Chapter 7

Designing Research to Catalyse Climate Action

Bruce Currie-Alder and Ken De Souza

Abstract Climate action ahead of 2030 requires ambitious research that is fit for purpose: working across scale, creating synergy among cohorts of projects, and enabling capacity to pursue research uptake. Research needs to bridge local and national levels and provide evidence that informs decisions with decadal implications. To become more than the sum of its constituent activities, research programmes and consortia require learning frameworks and equitable partnership among participating organisations. Beyond scholarships and fellowships for training and independent study, exchanges and embedding in real-world settings practical experiences allow people to gain experience beyond academia in diverse host institutions. Greater emphasis needs to be given to the spectrum extending from research to its application, including co-production and knowledge brokering with local people and decision-makers.

Keywords Climate adaptation • Climate resilience • Capacity building • Scale • Collaboration • Research design

7.1 Introduction

The world has entered a decisive decade of climate action. Greater ambition is needed to cut carbon emissions in half by 2030 and achieve carbon neutrality by 2050. Current commitments are insufficient and on track to over 3°C warming. Even with ambitious action to hold the increase in the global average temperature to well below 2 °C, many places will surpass the threshold of 1.5°C warming. This necessitates adaptation now and more in the coming years. It is an age of imple-

B. Currie-Alder (✉)

International Development Research Centre, Ottawa, Canada

e-mail: bcurrie-alder@idrc.ca

K. De Souza

Foreign, Commonwealth & Development Office, London, UK

e-mail: ken.desouza@fcdo.gov.uk

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A. K. Biswas and C. Tortajada (eds.), *Water Security Under Climate Change*,
Water Resources Development and Management,
https://doi.org/10.1007/978-981-16-5493-0_7

mentation, from the global stocktake to the wise use of climate finance, building global climate resilience no longer waits upon rounds of global climate negotiations. And being resilient by 2030 is not enough, as people need to anticipate how to survive and thrive in the future climates by 2050. The choices made now can widen or constrain those opportunities moving forward.

How can research best catalyse climate action? The authors have wrestled with this question as our funding agencies learn from the past two decades and decide how to guide the next decade of research investment. This chapter shares insights arising from our reflection over 2018–20, including evaluation reports, scoping studies, learning reviews, conversations with principal investigators and contributions to the forward-looking strategies of our organisations. The impacts of climate change are, and will be, disproportionately experienced by marginalised and vulnerable groups. There is a moral imperative to support communities to adapt and be resilient by addressing gaps in knowledge, acting on what is already known, and enabling local capacity for further action. Research needs to go beyond assessing risks and identifying impacts, to find solutions that are user-centred and action-oriented. In short, the ways of organising research need to respond to the urgency and ambition of the climate crisis.

7.2 Recent Directions in Research

Scholarship and practice of water security and climate adaptation have evolved over the past two decades. Many water systems are now considered “non-stationary” such that they no longer reliably replicate past patterns. Historic observations are not a reliable guide to current and future patterns of precipitation, runoff and storms. Instead, the Anthropocene is characterised by altered landscapes and watercourses with changing risks of drought, floods, landslides and coastal erosion. Beyond the cascading effects of climate on water, this non-stationarity also stems from fragmenting mosaics of land use and the cumulative impact of the past century’s efforts to store, divert and use water. The goal of water management has moved from optimising predictable and stable systems, to instead ensure robust and flexible responses to evolving complex systems. Approaches to decision-making and management must account for deep uncertainty and consider a range of possible futures (Smith et al. 2019).

Water security is created through relationships within society that enable people to enjoy water-related services. Residents do not value their municipal water plant or local water seller per se but rather the benefits they derive from using water for drinking, cooking and washing. Security is not simply a perimeter fence around such facilities but the results of efforts to administer municipal water, including adequate budgeting, operations and delivery. Security is embedded in the social, cultural and political relationships to water that enable people to lead a life that they have reason to value (Jepson et al. 2017). A similar turn can be seen within thinking and practice of climate adaptation, moving away from framing based on solutions

and technical fixes, and towards appreciating adaptation as the lived experience of communities and as a means of addressing equality and inclusion (Nightingale et al. 2019; Pelling and Garschagen 2019).

Climate adaptation is a process of adjustment to actual or expected climate and its effects, how people and society seek to moderate harm or exploit beneficial opportunities (IPCC 2018). Adaptation efforts have strengthened over the past two decades under the United Nations' Framework Convention on Climate Change (UNFCCC). Some milestones include the emergence of the Least Developed Countries Expert Group to provide guidance on adaptation plans, establishing an Adaptation Knowledge Portal, and creation of the Adaptation Committee and the Green Climate Fund (UNFCCC 2019). Since 2019, the United Nations' Climate Action Summit and the Global Commission on Adaptation have elaborated the business case for investing in adaptation, highlighting opportunities spanning food and land use, cities and human settlements, water and nature, industry and infrastructure, disaster risk and local use of finance. Looking ahead, a global stocktake is expected to occur every five years, starting in 2023, which will assess the adequacy and effectiveness of adaptation and support provided for it, as well as review the overall progress towards the global goal on adaptation (Article 7 of the Paris Agreement).

Research topics and questions have evolved over time. The quantity and breadth of climate change research has exploded such that it is increasingly difficult for any one person or team to keep up with the frontiers of knowledge (Minx et al. 2017; Callaghan et al. 2020; Nalau and Verrall 2021). One response is the use of evidence maps and systematic reviews to map the evolving network of ideas and actors. While understanding climate risks and defining adaptation were major topics prior to 2010, the following decade emphasised assessing progress, enabling conditions and implementation (Klein et al. 2017). Under the World Climate Programme over thirty research priorities were identified for the previous decade, including: factors that support or hinder adaptation, improving the ways researchers and policymakers interact, learning from developing countries, understanding hotspots (such as coasts, semi-arid regions and mountains), and co-generating knowledge thru partnerships, and supporting collaboration across spatial scales (Rosenzweig and Horton 2013). The field has since matured in both theory and practice. Multiple authors have contemplated the future of research on climate adaptation, calling for greater opportunity for early career researchers and southern authors, embedding equity in research practice and improving upon stakeholder engagement (Mustelin et al. 2013). Desired changes include increased transparency and consultation in research design, demonstrating tangible impact for the lives and livelihoods of local people, and more effective knowledge brokering and learning (Jones et al. 2018). Research must be "more radical, bolder, more experimental" (Klein et al. 2017), engaging the roles of power and equality, the interplay of adaptation and climate justice (Newell et al. 2020), and connected to learning with marginalised people (Eriksen et al. 2021).

7.3 Designing Research for the Next Decade

This chapter identifies three features for research to be fit for the decade ahead to 2030, drawing on the experience of multiple programmes (Table 7.1). In a sentence, it is critical to embed research into climate action by working across scale in cohorts to enable capacity. In terms of cross-scale, bridging local and national-levels offers promising opportunities for research uptake, particularly addressing an evidence gap to inform decisions with decadal implications. Larger projects and programmes should articulate learning questions as the basis for monitoring and evaluation. In terms of cohorts, research programmes and consortia involve multiple activities and participating organisations. To become more than the sum of its constituent projects, such programmes require a framework that link these activities and must foster equitable partnership among participating organisations. In terms of capacity, beyond scholarships and fellowships for training and independent study, exchanges and placements in real-world settings allow people to gain practical experience beyond academia in diverse host organisations. Greater emphasis needs to be given to enabling capacity across a spectrum extending from climate science to services, including the ability to engage in co-production, knowledge brokering and research uptake with local people and decision-makers.

7.3.1 *Cross-Scale*

The next decade of research needs to be more intentional in addressing and bridging different levels, connecting across near- and medium-term time horizons, as well as the local-to-global expanses of geography. Country-level context remains key in determining domestic policy and action, as well as national contribution to global commitments. More research is needed for and with least developed and most vulnerable communities, especially in Africa and western Asia. Research also needs to address the evidence gap at the decadal time scale, to both enhance resilience by 2030 and navigate the climate futures towards 2050. There are ways to organise research to realise synergies between projects and programmes, by establishing common approaches to and platforms for data sharing, knowledge management and research uptake. Nested theories of change provide a focus for learning as well as describing how activities are intended to produce research results and contribute to society.

Scale describes the extent of a phenomenon across time and space. Weather events and environmental change occur over days, seasons, years and decades. Water systems and climate impacts extend from local communities, through larger watersheds, to continental and global systems. Beyond the natural world, spatial scale can also describe the levels used to organise society, ranging from municipalities or districts, through state or provincial boundaries, to the nation-state or regional grouping. “Scale” refers to any one of these dimensions—time, geography

Table 7.1 Comparison of select research programmes

Name	Description	Structure and budget	Main countries covered
Collaboration Adaptation Research Initiative in Africa and Asia (CARIAA)	Build resilience for people who live in high-risk climate hotspots	4 consortia 60 organisations £43 million/ 6 years	Bangladesh, Botswana, Burkina Faso, Ethiopia, Ghana, India, Kenya, Mali, Namibia, Nepal, Pakistan, Senegal
Conflict and Cooperation in Management of Climate Change (CCMCC)	Evidence on how climate change affects conflict or cooperation	7 projects 39 organisations £5 million/ 5 years	Bangladesh, Burkina Faso, Cambodia, Ghana, India, Kenya, Mexico, Myanmar, Nepal, Vietnam
Ecosystem Services for Poverty Alleviation (ESPA)	Evidence needed for sustainable ecosystem management	125 projects 922 researchers £44 million/ 9 years	53 countries
Future Climate for Africa (FCFA)	Generate new climate science and ensure it has an impact on human development	5 consortia plus knowledge exchange 72 organisations £19 million/ 7 years	Botswana, Burkina Faso, Kenya, Malawi, Mozambique, Namibia, Senegal, Tanzania, Uganda, Zambia, Zimbabwe
Science for Humanitarian Emergencies and Resilience (SHEAR)	Improved forecasting and decision-making for disaster preparedness and response	4 consortia plus knowledge broker 37 organisations £23 million/ 5 years	India, Kenya, Mozambique, Nepal, Uganda
Weather and climate Information and Services for Africa (WISER)	Quality, accessible and useable weather and climate information services for sustainable development	support for national meteorological agencies £34 million/ 6 years	Burundi, Ethiopia, Kenya, Rwanda, Tanzania, Uganda

or administration—while “level” refers to a unit of analysis within a given scale (Cash et al. 2006). For example, city and national governments span multiple levels of human geography, while the interplay of watersheds and water policy is cross-scale between the natural and human geography. Addressing climate action and environmental change often involve a “mismatch” between the scale of problems and how society distributes responsibility for them. For example, salmon fisheries extend from the upper reaches of watersheds out to the open ocean, involving actors from municipal to federal jurisdictions, and activities from forestry to transport sectors. This requires coordination among actors to overcome

fragmentation of higher-level systems or contradictory actions emanating from different levels.

The national level remains key within climate adaptation and resilience. Parties to the UNFCCC are nation-states, which undertake national adaptation planning to organise their own response to a changing climate. They also identify Nationally Determined Contributions (NDCs) as their country's commitment toward the collective goals of the convention. Countries report on their progress through national communications, describing legislation and other means to reduce emissions, adapt to climate risks and assist other Parties. Climate Action Pathways encourage further commitments from non-party stakeholders such as cities, businesses and civil society. As research strives to be demand-led and action-oriented, an essential entry point is understanding who are the national-level actors responsible for NDCs: what are the decisions they are grappling with, what are the challenges faced in implementation and what forms of evidence and knowledge would be useful to them (Moosa et al. 2019). For example, research on climate impacts and how people respond helped inform Bangladesh's delta plan 2100, an ambitious national effort to guide investment to address flooding, land use, urban planning across the country over several decades.

Yet not all countries receive the same level of attention. Relatively less research has been conducted in smaller or more isolated countries and those with higher proportions of the population living in extreme levels of poverty. A review of the past decade of peer-reviewed articles in three prominent academic journals found relatively few articles on climate adaptation in large swathes of central, western and northern Africa or western Asia (Vincent and Cundill 2021). Certain countries feature prominently across multiple research programmes, while also leaving out large sections of the global south (Table 7.1). Over the next decade, there is a clear imperative to invest in research for and with the poorest and most vulnerable countries, especially those in the least developed countries group and Climate Vulnerable Forum (see LDC Climate change, n.d., and Climate Vulnerable Forum, n.d.). Such would be in keeping with the Paris Agreement mentions of developing countries that are particularly vulnerable to the adverse effects of climate change, and the 2030 Agenda pledge that "no one will be left behind... and to reach the furthest behind first".

Working across a range of scales and levels can reinforce each other. National-level actors may be initially reluctant to engage researchers simply to explore potential collaboration and discuss needs. Yet these same actors may be keenly interested to learn from research that provide insights from relevant local-level experience. For example, work in Botswana and Namibia drew upon practical actions at the district level to connect with the national policy processes on drought and vulnerability (Morchain et al. 2019). Local-level experience can also feed into global-level debates. For example, researchers have drawn on local empirical findings to present evidence to the United Nations' Commission on the Status of Women (ASSAR 2019). Such results were also compiled to show how environmental degradation affects women's agency across climate hotspots (Rao et al. 2019). Successful research teams not only integrate multiple disciplinary

perspectives but share evidence from different locations, reinforcing learning from local-to-global levels. Larger-scale research efforts bridge global-level science of peer-reviewed literature and climate modelling, with local experience of communities striving to improve their lives and livelihoods in the face of flooding, drought and other extremes.

Yet there is a missing middle in the scale of evidence. The published literature and available datasets are strongest at extreme time horizons: the near-term opportunities for the next growing season and the risks of storms or drought over the coming months, as well as the long-term magnitude of climate change beyond 2080 under different emission scenarios. Yet the state of knowledge is relatively weaker over the medium-term period of multiple years and decades, precisely the time horizons that are most critical for assessing the consequences of policy and investments (Jarvie et al. 2020). More work is needed to address the uncertainties regarding the future climate from 2030 to 2050, and how these differ from each other. This is the scale in which people grapple with decisions over how to respond to climate risk, assessing the viability of infrastructure, economic activities and adaptation measures over time. Science is currently best able to forecast the weather in the coming months and the potential state of the world for future generations, yet the most useful scale lies between these two extremes.

Combined with greater attention to time horizons of 2030 and 2050, there is a similar “sweet spot” in the middle of spatial scales vital for understanding climate impacts and risks. The current literature speaks more to global-level projections and local-level case studies, offering relatively less insights into sub-national levels such as downscaled climate projection or how particular biomes and landscapes will alter and shift. There is a disconnect between what science can easily speak to and the context within which governments, investors and entrepreneurs decide how to act and invest in their future. Diversified and specialised data products and climate services can respond to different political and practical needs, making information available in formats and at scales that supports adaptation decision-making (Adaptation Committee 2020). Research must address the evidence gap to inform decisions with decadal implications. The mid-range is ultimately more useful for informing how society can transform over time and become more resilient to future states of the world.

A further understanding of scale concerns the size of research effort and the value expected to result from it. The size of research effort can range from an individual investigator working in a single location, through to large teams working across multiple labs and field sites. Understanding the impacts of climate change over a continent requires a large size of a research effort. The study of complex problems also requires multiple skills and disciplines, giving rise to inter- and trans-disciplinary approaches to research. The ambition of research funding has grown over the past decades to support sizable research efforts needed to address complex societal challenges. At the same time, this growth has raised expectations of generating greater value in the form of economic and social benefit, including a wider set of options and opportunities for the future. Funding agencies have

articulated a desire for research projects to move beyond describing problems or testing pilot technologies, towards identifying and “scaling” solutions through implementation and replication.¹

Achieving a sizable research effort can come through synergy among different projects. A research programme or consortium can permit different projects and activities to “speak” to each other by establishing common features in project design, articulating an overarching theory of change and fostering ongoing communication among participants. Research projects often originate as a response to a funding competition that identifies a topic of interest, eligibility and selection criteria, a range of acceptable expenses and budgets, and a deadline for submission. The competitive nature of such calls means that proposals are developed separately with little coordination among prospective applicants. One promising way to better catalyse climate action is for funding agencies to be more intentional in such future calls for proposals, providing guidance on shared features such as high-level research questions, methods or datasets.

A programme or consortium can also provide guidance on, and support for, such aspects as data sharing, stakeholder engagement and knowledge brokering. For example, CARIIA participants elaborated a shared framework for how to understand and pursue research uptake (Prakash et al. 2019). Articulating a “theory of change” identifies overall goals, assumptions regarding how research activities and outputs link to broader outcomes and impact, as well as how to monitor performance and assess success. Such a logic model provides guidance for projects and activities, identifying how they fit together and contribute toward a common goal, as well as inspiring more detailed theories specific to the project level. A theory of change also provides a basis for evaluation and learning, which can address the underpinning assumptions and the extent to which these are borne out by experience.

Communication is vital to bridge different levels of research effort and connect participants located in different organisations and locations. Some programmes established a knowledge manager or exchange unit to compile information coming from various projects and generating common outputs. CARIIA had a knowledge management platform as an online location for participants to share files, convene web conferences, coordinate schedules. Quarterly newsletters or weekly digests kept participants informed about recent events and publications, forthcoming meetings, celebrated achievements and foster the identity of being part of the programme. Given the dispersed nature of large-scale projects and programmes, such online platforms are vital for keeping participants engaged and motivated. Coordinating large-scale research efforts requires weaving together internal

¹ There remains a need to consider which scale of research effort is best suited to making meaningful progress on different problems of societal and scientific interest. There is some evidence that small teams can be more radical and challenge existing knowledge, while larger teams are better positioned to coordinate across countries and consolidate existing knowledge (Wu et al. 2019). Producing the IPCC sixth assessment report involved more than 700 experts, while most journal articles involve less than a dozen authors.

knowledge management across participants, monitoring-evaluation-learning efforts to track and reflect on progress, and external knowledge brokering to engage and reach stakeholders (Harvey et al. 2019a). These functions are vital if a project or programme is to become a cohesive whole and participants feel part of something larger. They also help set the stage for synthesis of research results, enabling participants to better articulate their collective contribution to global and regional agendas, such as the World Climate Research Programme, the Intergovernmental Panel on Climate Change or World Adaptation Science Programme.

7.3.2 *Cohorts*

A second facet of organising research concerns cohorts, gathering together different efforts to realise synergies. Research programmes and consortia involve multiple activities and participating organisations. To become more than the sum of its constituent parts, such programmes require a framework that link these activities and must foster equitable partnership among the organisations involved. Creating a cohort is more than simply synchronising the start-up and lifespan of a set of projects. It requires building opportunities for collaboration among projects as well as fostering relationships among diverse participants across these projects.

Programmes and consortia can achieve coherence among research efforts at different levels. At the project-level, funding is organised around specific activities which encourage diverse participants to come together to define and jointly manage a large budget. For example, the CARIIA call for proposals provided some guidance on how to structure research projects, specifying that each application needed to focus on semi-arid lands, river deltas or glacier-dependent basins. Yet prospective applicants were left ample latitude to define their own research activities and methods and geographic coverage. Consortia are large and complex projects which require strong leadership and coordination to set the research agenda, manage the contributions of participants, share resources and track and report on progress. The skill set and time required often surpass the ability of a single principal investigator. Successful consortia appoint a full-time manager or convener to work alongside the principal investigator and establish shared management structures that involve representatives from the partner organisations. For example, the Adaptation at Scale in Semi-Arid Regions (ASSAR) consortium was led from the University of Cape Town working jointly with START International, the University of East Anglia, Oxfam Great Britain and the Indian Institute of Human Settlements. Representatives from each of these organisations served as co-PIs, meeting at least monthly to jointly guide implementation.

The programme-level needs to provide some degree of coherence among different projects, a set of ideas or logic within which individual activities are situated. For example, the CARIIA was based on climate change hotspots or landscapes experiencing pronounced climate impacts and that are home to vulnerable, poor or marginalised people (De Souza et al. 2015). While each consortium tailored its own

unique approach, they were interconnected by a programme-level theory of change and learning framework which established some overarching questions, as well as cross-consortium working groups which fostered collaboration among these teams. A share of the overall budget was then dedicated to integrating research in various ways, providing additional funding to incentivise participants to build on common interests or pursue novel collaboration across projects. For example, CARIAA supported additional efforts to contribute to the preparatory process for the Global Compact on Migration and to provide timely inputs into the IPCC Special Report on 1.5°C warming (O'Neill 2020). The programme utilised both intentional and emergent design, establishing collaborative spaces to bring participants together on foreseeable aspects while also maintaining an ability to respond as new opportunities arose (Cundill et al. 2018). To put it simply, programmes and consortia fit together their constituent projects and activities in ways that provide new insights and synergy.

Research programmes and consortia also need to provide guidance on the nature of partnership expected and nurture it over time. A partnership is the “ongoing, principles-based working relationships between diverse stakeholders, where solutions are co-designed and delivered, where each partner contributes a range of resources based on their strengths, commits to mutual accountability in return for mutual benefit, and where risks and benefits are shared” (Mundy 2020). Each project can be considered a partnership, whether as a small team of four individuals within a single faculty department at a university, or a large consortium involving more than a hundred individuals spread across several organisations. Whenever different people expect to cooperate on a joint endeavour, it can be useful to establish some common norms and practices. These become even more vital in situations when individuals work at distance from each other and do not regularly meet to sort out issues.

Where projects are identified through competitive calls for proposals, these have tended to privilege narrow considerations of scientific rigour and project management: assessing the academic merits of a proposal, the individual track records of participants in producing research, and a detailed work plan with a division of labour. Yet an emphasis on demonstrating why funding is needed and how it will be used can ignore how partners expect to work together. Future research needs to provide more explicit attention to partnership building during application and inception of new projects, considering matters related to project management, scope, research practices and communications (Martel 2020; Dodson 2017). Experience has shown that proposal development should also dedicate time and effort to clarifying expectations and ways of working among the people and organisations involved. Proponents can clarify norms and procedures for deciding on research design, methods and data management; access to funding and opportunities for travel; and the use of non-English languages in coordination and communication. Partnerships can only benefit if it is clear how decisions are made and who is involved.

Funding programmes can provide guidance on the nature of partnership and ensure partners establish and maintain a sense of fairness and equity. This starts with the research commissioning process. UKRI encourages research partnership to clearly articulate an equitable distribution of resources, responsibilities, efforts and benefits; recognise different inputs, different interests and different desired outcomes; and ensure the ethical sharing and use of data which is responsive to the identified needs of society (Mundy 2020). This is a good starting point yet could be supplemented with examples of successful past partnerships, creating conditions for partnerships to grow and evolve, and tools for creating and nurturing them. The experience of recent programmes underlines the need for research partnerships to understand the drivers and incentives that motivate different partners. Identifying and responding to what motivates each partner is essential to keeping them engaged over time, generating a range of outputs that satisfy diverse interests and needs.

Funding opportunities can unintentionally strain relationships by prescribing particularly organisational arrangements or size of budgets. For example, the call for proposals for CARIAA required applicants to identify five core partners and budgets equivalent to £7 million. These requirements displaced additional partners to a secondary status within projects and narrowed the pool of potential applicants to those able to receive and administer large budgets. In contrast, the research commissioning process can consider inviting a range of organisational arrangements and budgets. This would provide potential partnership with a degree of freedom to determine the size and structure needed to achieve its outcomes. Research partnerships can be encouraged to involve local and non-academic partners to help move knowledge from academic to real-world settings. They can also be encouraged to provide leadership roles for developing countries and non-research partners, including those from the private sector, government and civil society. Applicants should not only be assessed on their potential to contribute to cutting-edge knowledge on adaptation and resilience but their ability to fully understand and address the needs of real-world decisions and action. Applicants could also identify “gaps” or additional roles within their partnership, to be filled at a later date, providing space for the partnership to evolve during project implementation.

Partners can be encouraged to negotiate and agree to detailed ways of working, covering what each contributes and the added value to be realised from working together. Such a document serves to establish a shared perspective on overall purpose, means of coordinating the partnership, how to manage risks, protocols around decision-making and communication, as well as mechanisms to ensure mutual accountability and for recognising contributions, authorship and intellectual property. By agreeing to ways of working together, partners clarify expectations and establish a sense of fairness, equity and mutual accountability among themselves (Mundy 2020). Once underway, periodic reviews of the ways of working provide a routine “health check” on how the partnership is performing. Such reviews provide an opportunity to identify and address any issues and serve to induct new individuals and reaffirm commitment among existing ones. It can also recognise changes to the partnership over time, identifying the implications when a new organisation joins the project, an existing partner takes new responsibilities, or

following the departure of an existing partner. The ways of working also set the stage for anticipating how partners act following a project: how they will use data, results and ideas beyond the project life, and what each partner contributes to preserving and making this work available into the future. A project is just one chapter in a longer story as people and organisations build their careers and pursue their mandates. A successful research project can benefit from established relationships and lay a foundation for future collaboration (Izzi 2018).

Research funding agencies also contribute to partnerships. Funders need to consider their own role, including the extent to which their systems, language and approaches facilitate or inhibit collaboration within the programme and engagement with principal investigators. Funding agencies describe a broad topic or high-level problem, providing the scientific community scope to identify and propose specific projects. A call for proposals specifies the selection criteria used to assess these proposals, with those that score higher being recommended for award. This approach to commissioning research tends to select each project on its individual merits, without necessarily considering how similar it may be to other proposals. Alternatively, funders can intentionally craft a portfolio in which different projects complement each other. For example, the CARIAA programme intentionally sought to fund activities in three distinct “hotspot” landscapes. Meanwhile, Future Climate for Africa selected projects that collectively covered western, eastern and southern parts of the continent as well as underpinning science to improve understanding of Africa’s climate. Both these programmes brought participants together across projects to compile synthesis of diverse results across the portfolio and to reach audiences in policy and practice. As such programmes grew and evolved over time, they also benefited from adaptive management, shared between the funding agencies and principal investigators to jointly update budgeting, planning and procedures as needed (Currie-Alder et al. 2020).

Particularly when the source of research funding is official development assistance, or climate finance intended to assist developing countries, there is an expectation that the partnerships and programmes will have certain features and create some additional value. Beyond seeking geographic coverage or collaboration among projects, a portfolio approach to research can intentionally include projects that test alternative technologies, methods, or hypotheses. For example, within CARIAA, one project examined migration through household surveys carried out in communities that send and receive migrants, while another project conducted in depth life history interviews to uncover the lived experience of migrants (Singh et al. 2019). Privileging diversity of ideas and approaches within the portfolio can facilitate programme-level learning, permitting the comparison of project results to provide additional insights. Viewing the programme as a portfolio inspires thinking towards the unique value created by each project and the interaction among them, rather than simply generating more of the same types of results.

Funding competitions tend to discourage robust participation from least developed countries and work involving fragile and conflict-affected contexts states. Beyond having a relatively small domestic research community, many of the less-researched countries contain regions that are considered fragile or experiencing

conflict. Without specific requirements for participants from—and activities in—these locations, the commissioning process can unintentionally simply favour collaboration among scientifically proficient peers across the global north and middle-income countries. There are many merits to encouraging projects that cover multiple countries, including the opportunity to compare results in multiple locations, foster peer learning across national borders and to hedge against risk. For example, the past decade witnessed punctual and longer-term security situations disrupt access to field locations in parts of Bangladesh, Egypt, Ethiopia, Mali, Mozambique and Tanzania. There is a wealth of guidance on how to conduct research in such contexts, covering the additional challenges in terms of planning, logistics and ethics; safety of participants and safeguarding against exploitation; and the potential negative consequences of research (Peters et al. 2020). The risks to any one project can be partially mitigated by spreading activities across multiple locations and partnering with local organisations and participants.

Many recent projects and programmes convened annual or periodic in-person gatherings to understand how different activities and work packages are organised, update each other on progress and findings and seize opportunities for combining insights or datasets. In-person gatherings were found to be good value for money in past climate research programmes. Annual project meetings served to ensure everyone clearly understood the project aims, jointly assess progress, reflect on what was working well (and what was not) and revise plans for the period ahead. In-person interaction over a number of days creates the space for having deeper conversations and critical debates on the ideas and design underpinning the research, confronting different understanding among team members and providing shared experiences that allow professional and interpersonal relationships to flourish. Such gatherings also served to orient participants who join later, allowing them to learn the stories and personalities behind project origins and implementation. In contrast, the regular routines of electronic mail, written documentation and web-based meetings do not serve as well to bring people together and form teams.

Virtual and distributed alternatives to these meetings, while still imperfect will continue to evolve, beyond the COVID pandemic and to make research more carbon-neutral. Compared to the past decade, future research programmes will be more limited in travel and mobility. This suggests that project design might shift towards more distributed models of organisation in which geographic nodes or sub-teams have a certain amount of autonomy and self-sufficiency. Yet whether virtual, hybrid, or in-person, periodic gatherings will remain vital to strengthening project- and programme-level coherence by identifying opportunities for learning and further research; conducting “health checks” that reflect on how each organisation contributes to and benefits from the partnership and further impact by engaging stakeholders to understand the context in which they operate, and their demands for insights and evidence.

7.3.3 *Capacity*

Our third facet of research design concerns capacity. Beyond offering scholarships and fellowships for training and independent study, exchanges of personnel between organisations in different locations and embedded experiences in real-world settings allow people to gain experience beyond academia in diverse host institutions. Greater emphasis needs to be given to enabling capacity across the spectrum from climate science to services, including the ability to engage in co-production, knowledge brokering and research uptake with local people and decision-makers. This section briefly reviews the understanding of capacity within climate action and considers recent insights to enable capacity through research.

Under UNFCCC, capacity building describes the ability of Parties to fulfil their obligations under the convention. Article 11 of the Paris Agreement describes capacity as the ability of developing countries to take effective climate change action, including adaptation and mitigation, as well as access to climate finance, education, training and information. The Agreement focuses on support to disadvantaged parties. There has been less attention to the capacity still needed even among developed countries or the efforts of developing countries to grow their own capacity.² It is clear that all societies require a capacity to understand and assess climate impacts, to plan and undertake climate action and to navigate among various potential futures. In this regard, there is promising literature on pathways and transformation, understanding how policies and investments function over time, opening and closing opportunities or “solution spaces” towards a more climate-resilient future (Haasnoot et al. 2020; Werners et al. 2021). Scholars have addressed the enablers and barriers to adaptation and the danger that potentially well-intended climate action can become maladaptive in future states of the world (ASSAR 2019; Gajjar et al. 2019).

The IPCC describes adaptive capacity as the ability of a system to adjust to climate change, whether households and societies choose to act and the extent to which do so. This notion borrows from ecology and the ability of natural systems to retain or modify their structure and function in response to shock and stress (Siders 2019). Like recent notions of waters security, understanding of adaptive capacity draws on the human capability approach which examines entitlements to material assets and social opportunities that permit people to exercise agency in deciding what to do or become (Mortreux and Barnett 2017). At its core, this understanding of capacity concerns the ability of human societies to rally cognition, resources-lingness in order to identify problems, understand their causality, assess potential solutions and act with purpose. In other words, how do societies overcome the “ingenuity gap” to detect and respond to risks and hazards in order to survive and thrive over time (Home, and Wilr-Dixon 2000).

² There are promising signs that these issues are arising within the Paris Committee on Capacity Building, a voluntary network under UNFCCC to identify capacity gaps and needs, collect good practices and lessons learned and foster coordination and collaboration.

For research funding agencies, the sphere of control is investments intended to enhance or rally the ability to conceive, undertake, manage, share and use research and evidence. Such research can contribute to the capacity for action to implement UNFCCC and adaptive capacity to confront a changing climate. This ability to undertake and manage research is also referred to as the research capacity of an individual or an organisation. Over time, the notion of research capacity expanded from the skills and institutions required to solve problems, to consider how research products are used to bring about change as well as providing opportunities for peer learning from experiences elsewhere (Daniels and Dottridge 1993). Today research capacity is understood to include not only the skills and experience of an individual, but how individuals connect with others, to identify and analyse development challenges and to conceive, conduct, manage and communicate research that addresses those challenges (Neilson and Lusthaus 2007). In the UK, Vitae's research development framework includes 63 descriptors spanning the domains of knowledge and intellectual abilities, personal effectiveness, research governance and organisation, and engagement, influence and impact (VITAE n.d.). Individuals can be positioned along a timeline, ranging from early career to senior researchers. In the past, building one's research capacity was described in terms of gaining experience in different positions and increasing level of skill and responsibility over time. This can be achieved through an academic path from graduate student through postdoctoral awards, from initially contributing to work led by more established colleagues and collaborating with existing research teams, to gradually independence by progressing through faculty positions and gaining access to research grants.

Yet two factors have broadened the range of alternatives and complements to this traditional route. First is the rise of an "impact agenda" within research policy, predicated access to funding on demonstrating how the results of a project benefit society. Beyond merely addressing socially relevant problems and identifying some potential outcome, researchers are expected to undertake additional activities and engage with stakeholders in an explicit effort to bring about these outcomes. Second is the rising interest in large-scale collaborative models of research involving multiple organisations, multiple countries and multiple disciplines. As research funders seek greater levels of impact, there has been a rise in ambition whether under the assumption that larger-scale investments might generate greater returns, or that the breadth and complexity of societal problems requires proportionate broad and complex research efforts. Both these factors place a premium on skills not only to do and manage research but to collaborate with diverse actors beyond one's home organisation to interact and dialogue among scientists, policy makers and other actors, as well as joining and coordinating external partnerships (Araujo et al. 2020; Virji et al. 2012).

Various programmes have sought to enhance the capacity of individuals. The African Climate Change Fellowship programme (2007–2017) supported 120 early career awards across teaching and policy for doctoral and post-doc research. A subsequent Africa Climate Change Leadership programme provided small awards to 46 mid-careers to senior individuals in eastern and western Africa to

orient research to development outcomes through different roles whether as thought leader, knowledge broker or research users (Meijerink and Stiller 2013). Climate Impacts Research Capacity and Leadership Enhancement (CIRCLE, 2014–2017) supported 97 individuals as visiting fellowships to undertake supervised placement in African host research institutions. A pilot training course seeks to strengthen knowledge on climate diplomacy and negotiation skills among African professionals (AGNES n.d.) while the IPCC Scholarships support Ph.D. students from developing countries for research that advances the understanding of climate impacts and options for adaptation and mitigation. Across these programmes, there is a shift from simply contributing to the careers of an individual, towards instead considering the functions needed within teams, organisations and partnerships to pursue and realise climate-resilient development in practice.

Many more capacity building efforts are embedded within research projects, rather than as stand-alone fellowships. For example, CARIAA supported over 260 people to benefit from graduate-level fellowships or internships, while 540 people participated in activities such as small grants, training or workshops. Capacity building within such programmes enables people to join the collaborative efforts involving large teams spread across multiple partner organisations and countries. The Future Climate for Africa programme found that early career researchers benefitted from being part of inter- and intra-consortium networks, accessing diverse resources that are not present in stand-alone or individual fellowship schemes (MacKay et al. 2020). Whereas pursuing graduate studies can be a solitary endeavour, capacity building within a consortium or project provides ready access to contacts in different countries (including potential peers and mentors), an opportunity to contribute to a larger research effort (including access to data, field sites, exposure to novel methods) and exposure to the collaborative skills as well as professional opportunities. Individuals also benefited from opportunities to grow as a professional within this community, increasing their level of responsibility and contributing in new ways. Similarly, the African Research Universities Alliance (ARUA) integrates training within its centres of excellence, including a network on climate and development among the universities of Ghana, Nairobi, and Cape Town. Ecosystems Services for Poverty Alleviation found it vital to give partners the opportunity to travel to each other's institutions throughout the project (Izzi 2018).

Future Climate for Africa embedded individual researchers within city governments. Researchers learned to act as a conduit for bringing scientific knowledge into local planning and decision-making. They were also exposed to real-world issues shaping the demand for that knowledge, appreciating how climate impacts interact with other governance challenges in cities and building relationships with non-academic audiences for research. The programme also supported exchanges among Harare, Lusaka, Windhoek and Durban to share insights on how different cities are responding to climate impacts on informal settlements, hydropower and water supply (Ndebele-Murisa et al. 2020). Similarly, the Climate and Development Knowledge Network (CDKN) has supported peer learning among professionals and practitioners in different countries. The emphasis is not to educate people on the

findings from research but to provide exposure to how others are dealing with similar issues elsewhere. This involves connecting individuals across borders to share experiences and learning on delivering climate action on the ground. The overall message is not about transferring expertise from the global north, but sourcing capacity and insights within the global south.

Through these experiences, we are witnessing a shift beyond the capacity of researchers and organisations to do climate science and become leaders, to consider the capacity of diverse actors to access and use knowledge in the pursuit of climate action. As with the FCFA example, such approaches see research embedded in larger societal efforts to realise a more climate-resilient future, which necessarily means engaging and strengthening non-academic actors. One framing of this broader scope for capacity building considers the value created along chains and among actors that connect climate observation and information, to climate services and how they are used in decision-making. Considered in this way, the ultimate benefit or outcome depends not only on the existence of climate research, but the various links by which that knowledge is transformed and used across society. Weaknesses at any point along such chains can jeopardise the potential value of climate information. Funders need to recognise and support the interconnection among various actors, their outreach and interaction with decision-makers—whether politicians, firms or farms—and how their actions widen or constrain the opportunities available for such end users (Boulle et al. 2020).

Notions of research capacity have expanded. Traditionally research quality is viewed from the perspective of scientific peers in terms of its originality, relevance to academic audiences and integrity in terms of rigour and design. Yet research capacity is increasingly associated with the perspectives of practitioners and society: the extent to which research processes are seen as legitimate and pertinent in light of the concerns and values of stakeholders, as well as the extent to which the research outputs are seen as responding to practical needs and readily applicable to real-world contexts (McLean and Sen 2019; Clark et al. 2016). In particular, there is an expectation of co-design in research planning, co-production with stakeholders in the research process, as well as knowledge brokering to connect with users and their needs. The roots of co-production can be traced to traditions of participatory research and sustainability science (Miller and Wyborn 2020), involving local communities and interested stakeholders into the process of defining research questions, the process of gathering and assessing data and the creation of products based on that research. Co-production has been defined as bringing together different knowledge sources and experiences to jointly develop new and combined knowledge which is better able to support specific decision-making contexts.

Principles of co-production include transparency in the purpose of and methods used in research, tailoring the research process to specific context and decisions, timeliness in delivering results in keeping with those demands and communicating in ways that are accessible to diverse audiences (Vincent et al. 2021). High-quality knowledge co-production explicitly recognises multiple ways of knowing and doing, articulates clear goals that are shared among participants and allows for ongoing learning among actors through active engagement and frequent

interactions (Norström et al. 2020). For example, the Pathways to Resilience in Semi-arid Economies consortium within CARIAA consulted with in-country decision-makers to understand their knowledge needs and priorities, as the basis for defining the research questions and study areas (Ludi et al. 2019). Building on such experiences, Harvey et al. (2019b) distinguish four approaches to co-production based on whether the process intends to produce usable knowledge or see it arise from interaction, and whether the process is brokered by a third party or involves purposefully engaging different perspectives. This means research must go beyond simply convening a dissemination workshop at the end of a research project. Instead, researchers should cultivate their relationships with such stakeholders over time and incorporate real-world needs into their research proposals, seeking to simultaneously advance academic knowledge and catalyse climate action.

7.4 Conclusion

How can research best catalyse climate action? The authors have wrestled with this question as our funding agencies learn from the past two decades and decide how to guide the next decade of research investment. The world has entered a decisive decade during which research must strengthen adaptation to the effects of climate change that cannot be prevented or reversed, supporting the most vulnerable worldwide. The urgency of this age of implementation cannot wait upon the customary linear process of research publications informing policy formulation, but rather requires more engaged models of research that are embedded in practice to foster real-time learning. Climate action ahead of 2030 requires ambition and design that is fit for purpose: working across scale, creating synergy among cohorts of projects and enabling capacity to pursue research uptake. By looking back at several large programmes over the past decade, this chapter identifies nine insights for designing the next decade of research investments (Fig. 7.1).

Research needs to cross scales to bridge local and national experience, address evidence gaps at decadal time scale and invest in programme-level learning. Connect community-level experience with how countries determine their national responses and contributions. Develop robust evidence across distinct locations, particularly for and with least developed countries and most vulnerable communities, especially in Africa and western Asia. Address the evidence gap between enhancing near-term resilience by 2030 and further climate impacts by 2050, as well as how adaptation choices taken now widen or constrain opportunities over time. Establish common approaches for data sharing, knowledge management and research uptake to allow different projects to “speak” to each other and assess how their activities both produce research results and contribute to society.

Cohorts link research efforts together to design for collaboration, foster partnership, and privilege diversity. Retain some flexibility in money and time, within the overall programme and in each project, to seize unexpected opportunities for

Fig. 7.1 Principles for organising research on climate adaptation and resilience

research impact and collaboration. Programmes can gather different projects and teams to share findings, assess progress and explore opportunities to work together. Within consortia, establish and refresh how partners work together including what each contributes and how they are accountable to each other. Involve partners and locations that complement each other, seeking autonomy and redundancy among in-country teams. Combine the strengths of multiple organisations, disciplines, countries and locations to generate new scientific knowledge, and enable actors to use evidence to realise more climate-resilient development.

Capacity is strengthened by designing research to enable experiential learning and exchanges, embed opportunities in larger efforts and expand to new actors and co-production. This constitutes a broader understanding of capacity beyond the mere conduct of climate science to encompasses a spectrum of skills connecting with its use in society. Consortia and large projects not only require principal investigators, but team members specialised in coordination, data management, gender equality and social inclusion, knowledge brokering and research uptake. Provide opportunities for practical experiences in real-world settings, such as researcher placements in city councils or working alongside practitioners. Being

part of a consortium and programme provides early career researchers and professionals the benefits of working within a team, including mentoring and networking. Invest in capacity beyond academia to identify and address demand for climate knowledge. Provide practitioners and non-academic partners with leadership roles within projects to define research needs and realise impact.

In conclusion, designing research to catalyse climate action requires working across scale, creating synergy among cohorts of projects and enabling capacity to pursue research uptake. Together these features position research for impact, ensuring poor and vulnerable communities are more resilient to weather, climate change and related natural hazards in the near and longer term.

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