	95th	3.71	12.3	4
16	Getachew Mehabie Mulualem	AIMS South Africa	Application of artificial neural networks in forecasting a standardized precipitation evapotranspiration index for the Upper Blue Nile basin	2020	10.3390/w12030643	Water (Switzerland)	Article	32	94th	3.39	5.5	3

17	Francis Torgbor	AIMS Ghana	The spatial correlation structure of rainfall at the local scale over southern Ghana	2020	10.1016/j.ejrh.2020.100720	Journal of Hydrology: Regional Studies	Article	4	51th	0.45	5.8	3
18	Francis Torgbor	AIMS Ghana	Envisioning Change in the Statistics-Education Climate	2020	123456789/2387	Statistics Education Research Journal	Article	0		0	1.1	3
19	Nenkam Andree Mentho	AIMS Ghana	Which is more important to sorghum production systems in the Sudano-Sahelian zone of West Africa: Climate change or improved management practices?	2020	10.1016/j.agsy.2020.102920	Agricultural Systems	Article	15	91th	2.44	11.9	2
20	Abubakari Abdul Ghaniyyu	AIMS Ghana (2014)	Extreme Analysis of Maxima Rainfall in the Upper East Region of Ghana: A Case Study of Navrongo Municipality	2020	10.18576/AMIS/140413	Applied Mathematics and Information Sciences	Article	0	24th	0	1.7	2
21	Dzupire Nelson Christopher	AIMS South Africa	A copula based bi-variate model for temperature and rainfall processes	2020	10.1016/j.sciaf.2020.e00365	Scientific African	Article	7	44th	0.33	4.3	4
22	Athiah Winifred Ayinpogbilla	AIMS Senegal	A process-based validation of GPM IMERG and its sources using a mesoscale rain gauge network in the West African forest zone	2020	10.1175/JHM-D-19-0257.1	Journal of Hydrometeorology	Article	29	90th	2.35	7.8	7
23	Athiah Winifred Ayinpogbilla	AIMS Senegal	Trends and interannual variability of extreme rainfall indices over Ghana, West Africa	2020	10.1007/s00704-020-03114-6	Theoretical and Applied Climatology	Article	17	82th	1.48	6.5	7
24	Athiah Winifred Ayinpogbilla	AIMS Senegal	Validation of satellite and merged rainfall data over Ghana, West Africa	2020	10.3390/ATMOS11080859	Atmosphere	Article	20	89th	2.15	4.1	7
25	Athiah Winifred Ayinpogbilla	AIMS Senegal	Estimation of planetary boundary layer height from radiosonde profiles over West Africa during the AMMA field campaign: Intercomparison of different methods	2020	10.1016/j.sciaf.2019.e00228	Scientific African	Article	11	59th	0.6	4.3	7
26	Athiah Winifred Ayinpogbilla	AIMS Senegal	Investigating the merits of gauge and satellite rainfall data at local scales in Ghana, West Africa	2020	10.1016/j.wace.2020.100292	Weather and Climate Extremes	Article	16	81th	1.4	9.2	7

27	Bashiru Yahaya		Meteorological analysis of floods in Ghana	2020	10.1155/2020/4230627	Advances in Meteorology	Article	24	88th	2.05	4.6	3
28	Asenso Theophilus Quachie		Interaction Effects of Air Pollution and Climatic Factors on Circulatory and Respiratory Mortality in Xi'an, China between 2014 and 2016	2020	10.3390/ijerph17239027	International Journal of Environmental Research and Public Health	Article	11	73th	1.02	5.4	1
29	Daniel Mashishi	AIMS Senegal	Comparative Analysis of the 100-Year Return Level of the Average Monthly Rainfall for South Africa: Parent Distribution versus Extreme Value Distributions	2020	10.18576/amis/140507	Applied Mathematics and Information Sciences	Article	0	24th	0	1.7	0
30	Mateyisi Jacob Mohau		Changes in annual extreme temperature and heat indices in Limpopo province: period 1941-2016	2021	10.1007/s00704-020-03511-x	Theoretical and Applied Climatology	Article	2	45th	0.32	6.5	4
31	Uwizeye Clarisse		Morphological bases of phytoplankton energy management and physiological responses unveiled by 3D subcellular imaging	2021	10.1038/s41467-021-21314-0	Nature Communications	Article	21	88th	2.14	24.9	4
32	Nkongho Ayuketang Arreyndip		Identifying agricultural disaster risk zones for future climate actions	2021	10.1371/journal.pone.0260430	PLoS ONE	Article	1	32th	0.11	6.0	3
33	Nkongho Ayuketang Arreyndip		African continental free trade area (AfCFTA): projected economic impact assessment under future warming in CMIP6	2021	10.1088/1748-9326/ac1fbd	Environmental Research Letters	Article	3	50th	O.42	10.1	3
34	Brhane Kewani		Mathematical model for the dynamics of Savanna ecosystem considering fire disturbances	2021	10.1016/j.jtbi.2020.110515	Journal of Theoretical Biology	Article	3	61th	0.68	4.9	2
35	Mahamady Ouedraogo	AIMS Rwanda	Coping with a dual shock: The economic effects of COVID-19 and oil price crises on African economies*	2021	10.1016/j.resourpol.2021.102093	Resources Policy	Article	12	95th	3.77	11.3	1
36	Athiah Winifred Ayinpogbilla	AIMS Senegal	Trends of Rainfall Onset, Cessation, and Length of Growing Season in Northern Ghana: Comparing the Rain Gauge, Satellite, and Farmer's Perceptions	2021	10.3390/atmos12121674	Atmosphere	Article	6	65th	0.77	4.1	7

37	Mateyisi Jacob Mohau		African Case Studies: Developing Pavement Temperature Maps for Performance-Graded Asphalt Bitumen Selection	2022	10.3390/su14031048	Sustainability (Switzerland)	Review	4	69th	0.82	5.8	4
38	Nkongho Ayuketang Arreyndip		Monitoring the evolution of drought conditions over Africa	2022	10.1088/1755-1315/958/1/012004	7th International Conference on Water Resource and Environment, WRE 2021	Conference paper	0	53th	0		3
39	Rabiat Ohunene Abdulaziz		Modelling an Artificial Intelligence-Based Energy Management for Household in Nigeria	2022	issue_1/EL_30_1_16	Engineering Letters	Article	0	53th	0	2.0	0
40	Claude-Michel Nzotungicimpaye		Temporary nature-based carbon removal can lower peak warming in a well-below 2°C scenario	2022	10.1038/s43247-022-00391-z	Communications Earth and Environment	Article	18	98th	7.78	5.9	3
41	Mateyisi Jacob Mohau		Integrating project-based infrastructures with long-term greenhouse gas observations in Africa	2022	10.17159/caj/2022/32/1.13081	Clean Air Journal	article	0	53th	0	1.4	4
42	Djihouessi Metogbe Belfrid		Inventory of agroecosystem services and perceptions of potential implications due to climate change: A case study from Benin in West Africa	2022	10.1016/j.eiar.2022.106792	Environmental Impact Assessment Review	Article	5	89th	2.59	9.4	4
43	Francis Torgbor	AIMS Ghana	Stimulating small-scale farmer innovation and adaptation with Participatory Integrated Climate Services for Agriculture (PICSA): Lessons from successful implementation in Africa, Latin America, the Caribbean and South	2022	10.1016/j.cliser.2022.100298	Climate Services	Article	4	86th	2.06	5.1	3
44	Atuhaire Fatumah		Untangling the changing impact of non-pharmaceutical interventions and vaccination on European COVID-19 trajectories*	2022	10.1038/s41467-022-30897-1	Nature Communications	Article	16	95th	4.57	24.9	2
45	Emmanuel Iyamuremye		Modelling extreme rainfall events in Kigali city using generalized Pareto distribution	2022	10.1002/met.2076	Meteorological Applications	Article	2	75th	1.07	4.8	1

46	Rubby Aworka	AIMS Ghana	Agricultural decision system based on advanced machine learning models for yield prediction: case of east African countries	2022	10.1016/j.atech.2022.100048	Smart Agricultural Technology	Article	8	95th	4.26	2.6	2
47	Blessing Itoro Bassey	AIMS Cameroon	An online machine learning-based sensors clustering system for efficient and cost-effective environmental monitoring in controlled environment agriculture	2022	10.1016/j.compag.2022.107139	Computers and Electronics in Agriculture	Article	1	64th	0.61	13.6	1
48	Athiah Winifred Ayinpogbilla	AIMS Senegal	A meteorological dataset of the West African monsoon during the 2016 DACCIWA campaign	2022	10.1038/s41597-022-01277-7	Scientific Data	Data paper	0	53th	0	11.2	7
49	Anafo Abdulzeid Yen		The Modified Extended Chen Distribution: Properties and Application to Rainfall Data	2022	10.18576/amis/160506	Applied Mathematics and Information Sciences	Article	0	53th	0	1.7	0
50	Akinlabi Emmanuel Olutayo		Dispersive fluxes within and over a real urban canopy: a large-eddy simulation study*	2022	10.1007/s10546-022-00725-6	Boundary-Layer Meteorology	Article	3	82th	1.6	6.5	3
51	Benjamin Kweku Lugu		Indigenous Perceptions of Factors Influencing Behavioral Intentions Towards Climate Change Mitigation: An Assessment	2022	10.1080/01900692.2022.2078838	International Journal of Public Administration	Article	1	63th	0.55	4.4	6
52	Chinalu Miracle Amadi		Parameter Identification and Forecast with a Biased Model*	2022	10.1007/978-3-031-11818-0_30	Mathematics in Industry	Book chapter	0	24th	0	0.1	3
53	Athiah Winifred Ayinpogbilla	AIMS Senegal	Climate variability and impacts on maize (Zea mays) yield in Ghana, West Africa	2022	10.1002/qj.4199	Quarterly Journal of the Royal Meteorological Society	Article	9	93	3.75	12.1	7
54	Getachew Mehabie Mulualem	AIMS South Africa	Geospatial-based climate variability analysis, in Central Ethiopia Rift Valley	2023	10.1007/s00704-023-04376-6	Theoretical and Applied Climatology	Article	0	24th	0	6.5	3
55	Sehouevi Mawuton David Agoungbome	AIMS Senegal 2017	Optimal Sowing Windows under Rainfall Variability in Rainfed Agriculture in West Africa	2023	10.3390/agronomy13010167	Agronomy	Article	0	24th	0	5.2	0

56	TAKONG Ridick Roland		Improving rainfall simulations over the Drakensberg on weak-synoptic days	2023	10.1007/s40808-022-01686-y	Modeling Earth Systems and Environment	Article	0	24th	0	5.3	3
57	TAKONG Ridick Roland		Projected changes in precipitation characteristics over the Drakensberg Mountain Range	2023	10.1002/joc.7989	International Journal of Climatology	Article	0	24th	0	6.7	3
58	Athiah Winifred Ayinpogbilla	AIMS Senegal	Long Term Spatio-Temporal Variability and Change in Rainfall over Ghana (1960-2015)	2023	10.1016/j.sciaf.2023.e01588	Scientific African	Article	1	94th	5.61	4.3	7
59	Athiah Winifred Ayinpogbilla	AIMS Senegal	Mesoscale convective systems and contributions to flood cases in Southern West Africa (SWA): A systematic review	2023	10.1016/j.wace.2023.100551	Weather and Climate Extremes	Review	0	24th	0	9.2	7
60	Athiah Winifred Ayinpogbilla	AIMS Senegal	Environment of severe storm formations over West Africa on the 26-28 June 2018	2023	10.1002/met.2109	Meteorological Applications	Article	0	24th	0	4.8	7

* These publications do not present straight forward links to Climate Change. This remains to be investigated.

Of the 110 publications supplied by AIMS and referenced on Scopus, the table below lists the most prolific authors, i.e. those having published at least 4 papers:

Name	Scoupus author ID	Year of 1st publication	Total publications in Scopus supplied by AIMS	Total citations in publications supplied by AIMS	Total citations of documents authored	Total publications in Scopus	h-index Scientist	Current affiliation	Country
Klutse N.A.B.	55882952900	2014	13	292	886	33	14	African Institute for Mathematical Sciences	Rwanda
Sylla M.B.	7004829302	2005	11	258	3863	57	31	African Institute for Mathematical Sciences	Rwanda
Amekudzi L.K.	9233178200	2005	10	109	997	72	18	Kwame Nkrumah University of Science and Technology	Ghana
Atiah W.A.	57195470237	2018	10	109	147	14	8	Kwame Nkrumah	Ghana

								University of Science and Technology	
Nkrumah F.	5720237 4715	2018	6	11	84	343	7	University of Cape Coast Ghana	Ghana
Quenum G.M.L.D.	5721178 4428	2019	5	38	55	6	4	African Institute for Mathematical Sciences	Rwanda
Thorn J.P.R.	5661303 4600	2011	5	44	552	36	121	University of Cape Town	South Africa
Aryee J.N.A.	5719534 8014	2015	4	32	302	18	9	Kwame Nkrumah University of Science and Technology	Ghana
Akinyele D.	5625888 3100	2013	4	111	1802	43	20	Olabisi Onabanjo University	Nigeria
Danuor S.K.	1582727 8200	2002	4			38	12	Kwame Nkrumah University of Science and Technology	Ghana

| Diallo I. | 5535830 5000 | 2012 | 4 | 1419 | 162 | 43 | 22 | Pennsylvania State University | United States |
| Quagraine K.A. | 5720238 6826 | 2018 | 4 | | 155 | 8 | 5 | University of Cape Coast Ghana | Ghana |

A list of 12 authors who have contributed to at least 4 documents is provided. The two most prolific authors are researchers directly affiliated with AIMS and in Rwanda centre in particular. They are Klutse Nana (13 publications, 292 citations) and Sylla Mamadou (11 publications, 258 citations). The country with the most prolific authors is Ghana (6 out of 12)

D.4   Document by affiliations (at least 5 documents)

Affiliation	Documents
University of Pretoria	5
University of California, Los Angeles	5
University of Buea	5
University of Abomey-Calavi	5
South African Weather Service	5
Obafemi Awolowo University	5
Federal University of Technology, Akure	5
Botswana International University of…	5
University of York	6
Abdus Salam International Centre for…	6
University of Reading	7
University of Cape Coast Ghana	7
CNRS Centre National de la Recherche…	8
University of Ghana	13
Kwame Nkrumah University of Science and…	13
University of Cape Town	16
African Institute for Mathematical Sciences	23

D.5   Document by funding sponsor

Funding sponsor	Documents
U.S. Department of Energy	5
Department for International…	5
Botswana International University of…	5
Organization for Women in Science for…	6
National Science Foundation	6
National Research Foundation	7
Styrelsen för Internationellt…	8
Global Affairs Canada	18
Government of Canada	19
African Institute for Mathematical…	19
International Development Research…	20

## D.6 Top 9 most published journal

| JOURNAL	Total publications	Cite score 2022	Journal category	Journal rank in the category
Atmosphere	9	4.1	Environmental Science (miscellaneous)	51/163
Earth Systems and environment	5	11.8	Earth and Planetary Sciences Geology	3/284
Water Switzerland	5	5.5	Environmental Science Water Science and Technology	59/248
Climate Services	4	5.1	Earth and Planetary Sciences Atmospheric Science	53/137
Scientific African	4	4.3	Multidisciplinary	24/134
Applied Mathematics and Information Sciences	3	1.7	Mathematics, Analysis	90/187
Climate	3	5.2	Earth and Planetary Sciences, Atmospheric Science	50/137
Meteorological Applications	3	4.8	Earth and Planetary Sciences, Atmospheric Science	61/137
Theoretical And Applied Climatology	3	6.5	Earth and Planetary Sciences, Atmospheric Science	34/137

D.7   Countries Co-authorship network (at least 5 documents)
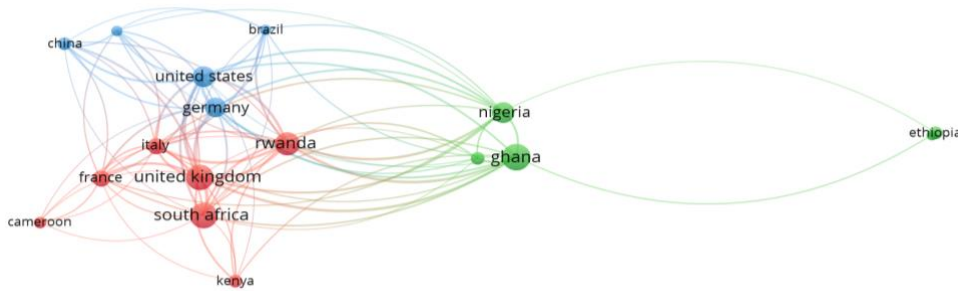
Results of co-authorship showed that Ghana was the most affiliated country (31 documents), followed by South Africa (29 documents), United Kingdom (28 documents), Rwanda (24 documents). African countries are predominantly represented in this network of publications (Ethiopia, Ghana, Nigeria, Benin, South Africa, Cameroon, Kenya...).

D.8   Countries Co-authorship network (at least 5 documents)

The graph below presents the recurrent terms appearing at least 3 times in the titles of the 110 publications provided.
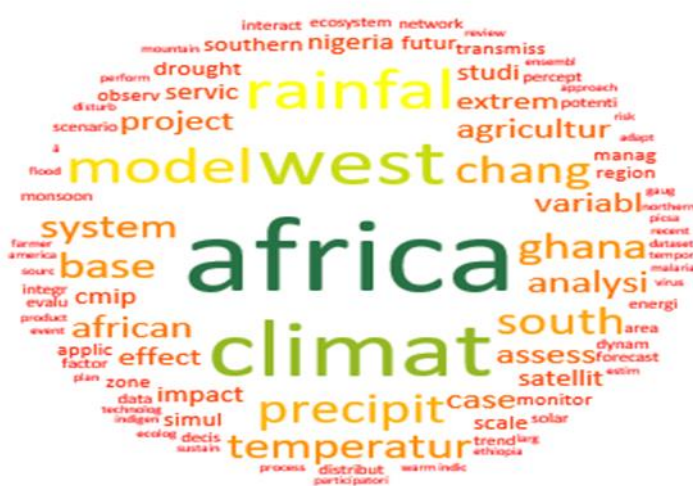
The analysis of the co-occurrences of terms in the titles of publications shows that the key words are indeed related to climate change. Indeed, the words most intervening are "climate", "Africa". The topics addressed deal with climate issues in Africa.

Appendix E Other higher education initiatives analysis

E.1 The Institute for Climate Change Adaptation (ICCA) of the University of Nairobi

The Institute for Climate Change Adaptation, ICCA of the University of Nairobi is an institute specialising in training high calibre professionals in Climate change adaptation and mitigation. The institute was established in 2011 and operational, i.e., received the first set of students in 2013. The institute is placed under the authority and supervision of the University of Nairobi, and the courses and training are accredited by the national authority in charge of accreditation (the commission for University Education). Therefore, it is considered a public higher education institution supervised by of the Ministry of Education of Kenya.

It also forms, alongside with the African Climate and Development Initiative (ACDI, based at the University of Cape Town), and the Institute for Environment and Sanitation Studies of the University of Ghana, the African Research Universities Alliance (ARUA) Centre of Excellence in Climate and Development (ARUA-CD). The ARUA-CD is an African-led and pan-African transdisciplinary network and community of practice aiming to provide response to the continent's climate-related development challenges and the knowledge and capacity urgently needed to address these and ICCA serves as the east Africa regional hub.

The institute offers formal training on climate change and adaptation at postgraduate level and professional short courses for various climate change and adaptation actors and stakeholders in the public and private sectors including NGOs. All these courses are paid. It also conducts Climate change and adaptation research and knowledge exchange, action-oriented community outreach programmes for implementation of practical climate change and adaptation options, and policy advice on climate change and adaptation.

The postgraduate degrees delivered at the Institute are a 2-year master programme in climate change adaptation (MSCA) and a 4-year PhD in Climate Change and Adaptation, offered both in part time and full time. The curriculum was developed through a workshop that gathered inputs from various stakeholders and the institute is focusing on climate adaptation.

The Institute is managed by a director, three coordinators and an administrative staff and has a staff establishment of six staff members consisting of a Professor, an Associate Professors, Senior lecturer, a Lecturer and Two tutorial Fellows.

The centre comprises both conventional lecturers, and the teaching approach incorporates group work and critical thinking exercises related to various subjects, scenarios, or real case studies. Furthermore, there is a field course where students enhance their skills in stakeholder engagements for co-development purposes. The pedagogy is characterized by a transdisciplinary approach, encompassing research and tackling uncertainties to create sustainable solutions over time. ICCA also hosts visiting fellows and organise thematic workshops throughout the trainings. The visiting fellows participate in sessions known as critical debates, which disseminate new knowledge from research and industry. Additionally, they engage in workshops that cover diverse areas, including the application of mixed methodologies and models like GIS and climate models. These workshops also emphasize training in critical thinking skills.

Regarding practical learning opportunities, industry collaboration is not yet fully established. The response from the industry has been somewhat slow due to certain engagement conditions, such as payment for internships. However, efforts are underway to address and improve this situation.

The key outcomes of the ICCA are the following:

- Since inception in 2011 the institute has recorded a total of 143 master's graduates and 186 PhD in enrolments.
- In 2020/2021-The Institute contributed to revenue stream of the University for in fees paid by students amounting to USD 47,492 and USD 253, 968 of research grants. Notably, it has attracted research grants of more than USD 705, 467 between 2011 and 2023.

According to the director, ICCA graduates can be found in various positions within NGOs and international organizations, working across different locations worldwide. The career prospects for these graduates are highly promising. A significant number of ICCA alumni find themselves immersed in opportunities offered by international organizations dedicated to climate-related work.

The financial resources and funding mechanisms supporting the Institute are from two main streams:

- School fees from students enrolling either into the master's or the PhD programme.
- Research grants the institute received due to ongoing projects and partnerships with like-minded institutions.

Regarding the latter, the institute is a Centre of Excellence under the African Research Universities Alliance (ARUA) and receives some funding pertaining to this initiative. Other key partners including REACH[76] an organization working to improve water security in Africa and ASIA, Development Corridors[77] Partnership, BRECci[78].

The main weaknesses of programmes concerning climate resilience are of various kinds. The curriculum is aimed to undergo a comprehensive review every five years. However, given the evolving circumstances, more frequent reviews might be required. Unfortunately, the university-level reviews can take weeks to months to complete. There is also a need to establish curriculum on climate finance. Another weakness is related to the limited staffing or staff freezes that have resulted in constraints on research and related activities. In the training component, ChatGPT emerges as a major challenge, which makes it difficult to ensure that assignments are effectively monitored to assess learning progress or if the intended learning outcomes are being achieved or not.

The key drivers of success lie in the excellent training delivered to students and graduates, the active engagement of the staff in research and publications, enhancing the institution's reputation. The university systems are also becoming increasingly efficient, as demonstrated during the Covid-19 period and there are ongoing developments in new ICT infrastructure, which allow for online teaching and backend tasks such as administration. The community outreach holds significant importance, and there is a dedicated programme that involves students based on certain criteria to engage them in these outreach initiatives.

E.2   The Western African Science Service Centre for Change and Adaptive Land Management (WASCAL)

The West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) is a regional research-focused Climate Service and training centre focusing on

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[76] https://reachwater.uk/,

[77] https://developmentcorridors.org/

[78] Building Research Capacity for Sustainable Water and Food Security in Dry Sub-Saharan Africa. (https://www.gcrf-breccia.com/

research and capacity building around Climate change, biodiversity, and renewable energy. and its impacts on West Africa.

WASCAL was established in 2012 as a joint initiative of Germany and 10 West African countries, aiming to enhance the understanding of climate change and its effects on the region and to develop strategies for climate change adaptation and sustainable land use. WASCAL is managed and represented by an Executive Director assisted by a Directorate and a Secretariat. WASCAL has at the apex of its governance structure, the Ministerial Council, composed by ministers in charge of higher education and scientific research in the members states, followed by a Governing Board with an Executive Committee as a subsidiary body, and a Scientific Advisory Committee (The SAC). The Governing Board has a mandate to set up sub committees to deliberate together with the executive management to review and recommend courses of action to a particular subject matter then report to the Governing Board for final decision.

WASCAL comprises three mutually reinforcing entities, namely:

- The Competence Centre, which conducts research and offers evidence-based advice on climate change impacts, mitigation, and adaptation to policymakers and stakeholders.
- The Core Research Programme complements the Competence Centre's scientific endeavours and operates through a network of German and West African research institutes.
- The Graduate Studies Programme, a network of ten graduate schools in West African universities, aiming to educate the future generation of African scientists and policymakers in climate change and land management.

The research is organized between several research centres and professors from the universities and research centres in the network and the German partner institutes. Other African and German universities are also associated to research activities and for each research topic large projects are being carried out and are led by different professors supported by experts.

The training and capacity building activities are conducted under the Graduate studies programmes which offers training at the **master and doctoral levels** to nationals of member countries. The institution offers a total of ten doctoral programmes and two master's programmes focused on climate change. Additionally, there are four international master's programmes specifically dedicated to energy and green hydrogen, known as IMP-EGH. The master programmes are completed in 24 months including 4 months in language training (mainly English as the courses are delivered in English) and the PhD programme lasts 36 months.

Since its inception, WASCAL has trained more than 250 students at the master and doctoral level. Each of the doctoral schools/ training programme recruit and sponsor only one student per member country.

It is noteworthy to mention that doctoral schools in the WASCAL network were established at different times. Initially, more emphasis was placed on creating PhD programmes. However, challenges arose, especially in finding master's level students with adequate qualifications to pursue PhD programmes in the chosen fields of each member country. As a result, the approach had to be adapted and the newly established doctoral schools have decided to offer master programmes to have a critical mass of students at the desired level before offering PhD programmes. That's the reason why there is only two master's programmes in climate change within the WASCAL network.

The graduate programme is fully funded by the Federal Ministry of Education and Research in Germany (BMBF) and the African partner universities can only host either a PhD or a master level programme sponsored by the partner. The selected students receive a full scholarship during their studies and the programme management staff is funded on the WASCAL

resources. Member states partners offer in kind contribution (university facilities, teaching staff, etc).

The teaching methodologies and pedagogical approaches employed in programmes delivered at the doctoral schools of WASCAL network are in line with those used at the host universities, as the schools are under the authority and supervision of the host university management. The degrees awarded in WASCAL network are signed by the presidents of the respective host universities.

The two masters' programmes offered under the climate change stream are the Master Research Programme on Informatics for Climate Change (MRP-INFORMCC), in Burkina Faso and the Master Research Programme on Climate Change and Marine Sciences.

The MRP-INFORMCC was finalised and welcomed its first cohort of students in 2020, bringing the number of graduates to 33 by 2023. The curriculum was jointly developed by academics at the national level with the support of WASCAL network and German partners. It is aimed at training a critical mass of experts with adequate scientific computation and climate data management skills in West Africa. This master is a multidisciplinary master's programme with a primary focus on the use of technology and artificial intelligence tools to address climate change. The programme covers areas such as climate system understanding, modelling, mitigation, and adaptation. The core of this programme lies in applying computer science to advance climate change research, enhance strategies, and foster sustainable development. Modules include machine learning, artificial intelligence, climate modelling, decision support tools, adaptation, mitigation, and sustainable development, data collection and analysis. The lecturers originate from member countries of the WASCAL network and are also sourced internationally and paid on the programme resources (BMBF funds directly managed by the PMU in the host university).

The duration of the courses is 14 months, preceded by 4 months of language courses in either English or French, depending on the student's primary language. After completing the theoretical training, students undertake a 6-month internship at a partner institution to validate their training. As per the WASCAL regulations, each student is entitled to a minimum of two main supervisors for their research work, including a "Maître de Conférence" serving as the primary research supervisor and a secondary supervisor with at least a doctoral degree. Internships are mainly held in the meteorological agencies of the member countries, the partner institutions, and the universities of the WASCAL network. the WASCAL competence centre also receives many interns. The graduates are composed of professionals returning to their previous positions and majority of the young graduates are currently pursuing further studies abroad by enrolling in PhD programmes.

Partnerships with the private sector are weak or non-existent and there are not enough human and material resources to develop this activity in the school. This constitutes a concern and an area of improvement. The development of the PhD programme has been completed and the current master's programme will be incorporated into the university's training programme; a partnership or sponsor must therefore be found to keep it dynamic and in line with the needs of the relevant stakeholders. Various initiatives are undertaken to offer fee paying capacity-building training modules in parallel with the main master programme. This approach is encouraged to benefit both our school and university. Although not emphasized at the moment, training opportunities are provided to strengthen the capabilities of students from Burkina Faso and other regions. Partnerships and collaborations are sought to sustain the efforts and avoid dependence on a single funding source. Partnerships with institutions at both national and regional levels are actively being established, and efforts are made to create Memorandums of Understanding (MoUs) to facilitate student internships. As a very young

institution, the aim of the MRP-INFORMCC is to establish the institutional presence at the national, regional, and international levels.

On the question of areas of improvement of the curriculum currently offered by this master's programme, there is no need to amend as it is satisfactory for the partners institutions and graduates.

The key outcomes of the WASCAL since its inception, according to the interviewees, can be summarised in two main points:

- The training offered by WASCAL is seen as highly relevant and impactful in the fight against climate change, covering aspects of adaptation, mitigation, and application development.

- WASCAL has trained more than a hundred PhDs who teach and work in various climate-related fields in universities, research centres and international institutions. Most of the climate science experts who have spread across the African continent, particularly those from west Africa, have done their training at WASCAL, either as graduates or as staff.

- The institution has made a major contribution to capacity building and the development of expertise in the field of climate change since its creation in 2010. Before WASCAL, over the past ten years, the training offerings in the field of climate change or climate sciences were primarily composed of small modules, such as climatology. However, WASCAL seized the opportunity to position itself by offering dedicated training in climate change sciences, thereby educating experts from diverse backgrounds, including land research, biology, and geology, among others. AKISSI's training now includes specialized master's programmes entirely focused on climate change and its impact on specific sectors. As a result, WASCAL holds a prominent position in the region, with a considerable number of experts, doctoral graduates, and master's degree holders well-distributed across various fields of activity. Within barely a decade, the institution has accomplished a remarkable feat, deserving well-earned recognition.

E.3   Africa Climate Development Initiative (ACDI)

The Africa Climate and Development Initiative (ACDI) is an institute of the University of Cape Town (UCT) in South Africa, created in 2018. It was started in 2011 by the Vice Chancellor of UCT as a strategic initiative to facilitate climate change research and education in Africa. ACDI delivered to its mandates as an initiative achieving its objectives as intended and thus chartered into a specialized institute at UCT.

ACDI serves both South Africa's national and Africa's regional needs. ACDI provides a platform for UCT and the African Research Universities Alliance (ARUA) to collectively respond to the climate challenges through coordination and centralizing resources for transdisciplinary research, teaching and learning on climate change in Africa and beyond.

The objectives of the programmes conceived at ACDI include:
- Respond to climate development challenges in Africa **through research focusing on**:
    - Support research in climate mitigation and low carbon development
    - Support research in vulnerability, impacts and adaptation to climate change.
    - Research in interaction of climate and natural sciences overarching to sustainable development themes.
- To consolidate on climate research and teaching at the University of Cape Town by acting as a **one stop shop for all climate change related activities**.

Since its formation the institute has recorded the following achievements:

- Graduated from a flagship initiative in 2017/2018 to a grounded institute mandated with core research on climate change in Africa.

- Launched post graduate study programmes including a master's degree programme in Climate Change and Sustainable development which involves 25 teaching projects where students gain practical experience during their studies. Students are attached to researchers and able to contribute on ongoing research work.

- Achieved interdisciplinary approach in research and collaboration to the challenges in climate change engaging in research output for development. This is through the specific projects hosted at the institute.

- African Research Universities Association (ARUA) selected the institute as a centre of excellence for quality research addressing development challenges in Africa. This responsibility remains a significant milestone for the centre as core stakeholder in research work relating to climate research in the continent.

The academic programmes of the institute are offered under the ACDI Climate Academy[79]. The institute offers **taught master's Programme in climate change and sustainable development.** This is **a full time one-year taught masters** that is aimed at providing interdisciplinary training to students in climate change and sustainable development with a focus on Africa's development. Research master's and PhD programmes are not specific but dependent on the prospective students' research topic which must be related to climate change and sustainable development. The students are enrolled and hosted by different departments within UCT and are supervised by ACDI professors. They can be involved in the ongoing projects which are funded and published on the institute's website. The process of enrolling[80] to the ACDI research master's or PhD is listed on the website and varies depending on the programme of interest which are offered at different departments of UCT. In addition, tailored courses[81] and training for specific professionals (academia, private/ not-for-profit sector, government) in need of climate change training are also offered at the institute.

Master's students are given an opportunity to undertake an internship[82] and work-based learning during the programme to gain practical knowledge of the concepts taught. Internships are only offered to master's students interested in the projects undertaken by ACDI researchers' network. In terms of duration of training, both research (MPhil) and taught masters (MSc) are offered for a period of one academic year. Applicants to the taught masters are required to have an honours degree or a four-year bachelor's degree and must have completed research project or dissertation in their final year. The taught master's Programme pedagogy entails a 50% course work and 50% dissertation requiring full time attendance with mandatory courses in climate change to provide a broad overview and knowledge of climate change to the trainees. These are;

- introduction to climate change and sustainable development.

- climate change adaptation and mitigation.

Taught masters are based on a mini dissertation whereas the research can be dissertation only programme. ACDI offers internships for students within its ongoing projects for students to learn in areas that interest them in climate change. PhD students are engaged in the project/research work in collaboration with other industrial partners.

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[79] https://acdi.uct.ac.za/education

[80] https://acdi.uct.ac.za/education/msc-and-phd-degrees

[81] https://acdi.uct.ac.za/education/short-courses

[82] https://acdi.uct.ac.za/internships#:~:text=ACDI's%20internship%20programmeprogramememe%20is%20designed,next%20stages%20in%20their%20careers.

Regarding financing options, the programmes can either be fully funded or the students pay schools fees. This hybrid model allows applicants who are able to meet the financing costs to pay for the programmes they wish to receive training in whereas the students limited on financing are also able apply for the funding opportunities that ACDI announces on its website. The Research masters hosted in other UCT departments attract different fee rates depending on the course selected by applicant. Funding opportunities are also made available to the PhD candidates announced on the dedicate website[83], or in monthly newsletter. However, PhD programmes are designed for **5 years** depending on the projects and duration of the research. Students are enrolled in various programmes in other departments at UCT[84]. PhD funding options are available based on the projects but also students enrolled and pay school fees in as per their respective programmes require.

The management of the institute consists of **core team: Director, administrative manager, communication lead, assistant administrator, and administrative assistant**. This core team runs the operational activities of the institute and reports to the University Management. In addition, a membership category is also designed to expand the network of the institute. Membership consists of the individuals such as research associates, institutional memberships including research groupings, academic departments, and other faculties whose interests intersect with the institutes'.

The pedagogical approach focuses on improving learnings understanding of climate change and development needs in Africa. Teaching is organized in three models:

- **Formal credits**: Available for all climate change-based graduates at the University of Cape Town including the Honours Qualifications, master's degrees (taught (MSc), research (MPhil) and PhD degrees from different departments in the University enrolled for climate research at the institute.

- **Certificates**. Available for students and working professionals taking the short courses and tailored trainings and learning opportunities offered at the UCT.

- **No credits/technical trainings**. To gain practical skill, the institute offers internships[85] for master's students and early career networks for students who would like to develop careers in climate change and development research. The interns can be hosted either internally or externally. Internally within ACDI ongoing research projects or various industry partner institutions with internship opportunities at the time of application.

The institute has recorded success in implementation of its programmes. It has continuously offered transdisciplinary research and training in climate change connecting academics, researcher with business and policy makers. In addition, it has substantially extended climate change research and education at the University of Cape town with a special approach of addressing African problems from African perspective. Findings from 5-year review of implementation from 2012-2017 indicated the below results:

- 671 research publications with a climate change and development focus from UCT and partners; 485 from ACDI members, (138 from research chairs and fellow, 48 from research staff),

- 56 master's theses from ACDI coursework master's programme and an additional 32 theses from the dissertation only master's programme, and a further 28 PhD theses,

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[83] https://acdi.uct.ac.za/opportunities

[84] https://uct.ac.za/students/applications/doctoral-candidates

[85] https://acdi.uct.ac.za/education/internships-and-work-based-learning

- 40+ seminars hosted between 2014 and 2018; 10+ networking workshops; 3 student conferences and 1 international academic conference (June 2018).

It is due to the success of the imitative as a flagship programme that it received a status of an institute in 2018. This success can be attributed to the collaborative work with researchers and funders through the ACDI research which aims to increase production of scientific knowledge and understanding that is needed to improve resilience to climate change. The level of collaboration has been implemented at two levels, **south to south cooperation and south to north cooperation**.

Through the programmes it has developed a global network[86] in various countries mapped in different continents address climate change challenges. In addition, the institute has built and established partnerships at local and international level. By 2018 there were more than 20 at local level, more than 6 at national level, and more than 20 at global level. The programme partners with foundations such as the Mastercard foundation providing scholarships to students. Also, BEIT Trust is engaged with the institute supporting graduate researchers in specific countries such as Malawi, Zambia and Zimbabwe. The Institute is further exploring partnerships with the WWF to offer new funding opportunities for students from Africa, Asia, Pacific, Latin America, Caribbean, Eastern Europe and Middle East. A key strength of ACDI is the backing of the University management having been born from an initiative of the Vice Chancellor. In addition, the institute operates with a clear strategic plan. Now on a 2018-2022 which includes clear financial flow to ensure there is financial stability of the institute.

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[86] https://acdi.uct.ac.za/about/network

Appendix F Interview questionnaire for stakeholders

F.1   Objectives of the interview

This interview is part of a study on the AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation. The purpose of the interview is to gain inputs on the effectiveness, impact, sustainability, recommendations. The interview is semi-structured.

This interview guide will frame the discussions. It shall be adapted to the experience and knowledge of each interviewee. Thus, depending on the case, certain questions or topics will be discussed in depth, while others will be addressed little or not at all.

F.2   Note on the confidentiality of the interview

Technopolis guarantees the strict confidentiality of all information provided by all respondents to its evaluations and undertakes not to disclose this information to third parties. The "actors' statements" are used in the context of cross-sectional analyses to guarantee the anonymity of the people interviewed in all the study's deliverables. If Technopolis evaluators deem impactful to provide information which may place its author in a position to be identifiable, they shall contact the person to obtain its consent.

Name of the interviewee	
Organisation	
In post since	
Date of the interview	
Interviewer	

F.3   Interview guide

Introduction:

- Could you present yourself?
- Could you briefly describe your involvement in the AIMS MS4CR programme?

Question	AIMS Secretariat	AIMS Centers	Lecturers / Tutors	Interns	Students, Alumni, researchers,	Employers of Intern/gradu	Government	Academic partners	IDRC & GAC
3.2.1 Relevance									
• Have the development priorities in Africa, specifically in terms of higher education and research in climate science, shifted in the last years?	•	•	•				•	•	•
• To what extent do you assess that the MS4CR responds to these challenges and how? Notably in increasing the contribution of African mathematical scientists/researchers (men and women) in finding solutions to CC challenges	•	•	•				•	•	

Question									
• Does the AIMS model respond to gaps in higher education and research in mathematical sciences and if so, which ones?	•	•	•	•	•	•	•	•	
• Does the AIMS pedagogical approach provide a significant advantage with respect to traditional university programmes, namely in terms of, inter alia, analytical rigour, critical thinking and leadership skills?	•	•	•	•	•	•	•	•	
• What were the emerging challenges during the period (COVID-19, others…)? To what extent was the programme able to adapt and respond appropriately to needs and priorities?	•	•	•	•	•	•	•	•	•
3.2.2 Effectiveness									
• Were programme activities delivered as planned? Were they rolled out successfully and as intended?	•	•	•	•	•	•	•	•	•
• What key factors influenced the achievement or non-achievement of the objectives of the MS4CR programme?	•	•							•
• What are your M&E mechanisms? How adequate are they? Did you face any difficulties?	•	•							•
• What effects of the programme do you identify? On the alumni, the professors, the government awareness, the research community etc… Are there some best practices, special stories to tell?	•	•	•			•	•	•	•
• Is the programme allowing alumni to access post-graduate opportunities? Which ones notably? What could be done differently?	•	•	•	•	•	•			
3.2.3 Efficiency									
• Was the programme implemented in the most cost-efficient means possible? What were the obstacles or on the opposite the drivers to cost efficiency? What could have been done differently?	•	•							•
• What are the strengths and weaknesses of the AIMS model, and does it enable cost-efficient, responsive, and timely programme delivery?	•	•	•						•
3.2.4 Sustainability									

• How and to what extent are AIMS students, alumni, donors, and governments promoting the sustainability of AIMS' activities after the end of the programme?	•	•	•	•	•	•	•	•	•
• How and to what extent has the financial stability of AIMS been improved? How successful has AIMS been in securing funding?	•	•							
• How diversified are the sources of funding secured by AIMS?	•	•							
• How can the organization's financial stability (sustainability) be improved?	•	•							
3.2.5 Conclusion									
• Are there any elements that you would like to mention in conclusion?	•	•	•	•	•	•	•	•	•

Appendix G   Interviews Conducted

Interviews Category	No of Respondents
Senior Management, AIMS Secretariat	7
AIMS Academic Directors	3
AIMS Research Staff	2
AIMS NEF – Industry Initiative	1
AIMS Lecturers	2
AIMS Tutors	0
Research Master's in Climate Science Candidates	1
PhD in Climate Science Candidates	2
Post-Doctoral Fellows	4
MS4CR Climate Science Women Fellows	2
MS4CR Small Research Grantees	1
MS4CR Interns	1
MS4CR Climate Science Stream/ Elective Courses Alumni (Focus Group)	1
Hosts and employers of AIMS MS4CR Interns and Graduates (5)	3
Donors (4)	4
AIMS Research Staff (1)	1
Government	1
Research institutes/partner universities covering climate change (4)	2
Institutes for Benchmark	3
Total	**41**

Appendix H   Focus group for MS4CR students and alumnus

H.1   Objectives of the focus group

The focus group is part of a study on the AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation. The purpose of the focus group is to gain the input of AIMS MS4CR students (current) on the effectiveness, impact, sustainability, recommendations.

This focus group guide will frame the discussion.

H.2   Note on the confidentiality of the focus group

Technopolis guarantees the strict confidentiality of all information provided by all respondents to its evaluations and undertakes not to disclose this information to third parties. The "actors' statements" are used in the context of cross-sectional analyses to guarantee the anonymity of the people interviewed in all the study's deliverables. If Technopolis evaluators deem impactful to provide information which may place its author in a position to be identifiable, they shall contact the person to obtain its consent.

Date of interview	
Interviewer	

H.3   Focus group guide

- Could you present yourself?

N°	Names of participants	Year of study/Alumni	AIMS Centre

- What is your thought about the pedagogical approach (in terms of analytical rigour, critical thinking and leadership skills) adopted in the programme? Do you have any gender approach adopted in the programme?
- Have you observed any difference between the pedagogical approach of the AIMS MS4CR Programme and that of other institutions?

- Do you believe that the Programme's pedagogical approach enhances your understanding in climate resilience compared to the traditional approach?
- Do you believe that the MS4CR programme adequately addresses the emerging issues in climate change in Rwanda/Africa? If so, how are they addressed? If not, what areas do you think could be further explored?
- What were your motivations for applying for the AIMS MS4CR Programme? Did the programme meet your expectations?
- Are there any specific challenges or gaps that you have encountered while participating in the MS4CR programme? How do you think those challenges could be addressed?
- Have you had opportunities to engage with professionals or industry experts (internships or somewhere else) through the MS4CR programme? If so, how has that exposure contributed to self-development?
- To what extent do you believe that theorical, practical experience and network acquired through the programme could enhance your employability? (for current master's student only)
- To what extent has the programme been able to provide postgraduate opportunities (for alumnus only)?
- What could be done differently to enhance postgraduate opportunities?
- Have you ever spread word about the MS4CR programme among your surrounding (friends, colleagues etc)? Which methods you have used to promote the MS4CR programme?
- Are you involved in any alumni networks or groups related to the MS4CR programme? Please describe your involvement and how it contributes to promoting the programme on the long run?
- Have you ever collaborated with other students, professionals, or organisations to promote the AIMS MS4CR programme? If so, please describe the collaborations and partnerships you have been involved in?
- Are there any elements/recommendation that you would like to mention in conclusion?

Appendix I Survey questionnaire

This survey is to be distributed to AIMS Mathematical Sciences for Climate Resilience (MS4CR) students in the five AIMS Centres (Senegal, Ghana, South Africa and Cameroon)

The survey is conducted online survey available through a link.

The next section includes an introduction to the survey that will be given and the list of survey questions that will be posed.

I.1   Introduction to the survey

This survey is part of a study on the AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation. The purpose of the survey is to gain the input of AIMS MS4CR students (current and alumnus) on the effectiveness, impact, sustainability, and recommendations as well as satisfaction on the master's level training Programme and the Internship Programme.
Your input is highly valuable to us. This way you can help us develop an action plan and tools to improve the AIMS MS4CR Programme. Your responses will be treated with strict confidentiality and processed in an anonymized and aggregated form. This survey is carried out by Technopolis Group. For our data policy, please refer to this link.
Should you have any questions related to this study, please do not hesitate to contact us at onlinesurveys@technopolis-group.com
The survey should take **no more than 15 minutes** to complete.
Thank you very much for your participation.

I.2   Some information about the student

* What is your gender? [One response]

    a- Male

    b- Female

    c- Other

* Are you a student or an alumni of the AIMS MS4CR Programme? [One response]

    a- Current student

    b- Alumni

* Which category do you belong to? ? [One response]

    a- Master student

    b- PhD

    c- Post-doc

* How did you hear about AIMS MS4CR Programme? [Multiple responses]

    a- University website
    b- Faculty or advisor recommendation

    c- Alumni referral

    d- Online social media (e.g. Facebook, Twitter, LinkedIn)

    d- Other (please specify: [open-ended response])

* What were your motivations for applying for the AIMS MS4CR Programme? [Multiple responses]

    a- Desire to gain in-depth knowledge and skills in climate resilience

    b- Programme's reputation and quality

    c- Financial support or scholarships available

    d- Other (please specify: [open-ended response])

- What is your career plan after completing the AIMS MS4CR Programme (for students only)? [Multiple responses]

    a- Seek employment opportunities related to climate in a private, government or non-governmental organisation focused on climate change/resilience

    b- Pursue further education (e.g., Ph.D. or other advanced degree)

    c- Starting a climate-related business/organisation

    d- Not clear about my career plan

    e- Other (please specify: [open-ended response])

- What is your current position (for alumnus only)? [Multiple responses]

    a- Seeking employment opportunities related to climate change/resilience

    b- Currently employed in a private organisation focused on climate change/resilience

    c- Working in a government or non-governmental organisation focused on climate change/resilience

    d- Currently pursuing further education (e.g., Ph.D. or other advanced degree)

    e- Currently launching or running a climate-related business/organisation

    f- Other (please specify: [open-ended response])

I.3   Effectiveness of AIMS MS4CR Programme:

- In terms of providing theoretical knowledge and skills in climate resilience, how well did the programme meet your expectations? [One response]

    a- Very well

    b- Well

    c- Not well

    d- Not at all

- How would you assess the level of support and guidance provided by the faculty members in the MS4CR programme? [One response]

    a- Excellent

    b- Good

    c- Average

    d- Poor

- How satisfied are you with the accessibility and quality of resources and facilities (e.g., libraries, labs, research materials) for your studies? [One response]

    a- Very satisfied

    b- Satisfied

    c- Neutral

    d- Dissatisfied

    e- Very dissatisfied

- Did you have opportunities to network and collaborate with other students or professionals in the field of climate resilience during your studies? [One response]

    a- Frequently

    b- Occasionally

    c- Rarely

    d- No

- Did the MS4CR programme provide you with practical experiences (e.g., fieldwork, case studies) that helped you to better understand and apply climate resilience concepts? [One response]

    a- Significantly

    b- To some extent

    c- No at all

- How well do you feel the MS4CR programme prepares you for a career in the field of climate resilience? [One response]

    a- Very well

    b- Well

    c- Not well

    d- Not at all

    e- Not effective at all

I.4   Impact of the internship programme:

- Did you participate in an internship as part of the MS4CR programme? [One response]
    a- Yes
    b- No

- How long was your internship? [One response]
    a- 1-3 months
    b- 3-6 months
    c- More than 6 months

- How well did the internship met your expectations in terms of enhancing your practical skills and knowledge? [One response]
    a- Very well
    b- Well
    c- Not well
    d- Not at all

- Do you believe that the internship experience contributes to your professional development and increase your employability prospects? [One response]
    a- Significantly
    b- To some extent
    c- Not at all

- How satisfied are you with the internship programme overall? [One response]
    a- Very satisfied

b- Satisfied

c- Neutral

d- Not satisfied

- How can the internship programme be further improved to provide more meaningful and impactful experiences? [open-ended response]

I.5   Sustainability

- Do you spread word about the MS4CR programme among your friends and colleagues? [One response]

    a- Regularly

    b- Occasionally

    c- Not at all

- If responses a or b were selected at the previous question, please select the methods you have used to promote the MS4CR programme: (Select all that apply)? [Multiple responses]

    a- Sharing information on social media platforms (e.g., Facebook, Twitter)

    b- Presenting about the programme at conferences or events

    c- Being part of information sessions or workshops at universities or educational institutions

    d- Other (please specify: [open-ended response])

- Are you involved in any alumni networks or groups related to the MS4CR programme? [One response]

    a- Actively involved

    b- A little bit involved

    c- Not involved

- If responses a or b were selected at the previous question, please briefly describe your involvement and how it contributes to promoting the programme on the long run: [open-ended response]?

- Have you collaborated with other students, professionals, or organisations to promote the AIMS MS4CR programme? [One response]

    d- Significantly

    e- A little bit

    f- Not yet

- If responses a or b were selected at the previous question, please briefly describe the collaborations and partnerships you have been involved in: [open-ended response]?

- What is the unique added value of AIMS? [Multiple responses]

    a- Free of charge

    b- International exposure

    c- Multiple teachers' exposure

    d- Multiple topics exposure

    e- Multiple methods of work exposure

    f- Internship embedded in the masters

    g- Quality of the teaching

    h- Recognition of the institution international

i-   Others [open-ended response]

- Conclusion

Is there anything else you would like to mention? (Please provide any additional comments, suggestions, or feedback regarding the AIMS MS4CR programme: [open-ended response])
Thank you for taking the time to answer this survey. In case you have any further questions about the survey, feel free contact: onlinesurveys@technopolis-group.com.

Appendix J Interview questionnaire for benchmark studies

J.1   Objectives of the interview

This interview is part of a study on the AIMS Mathematical Sciences for Climate Resilience (MS4CR) End-of-Programme External Evaluation. The purpose of the interview is to conduct benchmarking of initiatives, centers, and programmes of similar nature to understand the best practices, design and models contributing to their success. This will also underpin the challenges faced by these programmes/centers of initiatives to derive core learnings that will feed into the evaluation process and recommendations at the end of the process. The interview is semi-structured.

This interview guide will frame the discussions. It shall be adapted to the experience and knowledge of each interviewee. Thus, depending on the case, certain questions or topics will be discussed in depth, while others will be addressed little or not at all.

J.2   Note on the confidentiality of the interview

Technopolis guarantees the strict confidentiality of all information provided by all respondents to its evaluations and undertakes not to disclose this information to third parties. The "actors' statements" are used in the context of cross-sectional analyses to guarantee the anonymity of the people interviewed in all the study's deliverables. If Technopolis evaluators deem impactful to provide information which may place its author in a position to be identifiable, they shall contact the person to obtain its consent.

Name of the interviewee	
Role of the interviewee	
Organisation	
In post since	
Date of the interview	
Interviewer	

J.3   Interview guide

Introduction:

1. Could you present yourself?
2. Could you briefly describe your institution and your role?
3. What are the programmes offered in mathematical sciences and/ or climate changes and resilience in your institution?
4. What are the objectives of the programmes? To what extent have programmes achieved their objectives and outcomes?
5. How many students by type of degree (MSc, PhD etc) are enrolled in the programmes?
6. What are programmes' organisational structure, management, and overall performance?
7. What are the teaching methodologies and pedagogical approaches employed in programmes, enhancing students' understanding of climate resilience?
8. What teaching methods and pedagogical approaches are used in the programmes to improve students' understanding of mathematical sciences and their applications?

9. How do programmes identify and provide relevant skills to students for careers and leadership roles in the field of mathematical sciences pertaining to climate resilience and other aspects of mathematic?

10. How do programmes incorporate practical learning opportunities, such as internships, workshops, fieldwork, and industry collaborations?

11. What are the post-graduation outcomes and career prospects of students from programmes?

12. What are the outcomes, impacts, and successes of programmes on climate resilience in terms of research outputs, and policy influence?

13. What is the perception of students, faculty, and stakeholders regarding the relevance and quality of the programmes in addressing current climate resilience challenges?

14. What are the outcomes, impacts, and successes of mathematical sciences programmes in terms of research outputs, and policy influence? What is the perception of students, faculty, and stakeholders regarding the relevance and quality of these programmes?

15. What is the level of collaboration and partnerships between programmes and external stakeholders (e.g., government, NGOs, international institutions) in addressing climate resilience challenges?

16. What are the financial resources and funding mechanisms supporting the sustainability and growth of programmes?

17. How do programmes engage with the government, international institutions and other relevant organisations to raise funds?

18. How do programmes show commitment and strategies for long-term sustainability in terms of funding, staffing, curriculum development, and stakeholder engagement?

19. What are the key strengths and weaknesses of programmes in addressing climate resilience issues?

20. What are the barriers and facilitators to the successful implementation of programmes on climate resilience?

21. What are the key strengths and weaknesses of programmes in mathematical sciences?

22. What are the barriers and facilitators to the successful implementation of programmes on mathematical sciences and their applications?

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