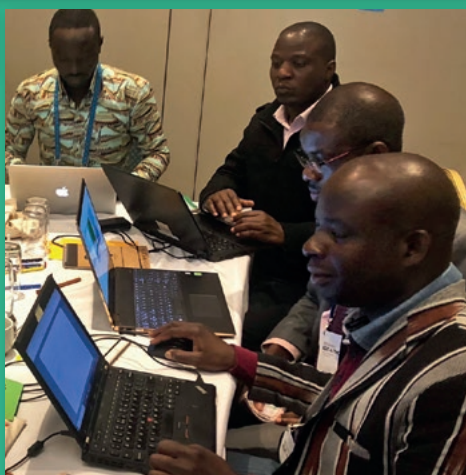


BUILDING RESEARCH CAPACITY IN EARLY CAREER RESEARCHERS

Insights from an international climate research programme



Authors

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and Roy Bower



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FUTURE CLIMATE FOR AFRICA (FCFA) CAPACITY DEVELOPMENT PROGRAMME IN NUMBERS

99

Early Career Researchers
(74 African and 36 women)
from 20 different countries

120

Individual travel grants
issued through the Mobility
Fund across the 5 research
consortia to support 72 ECRs

53

Journal articles
by 15 African ECRs and 16 non-
African ECRs (some authoring
more than one article)

12

Research projects
funded through the Innovation
Fund involving 27 ECRs

38

Journal articles
written by FCFA ECRs
as first authors

63

Knowledge products
involving 28 African ECRs and
13 non-African ECRs

2

Intergovernmental Panel
on Climate Change (IPCC)
co-authors
on the upcoming IPCC Sixth
Assessment Report are
FCFA ECRs

2

BSc (Honours)

10

Master's

8

Phd degrees
achieved by ECRs during
involvement in FCFA



Key Messages

- New opportunities for Early Career Researcher (ECR) capacity development emerge at the scale of international, multi-consortia research programmes. Within inter- and intra-consortium networks, ECRs can access diverse resources that are partially or wholly absent in stand-alone or individual PhD or postdoctoral grant schemes.
- Capacity development of ECRs should be included in the initial design of research programmes as an explicit objective with ring-fenced funds and appropriate resource allocation. This is particularly important to improve the under-representation of ECRs from developing regions.
- Within a research programme, a range of capacity development activities and flexible funding mechanisms are vital for building soft and hard skills of ECRs:
 - Travel grants provide opportunities for networking, collaborating and accessing data and infrastructure, but also provide ECRs with access to platforms to communicate their research.
 - Ring-fenced ECR research grants increase ECRs' involvement and provide valuable support from supervisors and mentors whilst addressing emergent knowledge gaps in a larger research programme.
 - Short, bespoke, problem-focused training and workshops throughout the programme can build particular skills.



*Learning exercise at HyCRISTAL annual general meeting, Kenya, 2016.
(Source: Julio Araujo, 2016)*



Introduction

Africa is highly vulnerable to climate change and most countries are already experiencing its impacts. There is a strong need to generate improved climate information for Africa and apply this information to build resilience. One of the key long-term opportunities to improve Africa's climate resilience is investment in building the capacity of African researchers.

Recognising this need, the Future Climate for Africa (FCFA) research programme aimed to develop greater capacity within the scientific community, particularly among African Early Career Researchers (ECRs), to deliver fundamental and applied research while promoting multi-disciplinary, international collaboration. Making capacity development of ECRs an explicit aim of a larger research programme presented new challenges and opportunities, and ultimately delivered significant additional impact.

This publication summarises learning from FCFA's scientific capacity development programme of activities, which ran from 2015 to 2019. It provides an overview of the support provided to ECRs and the main outcomes and learning from implementing the programme. The findings presented here capture feedback from 99 ECRs, their supervisors and FCFA programme coordinators over a period of three years. It provides recommendations for realising the opportunities that international, multi-consortia research programmes present for building the capacity of ECRs.

ABOUT FCFA



Future Climate for Africa (FCFA) aims to generate fundamentally new climate science focused on Africa, and to ensure that this science has an impact on human development across the continent. FCFA is a research programme, implemented by five international research consortia working across Africa, Europe and the UK and supported by a central coordination unit:

- **AMMA-2050** (African Monsoon Multidisciplinary Analysis 2050)
- **FRACTAL** (Future Resilience for African Cities and Lands)
- **IMPALA** (Improving Model Processes for African Climate)
- **HyCRISTAL** (Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in East Africa)
- **UMFULA** (Uncertainty Reduction in Models for Understanding Development Applications)
- **CCKE** (Coordination, Capacity Development and Knowledge Exchange unit)



A group photo of FRACTAL ECRs known as embedded researchers at the FRACTAL annual meeting in Cape Town, 2019. Embedded researchers were a key aspect of FRACTAL's design and these individuals acted as knowledge brokers and as a bridge between climate scientists and city officials and decision makers. (Source: FCFA, 2019)



Levels of capacity development and enablers of good practice

Capacity development can be considered to occur at three levels; individual, institutional and systems level (Cobban et al., 2017).



New benefits and opportunities for capacity building for individuals have emerged over several years.

Each level is made up of different components that contribute to research capacity (Figure 1). Furthermore, a review of previous research capacity development initiatives indicates enablers of good practice that should ideally be taken into account in designing a capacity development programme (Cobban et al., 2017) (Figure 2).

The capacity development initiatives of FCFA focused largely on the individual level. However, the feedback from FCFA ECRs provided strong evidence of the relationship between individual capacity development and involvement in a large multi-consortium research programme. A key finding from monitoring and evaluation of FCFA activities is that new benefits and opportunities for capacity building for individuals have emerged over several years at inter- and intra- consortium network scales.



A number of FCFA ECR's work on the Wikipedia Climate Change in Africa page at Africa's first Wikipedia edit-a-thon on climate change. (Source: FCFA and the Climate and Development Knowledge Network, 2019)



FCFA researchers discuss the progress of FRACTAL at the FRACTAL annual meeting. (Source: FCFA, 2019)

FIGURE 1 Descriptions of the components of scientific capacity development at individual, institutional and systems levels. Adapted from Cobban et al. (2017).

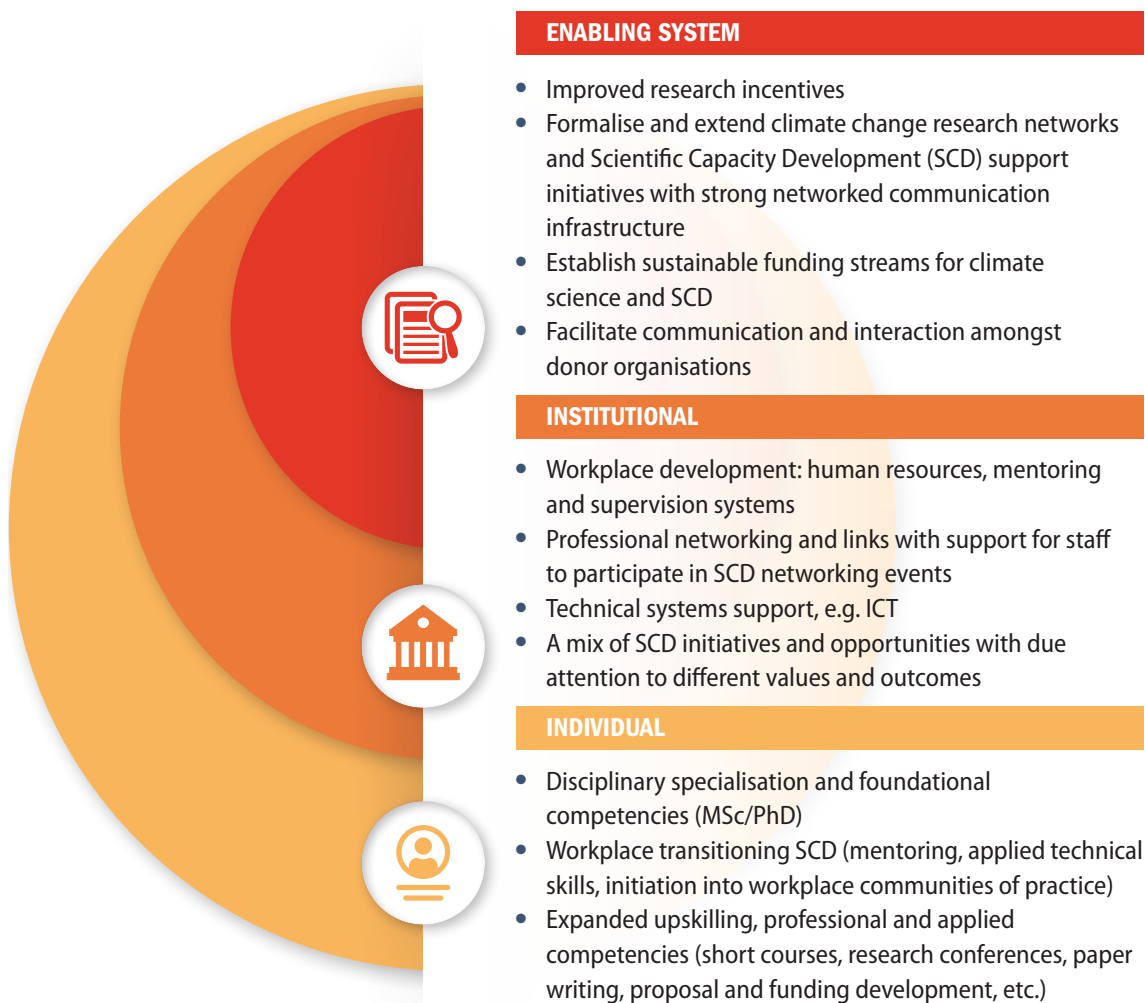











FIGURE 2 The good practice factors of scientific capacity development initiatives (Cobban et al., 2017) and reflections from FCFA.

FACTOR	 ADEQUATE FUNDING	 ADEQUATE HUMAN RESOURCES AVAILABLE	 ADEQUATE INFRASTRUCTURAL, DATA AVAILABILITY AND/OR COMPUTING CAPACITY	 ADEQUATE TECHNICAL AND ANALYTICAL SKILLS
DESCRIPTION	<p>Without suitable personal funding, individual development pathways can be constrained; institutional shortages can constrain the scope or effectiveness of activities.</p>	<p>At the institutional level, effective management and coordination of funds and activities, contracting, procurement, reporting, logistics; expertise present and available (i.e. time). At the individual level, personal time management.</p>	<p>Computational and internet infrastructure available at the institutional or systems (regional) level. At the systems level, data and climate information systems are functional.</p>	<p>At the individual level, an existing 'base' of technical or disciplinary skills, particularly analytical skills, on which the SCD can build.</p>
REFLECTIONS FROM FCFA	<p>FCFA was able to allocate sufficient funding (approximately GBP 480 000) to support a bigger group of ECRs than originally expected (particularly African ECRs based at African universities) due to adaptive management, flexible contracting measures, and a supportive donor.</p>	<p>The addition of a programme of support for ECRs involved more work from all concerned. Receptive and flexible consortia research coordinators were key to successful delivery. Arguably there was potential to leverage the multi-consortium network even further for capacity development. More human resources dedicated to sustaining structured mentorship programmes, while supporting the administration, coordination and monitoring of initiatives and grants could have further supported the capacity of ECRs within the FCFA network.</p>	<p>One of the key benefits of the collaborative consortium-based structure of FCFA research was the access that participating ECRs gained to data, models, and computing infrastructure at world-leading centres in the UK and Europe.</p>	<p>ECRs needed a pre-existing 'base' of technical skills to enable collaboration in FCFA research. Within FCFA, the availability of a larger group of networked peers and supervisors enabled problem-focused interactions (workshops or trainings) where ECRs acquired new technical skills by applying tools to cutting-edge research questions.</p>

 <p>SUPPORTIVE PLATFORMS FOR COMMUNICATION</p>	 <p>SUPPORTIVE ACADEMIC PROFESSIONAL INTERACTIONS</p>	 <p>ETHIC OF COLLABORATION</p>	 <p>INTEGRATIVE REFLEXIVE APPROACHES</p>	 <p>AUTONOMY TO PURSUE OPPORTUNITY</p>	FACTOR
					DESCRIPTION
					REFLECTIONS FROM FCFA
<p>Tools and channels that enable relevant information to transfer reflexively between relevant participants and stakeholders.</p>	<p>Peer-to-peer, professional networks or senior supervision or mentoring, to guide, soundboard, challenge or collaborate.</p>	<p>Commitment and value at the individual and institutional level for collaboration between peers, cross-disciplines, cross-institutions and/ or cross-border.</p>	<p>Involving participants and/or stakeholders across the full research or capacity development process.</p>	<p>At the individual level, ECRs have room to apply or practice skills, pursue research interests, build confidence and address their own skill shortages. At the institutional level, capacity to pursue new areas and create legacy.</p>	
<p>ECRs frequently noted the crucial role of face-to-face exchanges, such as annual meetings, which often included a platform for ECRs across a wide array of disciplines and institutions to share their research and engage in longer, more technical conversations with peers and actors outside of academia.</p>	<p>ECRs frequently noted the value of supervision from their primary supervisor (at their home institution) as well as secondary support from other consortium partners. Mentorship within FCFA largely happened informally and emerged based on the needs of ECRs. One example of formal mentorship from the FRACTAL project, whereby embedded researchers were mentored by a senior researcher, played an important role in capacity development of ECRs involved. More structured mentorship and formal arrangements between mentors and ECRs throughout FCFA, could have furthered opportunities for capacity development.</p>	<p>ECR feedback revealed that FCFA consortia succeeded in creating an environment where ECRs could undertake substantial research collaborations beyond their home institution.</p>	<p>Research consortia reflected on their practices and adapted to demands from various partners, pursuing more integrated research agendas over time. The ability of the CCKE to programme funds for capacity development in a staggered manner and the research consortia's flexibility to adapt to and absorb these funds were key to responding to needs and learning as it emerged.</p>	<p>Travel and research grants were provided in a flexible manner, where ECRs could initiate requests and pursue travel and training opportunities of their own choosing. Opportunities were not limited to FCFA events or training at partner institutions only.</p> <p>Giving individuals autonomy requires flexible grant making in the context of multi-consortium programmes.</p>	



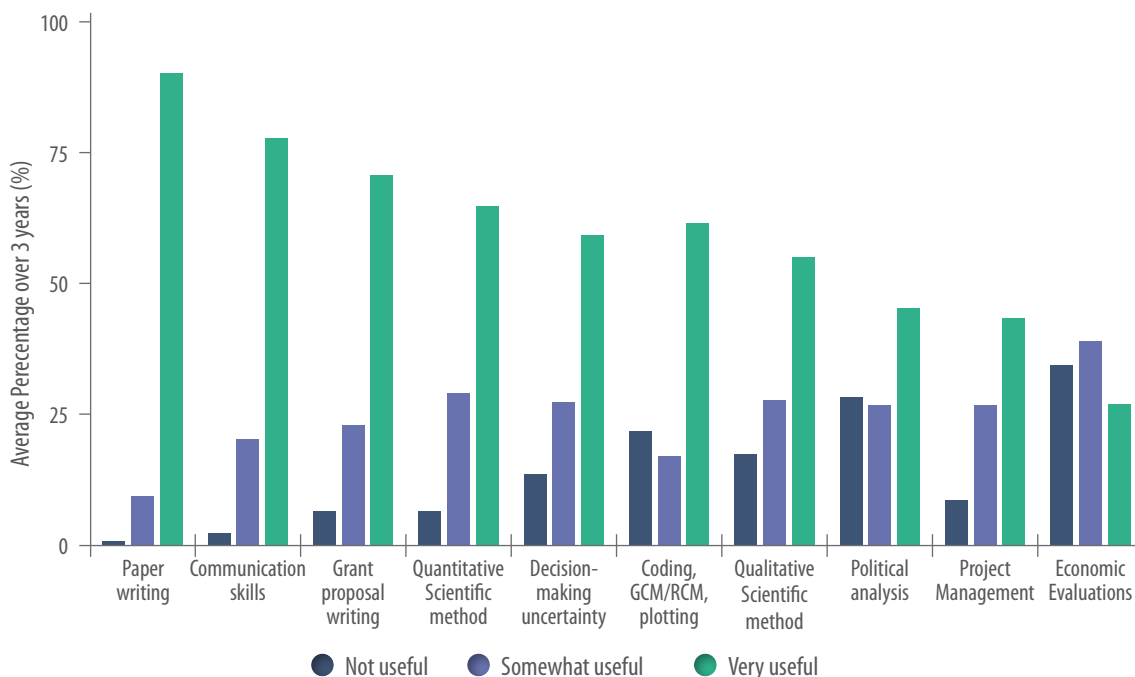
The important skill areas for climate ECRs

FCFA conducted annual surveys with all ECRs working on FCFA from 2017 to 2019 to track their career and capacity development during the course of the programme. In total 122 respondents completed one or more of the three surveys (of whom 64% were African and 40% were women) across a large sample of institutions, mostly universities.

Key soft skills and how they are best developed

ECRs identified the soft skills of paper writing, communication skills, and grant proposal writing as the most useful for their capacity development (Figure 3). Regardless of disciplinary background, ECRs saw these soft skills as key to furthering their careers by increasing the quality and impact of their research outputs, and securing funding for future research. These soft skills were identified as being best developed through a mix of experiential learning, including adequate mentoring, supervisory support, doctoral research and attendance of conferences and workshops. Undergraduate studies, doctoral training, short courses and online courses were perceived to make much less of a contribution towards soft skills development. FCFA provided ECRs access to communication platforms, networking opportunities, and mentoring support through multiple institutions across diverse disciplines, resulting in significant skills development in these soft skill areas. These resources emerge at the scale of a large multi-consortia, multi-year programme and may be largely absent when ECRs receive grants to pursue research in isolation.

FIGURE 3 The skills that FCFA ECRs rank as not useful, somewhat useful, and very useful as an average from the three surveys.



Note: the lower ranking of disciplinary hard skills, like economic valuation and political analysis, reflect the FCFA research agenda and composition of consortia and cannot be generalised.

Key hard skills and how they are best developed

ECRs identified hard skills of climate science analysis, including coding, working with Global and/or Regional Climate Models (GCMs, RCMs), data plotting, and quantitative methods, including principal component analysis and regression analysis as very useful skills (Figure 3). This is understandable, given that FCFA is predominantly a climate science programme. ECRs identified undergraduate studies, graduate studies, and doctoral research as the most frequent means through which these skills are acquired. This confirms that these 'hard skills' are often developed through formal education and training.

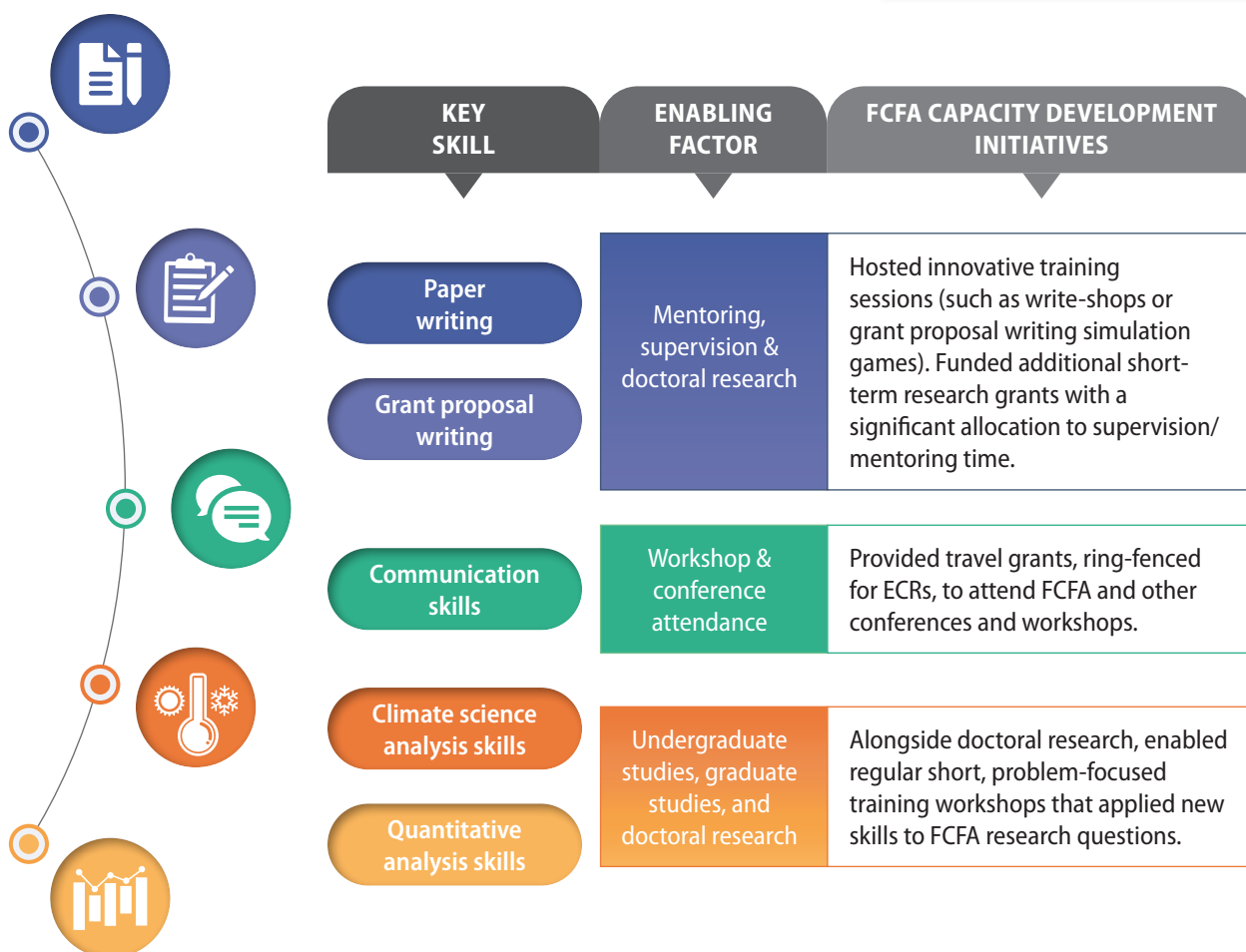
FCFA's international consortium-based research model enabled opportunities to build this capacity through bespoke, problem-focused training. For example, some FCFA consortia employed short, intensive, problem-focused workshops to great effect to assist ECRs with applying tools and methods to specific research questions and improving certain analysis skills.

WHAT ARE SOFT AND HARD SKILLS?

Hard skills are those tangible skills that can be gained through means of education, training or self-study. They are technical, functional and visible and they concern, for instance, the use of research methodologies or explicit knowledge. In other words, they are the skills allowing individuals to conduct their research practically in a particular discipline.

Soft skills are less tangible and are associated with researchers' professional development. These are the skills that allow researchers to navigate the process of being published, identify and secure funding, establish collaborations, communicate their research and influence policy makers.

KEY SKILLS IDENTIFIED BY FCFA ECRS AND THEIR MODES OF DEVELOPMENT IN SUMMARY:





FCFA researchers discuss stakeholder engagement at UMFULA annual meeting in Malawi. (Source: FCFA, 2017)



Learning from FCFA capacity development initiatives for ECRs

Three capacity development initiatives underpinned the FCFA approach: travel grants, ring-fenced research grants for ECRs and bespoke, problem-focused training and workshops.



Travel Grants

Within FCFA, ring-fenced travel grants, administered through a central 'Mobility Fund' for ECRs, enabled the achievement of several capacity development objectives. ECRs were able to further substantial collaboration and networking as travel grants were used to: attend conferences, workshops, and annual FCFA meetings; pursue FCFA and independent training; and support research exchanges.

In particular, attendance at FCFA annual meetings and workshops was essential for ECRs to integrate within a coordinated multidisciplinary research team, build skills and peer-to-peer networks, and progress FCFA research outputs (such as peer-reviewed papers).



ECRs were able to further substantial collaboration and networking using travel grants.

The provision of travel grants enabled ECRs to capitalise on substantial opportunities for collaboration, rather than merely extending their network of professional contacts in a more superficial way. An ECR attending the UMFULA annual meeting reflects; *"It is just a reminder of how much can get done when the different teams sit in the same room and not far distances over the internet. This is something that really needs to be recognised for future projects."*

Most ECRs' feedback also highlighted the development of interdisciplinary or trans-disciplinary research competencies as a key outcome from Mobility Fund support.

For some ECRs travel grants also provided access to infrastructure, data and computing capacity. The Mobility Fund enabled individual ECRs to leverage the FCFA consortia for short- and longer-duration travel, providing access to data and computing infrastructure at world-leading centres in the UK and Europe.

“The most involved ECR in the project had planned to use the CP4-Africa Control Simulation (model running as part of the IMPALA project). He managed to download the data during his one-month stay in Paris funded by the FCFA Mobility Fund. He also designed the sensitivity experiments with consistent expected long-term trends from a CURIE supercomputer during his stay. But he did not have enough time to finalize the work, because when he was back [at African institution], he was facing challenges such as internet speed (the waiting time before a job execution was too long),” noted a supervisor, highlighting the need to address the barriers ECRs face at their home institutions in future programmes.

For some ECRs, travel grants provided access to infrastructure, data and computing capacity.

FCFA travel grants provided ECRs with autonomy to pursue opportunities. Mobility Fund grants were provided by the FCFA Coordination Unit with very few strings attached. They sought to provide ECRs with sufficient funding and autonomy to pursue activities within the context of their own career development (in the first instance), and the outcomes of the FCFA programme and consortia work plan (in the second instance). Research consortia employed different approaches (with varying degrees of autonomy for ECRs) in the issuing of travel grants. The consortia with full-time coordinators were able to administer significantly more Mobility Fund grants. For some key FCFA events, such as the mid-term conference and Africa Climate Risk Conference 2019, informal quotas were set up to support increased African ECRs’ representation.



FCFA ECR presents on Climate Information for Resilient Tea Production in Malawi and Kenya at FCFA mid-term conference. (Source: Gregor Rohrig, 2017)



Ring-fenced research grants for ECRs

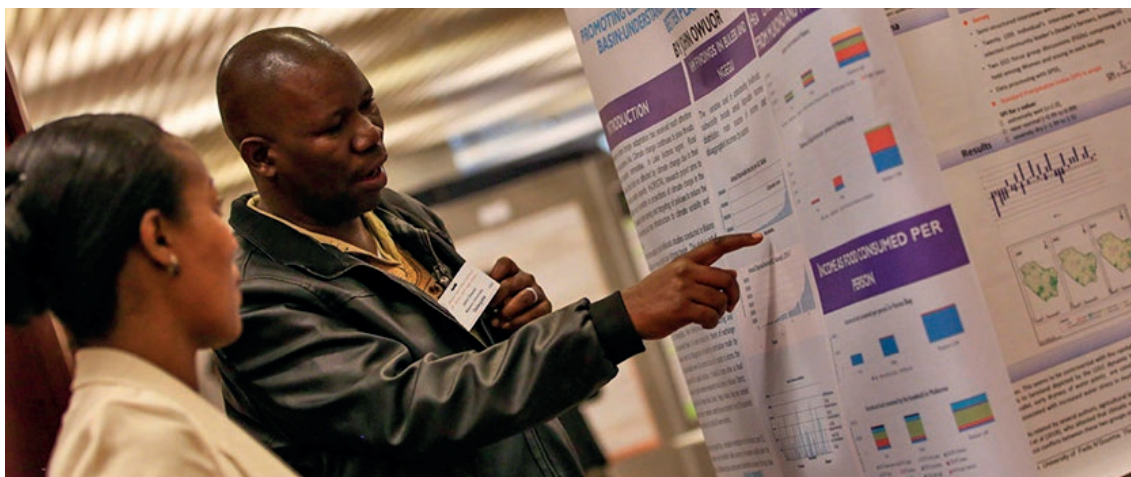
FCFA donors awarded the majority of the FCFA grant to the five winning consortia's research proposals at the outset of the five-year programme. Alongside this, the CCKE issued smaller, short-term research grants (lasting no more than 18 months) under an 'Innovation Fund'. The Innovation Fund was commissioned after the commencement of FCFA's main programme of activities, in response to the observed need to increase opportunities for ECRs to participate in FCFA, with a priority on African ECRs.



These small research grants strengthened and extended the research network by increasing the involvement of ECRs.

These small research grants strengthened and extended the research network by increasing the involvement of ECRs. A diverse portfolio of research projects, funded by the Innovation Fund, enabled the participation of new African ECRs in FCFA, and increased the involvement from existing ECRs. Whilst the consortium research partnerships were largely set at the outset of the programme, the Innovation Fund enabled ECRs to address emergent, 'gap-filling' research questions through new inter-consortium projects. Implementing these two years after the commencement of the initial research programme enabled proposals to respond to emerging research needs that had not been apparent at the programme's commencement.

Research grants provided ECRs with access to world-leading supervisor support within a collaborative, international research programme. ECRs often benefited from supervision or mentoring from FCFA senior researchers across two or more institutions and disciplines. Most ECRs had the opportunity to frame their research within the consortia, whilst accessing a wide network of future collaborators via the FCFA community. This enabled more ambitious research proposals and improved outcomes for the ECRs' career trajectories, which 'stand-alone' bursaries would have struggled to emulate. Regardless of the discipline, methodology or research question, ECRs noted significant improvements to their paper writing (sometimes across different formats) and of communication skills, often developed through the mentoring and support from supervisors.



An FCFA ECR presenting during the poster session at the African Climate Risks Conference, 2019. (Source: Kiara Worth (IISD))



FCFA ECR presenting research at the HyCRISTAL annual meeting. (Source: FCFA, 2019)

An UMFULA supervisor provides feedback, *“In the beginning, the ECR was unable to articulate the issues well, but [...] he is now able to prepare and present easily. He has also gained strength in writing. [With] regards to quantitative analysis, the candidate is now able to do statistical analysis and fit data to different model distributions and conduct several tests.”*

Similar to travel grants, ECR research grants provided some ECRs with access to infrastructure, data and computing capacity. Several African ECRs were able to access world-leading supercomputer infrastructure and new datasets through European and UK partners in FCFA.



Bespoke, problem-focused training and workshops

An international, consortia-based research programme can provide an array of resources from which to draw on to create bespoke and specialised training in response to ECRs’ capacity needs. Such training also enables new skills to be applied to cutting-edge research questions and make data more accessible through the programme, supporting ECRs to deliver high-quality research outputs.

Hosting repeated, staggered training or workshop sessions (in-person or virtual) that focused on a particular skill or application of tools related to climate research helped to build ECRs’ capacity over a longer period of time and in a more coherent manner. Further, the skills learnt in these training sessions went beyond their programmatic use and built the individual capacity of the ECRs for use in other projects and for sharing with their fellow students and colleagues at their home institutions. These factors increased the geographic and participant reach of the training.



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Two of the LaunchPAD fellows share and discuss their climate model evaluations at a LaunchPAD workshop. (Source: FCFA, 2020)

In FCFA, climate modelling and computer coding (Python) workshops were held for African ECRs in the HyCRISTAL and AMMA-2050 consortia. The HyCRISTAL collaboration enabled ECRs to develop their coding skills by exploring the new CP4-Africa dataset developed by the IMPALA consortium, enabling ‘spin-off’ research from core FCFA investments. Feedback from ECRs indicated the immense need for such problem-focused and bespoke training to apply these tools to climate science-related questions. The workshops also served to highlight further needs for training whilst enabling beneficiaries to assist their peers at home institutions.



Feedback from ECRs indicated the immense need for such problem-focused and bespoke training to apply these tools to climate science-related questions.

“Why this training? It’s really important – it’s technology transfer in action. Of course, in our country we are learning things, but when you take part in this kind of workshop, you meet people who can teach you about further computational tools, which are very important for us... when I am back, I need to start teaching Python to the Master’s students,” an African ECR reflects on the advantage of attending the climate modelling workshop at University of Leeds in December 2016.

“There will be ample opportunities, to pass the new knowledge to students in my home institution who are just starting out on climate change research,” commented an ECR on how he will be transferring his skills to fellow West African climate scientists.



Key recommendations for future research programmes

- **INCLUDE CAPACITY DEVELOPMENT OF ECRS IN THE DESIGN OF RESEARCH PROGRAMMES:** in particular, include explicit capacity development outcomes in the programme's business case and theory of change aimed at ECRs from smaller and emerging regional centres of excellence.
- **ALLOCATE SUFFICIENT FINANCIAL AND HUMAN RESOURCES:** financial resources for capacity development should be ring-fenced and available in a flexible, staggered manner to enable accountability and responsiveness to emergent learning, partnerships, and research agendas, which may not be apparent at the outset of a multi-year research programme. Sufficient human resources should be allocated to structured mentorship arrangements, the delivery and monitoring of capacity development activities and the integration with programmatic research objectives. Ideally, this should be in the form of a dedicated central programme manager and coordinators within research consortia.
- **BUILD THE ESSENTIAL SKILLS IDENTIFIED BY ECRS:** A range of capacity development activities and funding mechanisms are vital for building soft and hard skills. Establishing a skills baseline and needs assessment at the start of a research programme is necessary to maximize the impact of capacity development support. Travel grants provide opportunities for networking, collaboration and access to data and infrastructure. Staggered, short-term research grants can increase involvement of ECRs, provide valuable access to supervisory and mentor support, and fill emergent gaps in the research agenda. Bespoke training or workshops that are problem-focused can link skills needs with individual and programmatic research objectives.



ECR's were given the opportunity to present their research at various events (Source: Kiara Worth (IISD), 2019 and Gregor Rohrig, 2017)

- **SUSTAIN CAPACITY DEVELOPMENT THROUGHOUT THE LIFESPAN OF A RESEARCH PROGRAMME:** large, medium-term research programmes can create an enabling environment to build ECR skills in a more coherent and comprehensive way than isolated graduate and doctoral bursaries. A programme of support to ECRs that spans the length of the research programme is necessary to realise this opportunity.
- **DEVELOP ECR INTERDISCIPLINARY OR TRANS-DISCIPLINARY RESEARCH COMPETENCIES:** this is enabled by integrated research consortia when research proposals are co-produced between established and emergent centres of excellence across diverse socio-economic and cultural contexts.
- **PROVIDE OPPORTUNITIES FOR AFRICAN ECRS TO OVERCOME THE BARRIERS THEY FACE AT THEIR HOME INSTITUTIONS:** collaborative and interdisciplinary research programmes can provide opportunities to overcome limited access to data, computing capacity and infrastructure, faced by ECRs at many African institutions, whilst providing additional mentoring and peer-to-peer support. Research programme partners can also integrate the programme's research activities with existing teaching and training at African partner institutions.
- **EMBED ECRS WITHIN STRONG NETWORKS:** networks between ECRs and with more senior researchers is important and should be fostered throughout the programme by in-person workshops/events/meetings, encouraging collaboration (particularly cross-discipline and cross-consortia), and formal mentorship arrangements. To ensure the longevity of this network, funds should be set aside at the start of the programme for ECR legacy activities.
- **MONITOR, EVALUATE AND LEARN FROM CAPACITY DEVELOPMENT ACTIVITIES:** general self-assessment surveys may be necessary, but are not sufficient or optimal in tracking skills development of individuals. Reporting on specific initiatives through required application, completion and feedback forms (for example, back-to-office reports from travels), together with information gathered in focus groups and/or interviews, provide better data to understand ECRs' choices and needs, and their reasoning behind these.



FCFA researchers at UMFULA annual meeting. (Source: FCFA, 2016)



FCFA ECRs who are part of LaunchPAD discuss their West Africa climate research at LaunchPAD workshop. (Source: FCFA, 2020)

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Video: [Future Climate for Africa's Early Career Researchers discuss their capacity development](#) (2019).

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