



CARIAA
*Collaborative Adaptation Research
Initiative in Africa and Asia*

Building climate resilience in Africa & Asia

***Lessons on organisation, management &
collaboration from research consortia***

CARIAA Working Papers #24

*Bruce Currie-Alder
Georgina Cundill Kemp
Lucia Scodanibbio
Katharine Vincent
Anjal Prakash
Nathalie Nathe*



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About CARIAA Working Papers

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Titles in this series are intended to share initial findings and lessons from research and background studies commissioned by the program. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the CARIAA program, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

Contact

Collaborative Adaptation Research Initiative in Africa and Asia,
c/o International Development Research Centre
PO Box 8500, Ottawa, ON
Canada K1G 3H9
Tel: (+1) 613-236-6163; Email: cariaa@idrc.ca

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Abstract

During 2014–2018, the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) supported four transdisciplinary research consortia involving more than 40 institutions across 15 countries. Drawing on participant surveys, technical reports and focus group discussions, this paper identifies three sets of lessons around conducting collaborative research for adaptation.

The first set of lessons concerns partners, leadership, and relationships. Consortia bring together partners with different competencies, differing levels of capacity, and diversity related to culture, gender, age, hierarchy, professions, and expertise. The principal investigator and coordinator positions are vital and require individuals able to demonstrate leadership and dedicate sufficient time. Partners need to be accountable to each other and to leadership within a consortium.

The second set of lessons concerns teamwork, management, and collaborative research. Consortia must understand what motivates partners and define each partner's role. Nested levels of management permit consortia to coordinate diverse partners across multiple countries. Consortia can create collaborative spaces through thematic working groups, additional funding for emergent subprojects, and common platforms for engaging stakeholders.

The final lesson concerns transaction costs. There are benefits and costs to working in consortia. Complexity of coordinating a consortium increases with the number of partners, dispersed locations, and operating in diverse cultural settings. The CARIAA experience suggests that the size, authority and duration of the consortia contribute to research uptake and impact. Moving forward, further study of research consortia can seek to identify how much structure is required to foster collaboration, and detect when a research consortium has reached or surpassed an optimal size.

Key words

organization of research, research teams, climate change, adaptation, consortia

Acronyms

ASSAR	Adaptation at Scale in Semi-Arid Regions
CAR/IAA	Collaborative Adaptation Research Initiative in Africa and Asia
Co-PI	co-principal investigator (leads participation of partner organization)
DECCMA	DEltas, vulnerability and Climate Change: Migration and Adaptation
DFID	Department for International Development
HI-AWARE	Himalayan Adaptation, WATER and RESilience
IDRC	International Development Research Centre
PI	principal investigator (leads consortium)
PRISE	Pathways to Resilience In Semi-arid Economies
START	global change SysTEM for Analysis, Research, and Training

About the authors

Bruce Currie-Alder

Program Leader, International Development Research Centre
Ottawa, Canada

Georgina Cundill Kemp

Senior Program Officer, International Development Research Centre
Ottawa, Canada

Lucia Scodanibbio

Project Manager, University of Cape Town
Cape Town, South Africa

Katharine Vincent

Director, Kulima Integrated Development Solutions
Hilton, South Africa

Anjal Prakash

Associate Professor & Associate Dean, TERI School of Advanced Studies
Hyderabad, India

Nathalie Nathe

Programme Manager & Research Analyst, Vivid Economics
London, United Kingdom

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Introduction

More than two billion people live in deltas, semi-arid lands, and glacier- and snowpack-dependent river basins in Africa and Asia, hotspot regions that are among the most vulnerable to climate change.¹ The Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) was a seven-year programme (2012–2019) designed around four transdisciplinary research consortia that sought to build resilience in these hotspots. This paper draws lessons from the experience of implementing a large-scale collaborative research programme under CARIAA, to critically reflect on the initial expectations of the consortium model and inform the design of future research programmes.

CARIAA defined consortia as models of collaboration bringing together multiple actors (individuals or institutions) who are otherwise independent from one another outside of the context of the collaboration, to address a common set of questions using a defined structure and governance model (Gonsalves 2014, 3). The programme saw consortia as “boundary-spanning” in that they form collaborations that include not only diverse disciplinary contexts, but also diverse geographic settings, identities and practices. The nature of research on climate change and sustainability issues requires transdisciplinary knowledge that surpasses the knowledge and ability of any single organisation (Mauser et al, 2013, Hardon et al, 2008).

From the start, CARIAA articulated multiple expectations of research consortia, compared to smaller projects or the efforts of individual organisations. The size and varied composition of consortia (including partners beyond academia) was expected to increase the chance for research impact and uptake, by combining the expertise and legitimacy of multiple organisations, including non-academic partners such as civil society organisations. Consortia were expected to facilitate collaboration and knowledge sharing, leading to research findings and impacts that transcended individual partners’ expertise (DFID 2012). These expectations were restated as assumptions that underpinned a theory of change (Annex 1). In short, consortia were expected to increase capacity for the uptake and use of research results, encourage interdisciplinary endeavor, and tackle “more ambitious adaptation research and policy questions... at greater scale and over longer-term” (IDRC 2015).

To reflect on these assumptions and draw lessons from the experience of implementing four research consortia, this paper draws on programme documentation, including participant surveys, as well as evaluations, working papers, and technical reports over the full lifespan of the CARIAA programme.² Other evidence comes from focus group discussions organised during consortia or programme-level meetings, and open ended interviews with consortium participants and IDRC programme officers, predominantly in the final year of the programme.

¹ Two glacier-dependent basins alone, the Indus and the Ganges-Brahmaputra-Meghna, are home to more than 300 million and 630 million people respectively (FAO Aquastat 2011). Arid and semi-arid lands are home to up to 30% of the world population, much of which are in Africa and South Asia.

² The results of different participant surveys are described in Scodanibbio 2017, ASSAR 2018, DECCMA 2018a & b, Ludi et al. 2018, Singh & Ahmed 2018, and Mundy 2018.

Some aspects of the earlier learning with regard to the consortium model have been published elsewhere (Cochrane and Cundill 2018, Cundill et al. 2018).

The paper is divided into multiple sections. This introduction laid out some of the expectations that underpinned the CARIAA programme and identified learning questions that explore strengths of the consortium model, how CARIAA approached project coordination, and how it fostered transdisciplinary research. The next section provides an overview and comparison of the four research consortia. The paper then proceeds to identify three sets of lessons from this experience, drawing in evidence from participant surveys and the reflections from IDRC and consortium coordinators.

The first set of lessons are to seek diverse partners, invest in leadership and coordination, and strengthen relationships among partners. The second set of lessons are to nurture teamwork, foster collaborative management, and enable collaborative research. The third set of lessons concern how to manage transaction costs. These lessons are followed by a discussion that revisits the programme expectations and learning questions³ to provide three additional insights on the opportunities associated with research consortia. Throughout, the paper emphasizes 'what worked' with this programme and provides advice for the design of future research programmes.

³ Over time, CARIAA management asked: what are the strengths of the consortium model, how do consortia manage project coordination, and how to foster collaborative transdisciplinary research within and across consortia (IDRC 2015, Executive Committee - July 2017, and Program Management Committee - September 2018).

1. Programme and consortia design

CARIAA was a partnership between two research funders, the United Kingdom's Department for International Development (DFID) and Canada's International Development Research Centre (IDRC). These funders initially agreed to award three consortia, one each for semi-arid lands, for river deltas, and for glacier-dependent basins. A call for proposals sought applications for potential consortia of five partner organisations. Each consortium would eventually receive in excess of CAD 13 million over five years. Given early gains in the exchange rates, and the high quality of proposals received, DFID and IDRC opted to fund an additional consortium addressing semi-arid lands, bringing the total to four: Adaptation at Scale in Semi-Arid Regions (ASSAR); DEltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA); Himalayan Adaptation, WAter and RESilience (HI-AWARE); and Pathways to Resilience In Semi-arid Economies (PRISE). Table 1 describes each consortium's distinct partners and research focus, while and Figure 1 shows the countries and locations covered.

By design, consortia were required to identify a lead organisation to host a principal investigator and consortium coordinator. Two of the lead organisations were located in the United Kingdom, one in South Africa and one in Nepal. Two of the lead organisations were universities, one was a non-governmental organisation and one was an intergovernmental organisation. Lead organisations received a substantially larger share of the budget in three consortia (Annex 2), in part due to additional responsibilities for coordination, communications, and expenses on behalf of the consortium. The principal investigator (PI) convened and chaired a steering or management committee, consisting of representatives (co-PIs) from each of the four other core partner organisations. Beyond the core members, each consortium also convened or subcontracted between four and 20 additional members as in-country or strategic partners.

Each consortium also adopted a unique approach to organising its research activities and field sites. DECCMA adopted the most uniform approach and methodology, involving six interrelated work packages examining governance, climate impacts, economics, migration, adaptation and integrated modelling across two smaller deltas (Volta and Mahanadi rivers in Ghana and India) and one large transboundary delta (The Ganges-Brahmaputra-Meghna that straddles the Bangladesh-India border). HI-AWARE involved five research components, ranging from impacts and vulnerability to adaptation practices and pathways, using twelve field sites across four basins shared among the four contiguous countries in the Hindu-Kush Himalaya mountains.

The two consortia focusing on semi-arid regions were more geographically dispersed. PRISE focused on climate-resilient economic development in drylands, organised into seven research projects. Each project involved at least two countries, that collectively concentrated into three regional clusters (South-Central Asia, West Africa, and East Africa). ASSAR was similarly structured around four regional nodes (India and Southern, East and West Africa), which worked under a single conceptual framework organised around five research streams and pursued the same four research streams and contributed toward high-level synthesis topics. PRISE and ASSAR provided each of their project or regional subteams with some autonomy in tailoring research design while ensuring some related methods and a connection with overarching research questions.

Each consortium produced a distinct combination of outputs, including journal articles, conference papers, datasets, and multimedia products (Annex 3). This is hardly surprising given the diverse combinations of members and research activities involved, and highlights the extent to which consortia may differ from each other.

The consortia also varied in the extent to which they built on previous research projects or prior collaboration among members. DECCMA represented the greatest degree of continuity building on a previous project pursued under the programme [Ecosystem Services for Poverty Alleviation \(ESPA\)](#). Similarly, HI-AWARE benefited from existing work among core members and welcomed the opportunity for deeper collaboration. In comparison, the two semi-arid consortia represented more novel approaches (e.g. including methods in value-chain analysis and scenario planning), newer relationships, and more dispersed locations (e.g. spanning western, eastern and southern Africa, and south/central Asia). Yet all four consortia represented a new level and intensity of collaboration, which ultimately required members to (re)negotiate roles. This required either formal partnership agreements or less formal means of governing and managing partner relationships (including mechanisms to address tensions and conflict among members).

The programme also sought to foster collaboration between and across the four consortia. Different groups coalesced around cross-consortium functions, in-country engagement, and specific research ideas that emerged during implementation (figure 2). While the bulk of the CARIAA budget was allocated directly to the consortia (78%), a portion was kept aside for the purpose of research integration (9%), including an “Opportunity and Synergy Fund” that held calls for proposals for collaborative activities between consortia that were not foreseen at the start of the programme.

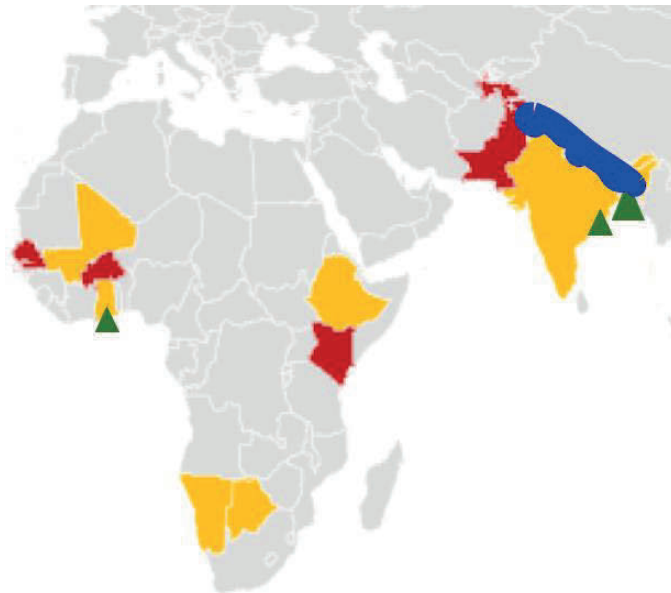










Figure 1: CARIAA addressed climatic hotspots across Africa and South Asia (ASSAR in yellow, DECCMA in green, HI-AWARE in blue, and PRISE in red)

Table 1. Each research consortium brought together distinct partners, geography, research focus and activities

				
Core Partners	5 University of Cape Town, Indian Institute for Human Settlements, START, University of East Anglia, Oxfam	4 University of Southampton, Bangladesh University of Engineering and Technology, Jadavpur University, University of Ghana	5 ICIMOD, Wageningen University, The Energy and Resources Institute, Pakistan Agricultural Research Council, Bangladesh Centre for Advanced Studies	4 Overseas Development Institute, Sustainable Development Policy Institute, London School of Economics, IED-Afrique
Strategic Partners	12 Addis Ababa University; Universities of Nairobi, Botswana, Namibia & Ghana, ATREE, Watershed Organisation Trust, ICRISAT, Reos Partners, Red Cross Climate Centre, Indian Institute of Tropical Meteorology, Desert Research Foundation of Namibia	20 Bangladesh: Centre for Environmental and Geographic Information Services, Refugee and Migratory Movements Research Unit (University of Dhaka), South Asian Network on Economic Modelling, Bangladesh Space Research and Remote Sensing Organisation, Water Resources Planning Organisation India: Centre for Environment and Development, Chilika Development Authority, National Remote Sensing Centre, Sansrisiti Other: Basque Centre for Climate Change, Food and Agriculture Organisation (United Nations), Kulima Integrated Development Solutions, MET Office (UK), Plymouth Marine Laboratory, Universities of Dundee & Exeter	6 Centre for Ecology Development and Research, FutureWater, LEAD Pakistan, Practical Action, Megh Pyne Abihaman, The Mountain Institute	4 Regional Environment Center for Central Asia, Kenya Markets Trust, Mountain Societies Research Institute, University of Ouagadougou
Geography of field sites	4 regions - West Africa (Mali & Ghana), Southern Africa (Botswana & Namibia), East Africa (Ethiopia & Kenya), South Asia (Maharashtra, Karnataka, & Tamil Nadu in India)	3 river deltas - Volta (Ghana), Mahanadi (India), Ganges-Brahmaputra-Meghna (Bangladesh & India)	12 study sites - 3 locations in each of 4 rivers: Indus (Pakistan), Upper Ganga (India), Gandaki (Nepal & India), and Teesta rivers (India & Bangladesh)	3 regions - West Africa (Senegal & Burkina Faso), East Africa (Kenya, Tanzania & Ethiopia), Asia (Pakistan, Tajikistan & Kyrgyzstan)

				
Research Focus	Barriers and enablers for effective adaptation (2030 and beyond) Responses that enable more widespread, sustained adaptation	To assess migration as an adaptation in deltaic environments with a changing climate To deliver policy support to create the conditions for sustainable, gender-sensitive, adaptation	To adapt to climate impacts on glacier and snowmelt induced runoff in order to improve the resilience of livelihoods of the poorest and most vulnerable people	Identify how economic growth is affected by climate change, and how it can meet the needs and aspirations of poor and marginalised people.
Key methods	Participatory & transformative scenario processes, Vulnerability and risk assessments	Policy and governance analysis, Biophysical risk mapping, Household survey, Adaptation inventories, Integrated modelling	Climate and hydrological modelling, Vulnerability studies, Participatory planning and action research	Study of migration & remittances, Value-chain analysis
Activities	5 research streams - social differentiation, governance, ecosystem services, gender and knowledge systems. 5 synthesis topics - changing household structures, land-use-land-cover (LULC) change, water governance, invasive species, migration 4 high-level synthesis topics - barriers and enablers to adaptation, transformation, effective adaptation, collaborative consortium model	6 work packages - Common approach in each delta including: governance and policy review, risk mapping based on IPCC framework, well-being and the lived experience of migrants, economic modelling (how environmental change affects economic output), and inventories of documented adaptation	5 research components - Biophysical & socio-economic drivers of vulnerability, assessment of adaptation practices, critical moments & turning points, adaptation pathways 3 pilot technologies - Solar-powered water pumps (Pakistan), flood-resilient housing (Bangladesh), raises floor eco-san toilets (India)	7 projects - Migration futures, use of remittances, value chain & adaptation options, enabling private adaptation, property rights & investments, multi-scale governance & resilience measuring, and water governance
Outputs (Dec 2018)	63 peer-reviewed publications 62 engagement events 115 awardees	48 peer-reviewed publications 51 engagement events 79 awardees	32 peer-reviewed publications 73 engagement events 27 awardees	77 peer-reviewed publications 89 engagement events 39 awardees

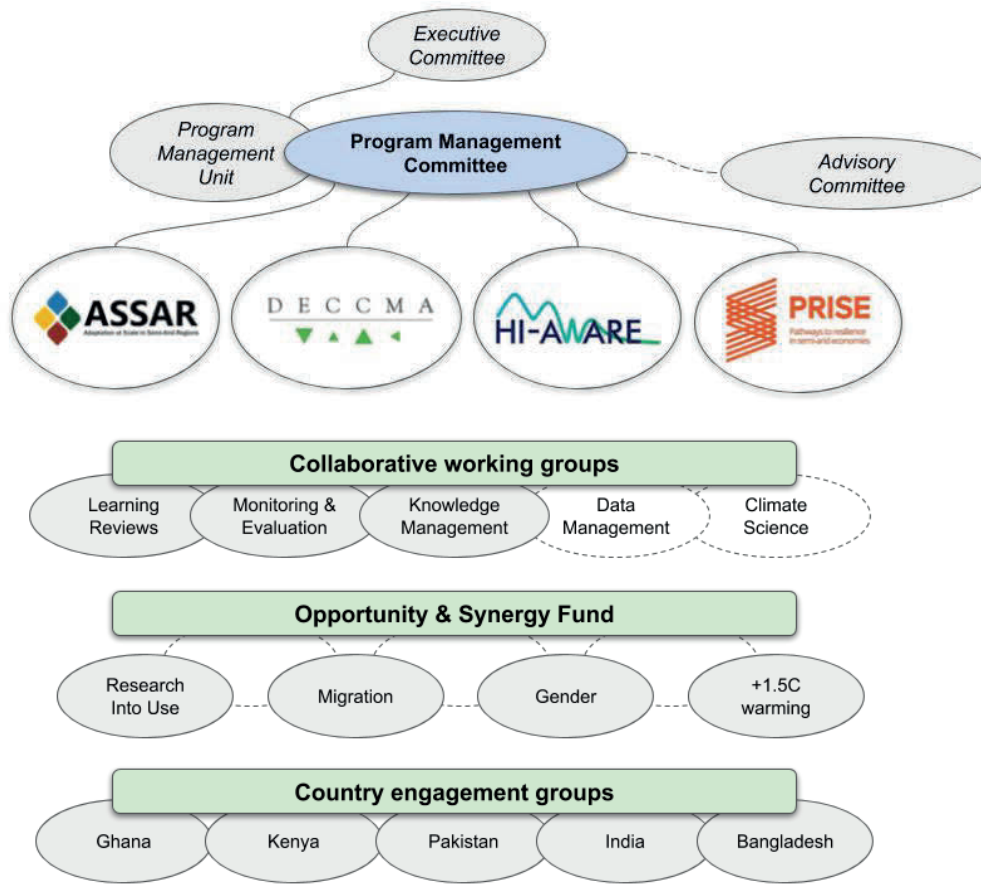


Figure 2: Layers of collaboration underpinned the four research consortia. Different groups coalesced around cross-consortia functions, in-country engagement, and specific research ideas that emerged during implementation.

2. Partners, leadership, and relationships

2.1 Seek diverse partners

Consortia brought together diverse partners with competencies required to bridge science, geography, and practice. In terms of science, each consortium included individuals and organisations with expertise in diverse disciplines tied to climate science and adaptation, who also differed according to academic qualifications, research experience, and scholarly contributions. Some participants had established track records authoring peer-reviewed publications and contributing to the scientific community, while others were students embarking upon their master’s or PhD degrees. In terms of geography, each consortium included organisations in the countries where it intended to work. These partners facilitated access to field sites and local communities, provided a grounded understanding of context, and enhanced the legitimacy and local ownership of the consortium’s activities (e.g. navigating the regulatory requirements for conducting research). In terms of practice, each consortium

included members with ties to local and national policy processes or the concrete implementation of adaptation options on the ground. To engage potential audiences for research uptake, consortia included partners with skills in public communications, informing policy, capacity building, and community development. As one participant noted consortia benefited by “choosing partners that already have well-established networks and higher-level government positions”.⁴

There are advantages and disadvantages to both large and small consortia. Having several partners allows a range of experience to come together and to create a team with expertise that surpasses that of any one individual organisation. For example, ASSAR (2018) found that each of its partners brought complementary strengths into the consortium, including START on capacity building, the University of East Anglia on gender and social science, and the University of Cape Town on governance and climate science. Whilst consortia provide opportunities to bring together complementary expertise, this can come at a cost. Bigger is not necessarily better, as the complexity of coordinating a consortium increases with the number of partner organisations. DECCMA included the largest number of organisations, which made coordination difficult and led to high transaction costs. One DECCMA participant stated that the time and cost of maintaining contact with the team was one of the biggest challenges.

While having a unique contribution for each partner speaks to an efficiency in structure, the flip side is that the resulting lack of redundancy can also disrupt work plans and impede coordination channels if one partner leaves the consortium. All consortia dealt with the exit and entry of partners over time. DECCMA originally planned to include the Nile delta, yet lost a core partner when a north African organisation decided not to participate in the consortium. Meanwhile PRISE lost a core partner in east Africa following concerns over the quality of its research contributions. In both cases, the consortium had to reorganise its activities and budget to adjust to the departure. DECCMA was able to invest in skills for research-into-use, and create a new network on African deltas.⁵ HI-AWARE experienced challenges partway through the programme, which were addressed through a learning review and renewed partnership agreement (Douthwaite et al. 2016, Mundy 2018). Towards the end of the project, HI-AWARE began to recognise both core and strategic partners in its publications. ASSAR also remained relatively stable, aided in part by arranging itself into regional teams, each of which was led by a different core partner. Yet the bankruptcy of one strategic partner forced adjustments to activities and budgeting midway through the project. In hindsight, the CARIAA experience suggests that consortia could have been more agile if they were able to permit the entry and exit of partners more easily over the course of the project, and CARIAA could have afforded consortia the option of changing core partners over time.

To become more than the sum of the parts, consortia needed to facilitate collaboration across partners and seize upon how they complement each other. In the words of a respondent to the PRISE survey (Ludi et al. 2018), there is value in “the opportunity to work with a broad range of researchers and support staff with varied expertise and from different cultural backgrounds, all bringing with them strong knowledge basis and experiences that I have been able to learn

⁴ Quote from participant at 4th Annual Learning Forum (Cape Town, June 2018)

⁵ [Western Indian Ocean Deltas Exchange and Research network](#) (WIODER)

from". ASSAR (2018) describes how members appreciated "bringing in competences that may not be the realm of researchers" such as skills in how to communicate to different audiences and think beyond the academic realm. Working with international experts across disciplinary boundaries was also widely appreciated as a benefit of working in consortia. In the words of one DECCMA respondent, "collaborative work is extremely significant, at international, national and local level. I have learnt that the impact of collaborative work on stakeholders is far greater than that of solo work".

Consortia invariably confronted different levels of capacity among their partner organisations and participating individuals, as well as challenges in incorporating new participants over time. One DECCMA participant was surprised to find (s)he was "working with peers who have no experience of the topic under investigation, or any of the skills needed to research it." HI-AWARE identified that participation was enhanced through strengthening partners' capacity in areas such as evaluation, knowledge management, and working in collaboration (Mundy 2018). HI-AWARE also found it useful to revisit members' capacity when there were changes in key personnel. ASSAR (2018, 7) realized that colleagues who joined later in a programme found it difficult to fully understand the multiple activities, reporting requirements and acronyms used by the longer-standing participants that made up the consortium. One respondent noted that staff recruitment and replacement became increasingly difficult over time, given the limited opportunity available to newcomers to shape the direction of the work and the need to use other people's data (2018, 8). ASSAR also found it important to ensure the inclusion of a sufficient number of senior researchers to ensure the quality of research produced and to mentor early career participants.

Diversity among participants included differences related to culture, gender, age, hierarchy, professions, and expertise. Nearly half (44%) of CARIAA authors were women, exceeding the level within recent IPCC reports.⁶ Nonetheless men occupied the majority among the principal investigator positions throughout the programme. Gender balance was stronger over time among the consortium coordinators (2:2 in most years) and among all participants (202 women out of total 461 persons). Ninety six percent of peer reviewed papers in CARIAA were co-authored, with 56% of these papers having co-authors based in different countries, indicating a high level of collaboration. Approximately 47% of all lead authors on these papers were based in the global South. HI-AWARE noted that diversity among its partner organisations offered opportunities, yet cautioned that openness, intention, and patience were required for such diversity to be genuinely valued and understood (Mundy 2018). Working in consortium means developing practices across organisations and individuals, ideally strengthening all partners.

Different access to funding, and difference in the power to shape the research design, permeated and shaped various issues consortia needed to confront. A key tension revolved around access to funding and its purpose. Beyond the five core partners, each consortium convened or sub-contracted from four to 20 additional in-country or strategic partners. Each core partner formed part of the consortium steering committee and held a grant agreement to receive funding directly from IDRC. In contrast, in-country or strategic partners did not necessarily participate

⁶ Women were 38% of authors in the IPCC special report on +1.5C warming, and represent one-third of the authors contributing to the sixth assessment report

in management; and they tended to have a narrow set of tasks, relying on core partners for access to funds. This distinction in levels of membership limited the decision making of sub-contracted partners over activities and priorities, while placing reporting requirements on them to access funds. While such differences are particularly pronounced between organisations based in global North versus the global South, they also occur between organisations who partner across the global South. One participant found that the consortium model allowed for diffusing power between organisations in South Asia and helped to foster an appreciation of each other on a more equal footing.⁷ In another case, however, sub-contracted partners found it difficult to access certain opportunities, as one ASSAR respondent recognised, “Sometimes opportunities are skewed in favour of lead partners (maybe due to nature of the contracts and funds availability)”.

Selecting partners is therefore a core consideration that must be taken very seriously by anyone contemplating the development of a consortium. Considerations include the expertise of the partners, previous relationships, likely power differentials and the extent to which these can be minimized, and the number of partners and their graduated levels of involvement (i.e. core versus peripheral partners).

2.2 Invest in leadership and coordination

Principal investigators, at the lead and core partner organisations, are vital positions in staffing a consortium. Together these individuals led the consortium on a day-to-day basis, fostering a consortium identity and overall direction. In the words of one respondent, “leaders either inspire or de-motivate staff members, and either promote or hinder effective working environments. Their actions... have a direct bearing on the project's overall productivity and success” (Scodanibbio 2017, 20). Another respondent noted “effective leadership can motivate the team and lack of leadership (or conflicts in leadership) can leave the team disoriented”. Participants looked to principal investigators as a source of intellectual leadership for the consortium, focusing research activities and ensuring rigour in the methods and publications. Based on the CARIAA experience, in order to effectively fulfil this role the authors recommend that a principal investigator dedicate at least one-third of her or his time to a consortium. This proved difficult as PIs held senior positions within their organisations, with competing responsibilities for research, teaching, administration, and supervision.

Principal investigators dedicated many additional hours to CARIAA in excess of what was budgeted. Consortia responded in different ways to such time and budget constraints. DECCMA established a deputy PI position, also based at the lead organisation, and had coordinators in each of its country teams. PRISE established a co-PI responsible for the lead organisation's own activities within the consortium, in addition to the PI responsible for the consortium as a whole. At one point, PRISE sought to reduce staffing expenses by placing more junior personnel as acting PI and Co-PI for a period of three months. In HI-AWARE, the person initially in the

⁷ Quote from participant at 4th Annual Learning Forum (Cape Town, June 2018)

coordinator role expanded his responsibility over time, delegating some tasks to a deputy coordinator, while becoming an IPCC author and then university professor. As mentioned above, as ASSAR organised around four regional teams, each of these took on some responsibility for coordination within their specific geography in concert with the consortium coordinator.

While deputy or acting positions can help to share the workload, there are advantages in having people who dedicate a major share of their time to the consortium.⁸ In the words of one ASSAR participant, "hiring fewer full-time researchers, rather than many part-timers can avoid a number of lags and delays, and enable swifter, more responsive collaborative work across institutions" (ASSAR 2018, 8). CARIAA grant agreements sought to limit salaries and indirect costs claimed by partner organisations, under the assumption that principal investigators held full-time paid positions. For example, university professors are assumed to already have a salary and a portion of their time counts as an in-kind contribution from the organisation to the project. These guidelines proved challenging for other organisations, such as think tanks, where staffing is more fluid and the organisation sought to assign the full cost of personnel associated with the consortium.

The position of consortium *coordinator* proved indispensable within CARIAA. Originally envisioned as an administrative position, the level of responsibility held by these individuals was more akin to a manager. In practice, the full-time consortium coordinators acted as a constant presence, meaning they were effectively deputies to the principal investigator, particularly when the PI was limited in the amount of time they could dedicate to CARIAA whether through funding constraints (i.e. days of work covered by the programme) or competing demands on their time (e.g. involvement in other projects, teaching, other duties within their organisation). Coordinators often acted as the voice of their consortium: interpreting and rallying partners to the overall vision, championing internal and external communication efforts, and acting as full members in overall CARIAA-level management. Coordinators were also regularly part of programme-level fora, including the research-into-use working group and planning for the annual learning reviews. This added to their individual workload, yet enhanced the quality of such fora and increased consortia ownership in them. Increasing the budget for and/or seniority of the coordinator position would be a wise investment in future consortia given the level of workload and responsibility involved. Another option is to create a set of coordinator positions, focused on acting as the contact point and providing coherence within a particular geography. For example, DECCMA had country-level coordinators in India, Bangladesh and Ghana who supported the consortium-level coordinator based in Southampton, as well as the co-PI in their home institution. Similarly, ASSAR found it would have benefitted from having regional-level coordinators to share the workload involved and better respond to demands from the programme.

Later in implementation, IDRC worked with PIs and coordinators to share financial analyses of spending across partners, and encouraged partners to perceive the consortium budget as a whole to be shared and optimized among partners. As CARIAA neared its final year, each consortium reallocated funding from partners that were underspending in order to mitigate

⁸ Cumming and Haas (2012) found that teams whose team members devoted a higher percentage of their time to the focal team performed more successfully than did teams whose members devoted a smaller percentage of their time to the focal team.

exchange rates eroding the grant value in local currency. This process was only possible because of the investment over time in the nested levels of organisational units within the programme (particularly the steering committees), and permitted redistribution of financial resources during the final two years of the programme. In hindsight, IDRC could have required PIs to approve the milestone payments under each grant agreement and to reassign funding as needed throughout implementation. This would have permitted consortia to withhold funding to partners pending delivery of overdue work. The research funder could have also strengthened consortia leadership by providing PIs and coordinators with timely access to financial and technical progress of each partner and the programme as a whole.

2.3 Strengthen relationships among partners

A research consortium is akin to a network, with the participating organisations as the nodes or vertices, and the relationships among them as the edges or links. Investing in those relationships, to establish and foster trust over time, is essential to function and success a consortium. Ultimately collaboration requires trust among partners and participants. Once established, trust was reinforced through consistent face-to-face and online engagement in working groups, learning reviews, training events and annual meetings (as mentioned above). By the end of the programme, significant trust had been built, with one DECCMA participant noting that “We have had a genuine sense of family and community within the project” and another stating that the highlight was “meeting some very nice people who I would like to collaborate with in the future”. Yet fostering this trust in the first place required time and financial investment in practical steps to clarify the roles of each member, create norms of behavior, and address incentives (covered in the first three sets of lessons above). Partner organisations and individual participants needed to understand what they were responsible for, what others expected of them, and how everyone would be held accountable for their contribution. Much of this work started slowly through the proposal and inception phase of each consortium, and later codified in collaborative management and work plans. HI-AWARE explicitly used a brokered partnership approach, formalizing an agreement among core partner, and conducted periodic ‘health checks’ involving the core members (Douthwaite et al 2016, Mundy 2018). Through such practical steps, consortia laid a foundation for partners to trust consortium arrangements.

Trust was challenged when a participant or organisation failed to fulfil their role. Within an organisation, individuals can defer to the formal authority of senior personnel to intervene when things go awry. Yet consortia did not necessarily have such backstops if collaboration was not working. DECCMA relied on its monthly management committee and regular in-country meetings to rapidly identify and resolve issues arising. In contrast, PRISE’s more decentralized set of seven projects, encouraged a more autonomous distribution of work and responsibilities among partner organisations. In the words of one respondent, participants “each had a shared stake in the quality of all aspects of the research process and outputs... a sense of being equal... in a joint enterprise” (PRISE 2018).

Interpersonal trust in other participants is an intangible attribute that arose in part through repeated interaction and in-person engagements. With time and experience, colleagues grew to appreciate each other’s expertise and empathize with each other’s needs, passions, and

character. The layers of collaboration within the program ‘worked’ by drawing upon this trust. Face-to-face interactions were thus crucial, as recognised by one ASSAR respondent: “Strong partnerships and trust have been slow to develop due to the lack of time spent together. Google Hangout and emails take much longer to develop trust than handshakes and hugs.” A working group or collaborative sub-project would start by seeking representation of diverse consortia or partner organisations. Yet members came to value the individual person above organisational affiliation, including the skills, attitude and energy she or he brought to the shared task. A sign of successful collaboration is the cultivation of multiple identities. While each participant started identifying with their home or hiring organisations, they learned to see themselves as part of a consortium contributing to a joint work plan. As each consortium matured, participants also identified with themes that cut across consortia. Thus a CARIAA participant could see herself as part of Sustainable Development Policy Institute (SDPI) as a partner organisation, part of PRISE as a consortium, and part of the CARIAA work on migration. While collectively CARIAA included hundreds of participants, each individual cultivated their unique role and contribution.

Those funding or commissioning consortium-based projects also need to be clear regarding their role. Individual IDRC programme officers were assigned to each consortium, with the responsibility for monitoring project implementation, authorizing payments to core partners, and reporting on overall progress. These individuals also facilitated engagement with other consortia, offered advice and critical comment on the research performed. Tact was needed to ensure that the leadership remained with the principal investigators. HI-AWARE expressed this as an appreciation for IDRC as supporter, guide and investor, being “flexible and willing to adapt to the needs and circumstance of each consortium... prepared not to ‘take the power’ which might otherwise sit with them” (Mundy 2018). Each IDRC programme officer also cultivated a role as a “thought leader” facilitating programme-level thinking and synthesis on a set of five themes including migration, climate science, and research impact.⁹

3. Teamwork, management, and collaborative research

3.1 Nurture teamwork

Consortia also benefit when there are norms of behaviour or working practices that partners share. By virtue of having a diverse membership, consortia had to operate across distinct workplace cultures and time zones, with limited face to face opportunities. As recognised by one ASSAR respondent, “all members of the consortium work in different ways (e.g. work culture, organisation structure)”. As many activities involved multiple participants, any one member was often dependent upon others for needed inputs. This created occasional bottlenecks, with delays having knock-on effects. One ASSAR respondent expressed frustration over “not being able to make things happen because of others. Having way too much on my plate and not being able to focus on strategic aspects and important deliverables such as writing papers”

⁹ IDRC staff also played a role akin to what Cooke et al (2015, 83) term as “charismatic connectors,” who circulate among all team members and spend equal amounts of time listening and speaking, while also seeking ideas outside the team.

(Scodanibbio 2017). One DECCMA participant recognised his/her role in the chain, stating that challenges were “obtaining the necessary inputs from consortium members to develop the country models, and delivering results on time so other researchers in the consortium team could carry on with their assignments.” Participants faced the dual challenges of keeping up with their inbox and dealing with less responsive colleagues (see Annex 4).¹⁰

Consortia needed to understand the multiple and various *incentives* that motivate individuals and organisations and to create space within the consortium for a range of identities and priorities. Overall vision and purpose serve to inspire people, yet dedicating time and effort to a collaborative endeavour over several years requires more. PRISE explicitly sought to understand each member’s motivations and attempted to design a work plan that provided opportunities that were recognised by participant’s home organisations and in their career paths.¹¹ Nonetheless, over one-third of participants reported that they faced different expectations from their home institutions versus the consortium (PRISE 2018). In ASSAR, one respondent cautioned that working in consortia “requires lots of time - for relationship building, keeping everyone in the loop... You have to spend a lot of time doing things that are not a priority for your career - or not recognised by your institution” (Scodanibbio 2017). Some graduate students found that being involved in consortium activities detracted them from concentrating fully on their dissertation, even while providing exposure to new approaches. A similar tension arose between academics required to publish to advance in their careers, and the consortium demands on their time, for reporting, monitoring, and meetings (ASSAR 2018, 6–8). Yet many early career researchers later reported high levels of satisfaction with having been in an individual consortium and CARIAA as a whole. Specifically, respondents mentioned the opportunities for mentorship outside of their host institutions, opportunities to contribute toward synthesis activities, and building social networks that are global in scope.

There were, however, examples of creation of incentives recognising different motivations. In DECCMA several whole consortium meetings held a poster competition open to all graduate students and post-doctoral researchers (including those who were not able to attend the whole consortium meeting in person) offering a monetary prize expressly to cover attendance at an international conference. HI-AWARE discovered different motivations and pressures of each partner with respect to academic traditions (Mundy 2018), including differences in training and career paths among researchers from different countries. For example, all consortia faced decisions over authorship in publications, and how to recognise the individuals who carried out field work and data gathering. DECCMA ultimately used the ‘Vancouver rules’ which define criteria for authorship, including contributing to design of the work, drafting and revising the publication, and approving the final version (ICMJE 2018). Applying this from the start meant that there was a transparent procedure in place and an equitable system for fair recognition of contributions, regardless of status (e.g. seniority) within the consortium.

Consortia needed to broker a common understanding of methods and research design. There is a growing literature on the challenges of working across disciplines including choosing units of

¹⁰ Two participants have gone on to contribute to a project under the Global Challenges Research Fund. Citing their CARIAA learning, they recount now encouraging a “code of conduct” which partners sign outlining expectations around replying to email, etc.

¹¹ Interview during 3rd Annual Learning Review (Kathmandu, May 2017)

analysis, ontology, methods, and research questions (Frodeman et al. 2017, Cooke et al. 2015, Misra et al 2011). Ultimately consortia opted to permit some tailoring of methods and datasets between activities or regions. While this limited the comparability and aggregation of data within each consortium and across the programme, it allowed consortia to sidestep protracted debates on research design. The diversity of interests and expertise, and the difficulty involved in reaching consensus across large numbers of partners was noted by an ASSAR participant when asked what had been most difficult about working in a consortium: “Coming to consensus on methods (we actually still haven't done that!). I feel the consortia model doesn't allow for methodological innovation. We tend to fall back on the lowest common denominator - e.g. household surveys.” (Scodanibbio, 2017). Similarly, another respondent recognised that “Too much time [was] spent in conveying ideas and convincing scientists and partners having different subject backgrounds” (Scodanibbio, 2017). Partners also negotiated their own mandates and priorities to pursue collectively a range of goals that encompassed contributing to global science, engaging national-to-district level policy, and building capacity among communities, early-career professionals, and students.

All consortia recognised that having clear roles was essential. Early in implementation, each consortium prepared a work plan detailing the activities to be performed, responsibility for these activities, along with timelines and deliverables. One DECCMA participant stated that “clearly defined roles and responsibilities, timelines and work plans” was one of the things that (s)he will be sure to replicate in future projects. ASSAR (2018, 16) however found that until relationships between its members (most of whom had not previously worked together) were strengthened and solidified, discussions on deliverables and budgets were stifled by lack of trust and unclear, undiscussed expectations. Future programmes should provide for early meetings focused on trust building between partners, along with agreeing to a joint vision and framing of what is desired, how work will be undertaken, and how to deal with conflict and risk. A key focus of these early meetings should be on trust building between partners.

Given the complexity of consortia, invariably certain partners and participants became responsible for a variety of tasks. In most cases, the lead organisation held a dual role as both a coordinator and participant; tracking the work plan and convening the steering committee, while also being responsible for its own distinct set of activities and deliverables.

Throughout the course of the programme, roles evolved over time with changes in work plan or consortium membership, or as participants experienced challenges or delays in implementation. Virtual and in-person meetings provided essential fora for refining and reaffirming who was responsible for what, and renegotiating timelines and priorities. Acknowledging the expense involved, in-person meetings of the consortia or smaller teams were exceptional value-for-money. DECCMA held twice yearly whole consortium meetings and noticed significant increases in the trust built through the face-to-face interactions that had positive effects on subsequent remote team working and productivity, with one participant stating that “impetus was gained at these meetings and they achieved more than many months of to and fro of emails”. These events provided a venue for critical conversations that addressed issues left unspoken in more frequent, yet more superficial, virtual meetings.

A *knowledge management* platform provided all CARIAA members with file sharing and storage, tools for collaborative editing, and web-conferencing. Based on the Google suite of software, cloud storage, and collaboration tools, each participant was provided with an individual

account. The platform included an internal webpage for sharing programme news, as well as mailing lists for different working groups. Having this common platform allowed participants to work whenever was most suitable for their schedules, as well as see and contribute to other documents created by others. Cloud storage was particularly valued for providing a means for sharing files and version control. Meanwhile web-conferencing permitted participants to easily conduct virtual meetings across different partner organisations, and were used for calls of the cross-consortium working groups. Having access to the cloud storage fostered transparency within the program, allowing participants to see and contribute to shared files.

Knowledge management and internal communication were vital to ensuring transparency and fostering a sense of belonging. Whether a quarterly internal CARIAA newsletter or weekly digest within the consortia themselves, regular internal communications kept participants informed about recent events and publications, as well as forthcoming meetings, deadlines and opportunities. They also became a means to celebrate achievements and foster the identity of being part of the consortium and programme (ASSAR 2018, 13). Given the dispersed nature of a consortium, internal communications are needed to keep partners engaged and motivated. This was particularly important for participants who had fewer opportunities for face-to-face interactions (ASSAR 2018, 16).

3.2 Foster collaborative management

CARIAA was organised in a nested series of organisational units that connected and supported coordination efforts within each consortium, across the consortia, and across the whole programme (Figure 2).

Within CARIAA as a whole, a key organisational unit was the Programme Management Committee which brought together the principal investigators and coordinators from each of the four consortia, together with IDRC staff (programme leader, management officer, and the responsible program officers). Monthly meetings provided a forum for sharing information, deciding on the use of the Opportunity and Synergy Fund (see section 2), identifying strategic events, and evolving and adapting the programme structure and processes. This included planning of annual learning reviews, oversight of programme-level working groups, and guiding the programme mid-term and summative evaluations.

IDRC acted as the secretariat for the Programme Management Committee, administered funding to core partners, and monitored the technical and financial progress of the consortia. This programme-level team served as a distinct fifth component to CARIAA connecting the four consortia and helping to support collaboration across consortia. CARIAA was also guided by an Executive Committee, with senior representatives from the two research funders, and an Advisory Committee of senior contacts within science and policy communities. The Executive Committee met virtually twice per year and contributed to programme-level strategy and implementation, and ensured ownership and awareness of CARIAA within both DFID and IDRC. The Executive Committee provided a forum for reporting on progress, monitoring risks, and preparing for future needs, such as deciding on the scope of a summative evaluation and discussing the transition after the programme.

Consortia had their own structures for collaborative management. As noted above, the principal investigator chaired a steering committee within their own consortium, enabling shared decision making among representatives from each of the core partners. The steering committee was responsible for intellectual leadership; guidance on consortium strategy, direction, approach and methodology; and sign-off on critical decisions throughout the project (ASSAR 2018, 9). These committees also formed a critical structure to enable monitoring of research progress and consortium performance and enable rapid resolution of emerging issues. In DECCMA the steering committee reviewed monthly reporting inputs from representatives of all work packages in all country teams submitted in advance through google forms. Steering committees tended to meet virtually once a month, and in person at least once per year. These committees were in turn supported by a set of within-consortium working groups responsible for distinct projects, activities or themes, as well as contact groups convened by each core partner to coordinate with country strategic partners.

Partners needed to be accountable to each other and to leadership within a consortium. The separate grant agreements enabled IDRC to send funds directly to each partner, providing them an opportunity to administer their own portions of the consortium budget. IDRC programme officers also interacted with each partner organisation and co-principal investigator. Yet having a grant agreement and being subject to monitoring from IDRC meant that partners were accountable directly to the research funder. At times this undermined their obligations towards consortium leadership, and left principal investigators with limited mechanisms to deal with non-delivery. Some partners initially perceived the grant agreement as an individual budget for their own activities. On the other hand, had all the funds been allocated to the lead partner who then created sub-grants to core partners, further transaction costs for program delivery would have been imposed onto grantees. Through most of CARIAA, each partner provided its own reports to IDRC on the financial and technical progress, while the lead partner was required to prepare an additional report on the technical progress of the consortium as a whole. Consortium leadership found it challenging to be held to account for the overall performance of the consortium when it was not able to exert oversight over associated funds dispersal or management. As one ASSAR respondent noted, it was “Difficult to coordinate various independent organisations which didn't have necessary a real obligation between each other” (Scodanibbio, 2017).

There were considered reasons why CARIAA did not award a single grant agreement to the lead organisation for the entire budget for each consortium. Doing so might have inadvertently narrowed the pool of potential recipients, as not all organisations have the capacity to receive and administer such large amounts of funding, nor the ability to transfer funds to partners in different countries. While the Overseas Development Institute (ODI) or the International Centre for Integrated Mountain Development (ICIMOD) could transfer funds to PRISE or HI-AWARE partners, it would have been more difficult for the universities that were the lead organisations within ASSAR and DECCMA. HI-AWARE established a portion of the overall budget (30%) for expenditure on behalf of the consortium as a whole, such as travel and attendance at meetings. As the lead organisation, ICIMOD managed this in addition to its own activities, effectively holding two portions of the consortium budget for distinct purposes. This was not always clearly understood by partners, and required careful communication. With hindsight, HI-AWARE partners might have been better placed to assume autonomy and responsibility for more of the consortium-level expenses within their respective budgets.

3.3 Enable collaborative research

CARIAA was underpinned by three layers of collaboration, including working groups that addressed thematic issues, those that addressed specific cross-consortium research ideas, and those that covered in-country engagement activities (figure 2).

Working groups operated below the Programme Management Committee and included individuals from all four consortia, thus fostering collaboration among distinct sets of people. Working groups on Monitoring and Evaluation, and on Knowledge Management and Communication, were created at the outset of CARIAA and sought to harmonize efforts across consortia. These two remained active until the end of the programme. In contrast, a working group intended to harmonize data management across consortia was convened too late, since consortia had already developed their datasets which made coordination very challenging. Working groups on climate science and on gender & inclusion, also created at the start of the programme, refocused their efforts over time to respond to emerging opportunities for collaboration. For example, the effort to strengthen climate science across the consortia was revitalized later on to study the implications of +1.5C warming across the hotspots as inputs towards the Intergovernmental Panel on Climate Change (IPCC) Special Report released in 2018.¹² Meanwhile, a general effort to coordinate on incorporating gender into the research methods of each consortium evolved into distinct collaborations, including a qualitative comparative analysis across the hotspots examining changes in women's agency associated with environmental stress (Rao et al, forthcoming).

Short-term working groups were convened to plan each of four annual *learning reviews* held during the program. From 2015 to 2018, CARIAA convened these learning reviews in Nairobi, Wageningen, Kathmandu, and Cape Town. The change in location was intentional to facilitate attendance of participants from different regions over time, as well as to rotate the workload involved in hosting the event between consortia. In 2016 and 2018, the learning review was held in conjunction with the Adaptation Futures conferences. This helped to reduce the need for additional travel expenses, yet made for an exhausting week of meetings.¹³ It also meant that participation in the learning review was shaped in part by who was accepted to the conference rather than solely based on the program's needs. The first learning reviews served to build relationships among participants, identify synergies among the consortia, and build capacity in certain topics such as the theory of change. The latter learning reviews served to share and refine research findings and their impacts in policy and practice.

In hindsight, some of the working groups were formed too early in the programme and struggled to set their agenda. For example, the gender & equality working group, initially tried to develop a common methodology for all consortia before later drawing together evidence

¹² See Cundill et al (2018) for further insight on fostering collaboration across CARIAA.

¹³ Our experience suggests it is better to convening the more intimate programme meeting ahead of the larger conference, to both benefit when people are more rested and to fine-tune messaging and participation in the conference.

from the programme. In contrast, the research-into-use working group responded to a clear need that emerged later in the programme, yet also had limited ability to shape the research process and products. The best period to foster collaboration is once each consortium is clear on what it wants to do, yet early enough that there is still an opportunity to modify activities and participants still have some time available to commit. Collaboration ideally emerges spontaneously, with the programme and consortia creating conditions for it to thrive by reminding participants of their potential and making resources (time and funding) available to seize it (Cundill et al. 2018).

An *Opportunity and Synergy Fund* provided additional funding to respond to emergent ideas for cross-consortium research, and indeed supported some of the working groups. The Programme Management Committee convened calls for proposals and jointly decided on how these funds were awarded. Funded activities included cross-consortium syntheses on gender, on migration, on research-into-use, and on adaptation pathways.¹⁴ These working groups were largely self-organised, and embodied the spirit of the ‘open space’ facilitation technique responding to organic, emerging, and sincere interest in working together. The resources provided by this fund allowed the programme to seize emergent opportunities for collaboration that arose spontaneously during the learning reviews and consortia meetings (Cundill et al. 2018). Yet Harvey et al. (2017) caution that the availability of funds alone was not always sufficient for partners to submit proposed learning activities for funding. During the final two years, the limiting factor for many participants was simply time rather than funding, and there was a reluctance to take on further responsibility in addition to the already substantial workload. In hindsight, the funded projects benefited from IDRC efforts to convene and facilitate the subgroups that coalesced around these subprojects.

Consortia also established their own mechanisms to respond to emerging opportunities, including for the implementation of actions on the ground. PRISE provided funding opportunities for young researchers, while HI-AWARE supported pilot technologies in communities. ASSAR provided small grants for working groups to develop cross regional syntheses, respond to the needs of local communities, and follow through on ideas emerging from scenario planning processes. ASSAR also supported skills exchanges between early career researchers and experts, and through this specific small grant mechanism fostered an additional comparative research collaboration on migration across its four regions using a common methodology and analysis. A key point is that collaboration cannot rely solely on goodwill: it is enabled by having extra resources available for responding to the purpose which is essential in geographically dispersed teams. One DECCMA participant noted the importance of “recognising that international collaboration cannot happen effectively without allocating a significant amount of resources (human, financial and time)... For future projects I will ensure that significantly more resource is budgeted for these interactions”. Specific items mentioned included training, supporting delivery of research, supporting data collection and data cleaning, supporting analysis and peer review of findings, and supporting authoring papers.

The programme established *country engagement* platforms in Ghana, Kenya, Pakistan, India, and Bangladesh as a mechanism to coordinate stakeholder engagement in places where two or more

¹⁴ See Annex 6 for a list of the sub-projects supported by the Opportunity and Synergy Fund

consortia were active. These platforms supported joint engagement events and research-into-use activities, such as common policy briefs to summarize findings. The experience with these engagement tables was mixed. Arguably the most effective were in Ghana, Pakistan, and India as the partners in each location had particular attributes. In Ghana, coordination was facilitated by the same university being involved in two consortia. In Pakistan, a policy think tank drew on its ties to convene dialogues with parliamentarians. Similarly in India, a national non-governmental organisation gained access to national government sharing a joint policy brief and videos covering all three hotspots. The consortia were active in different parts of each country, and tended to focus on different stakeholders. For example, CARIAA activities in Ghana and Bangladesh included distinct landscapes in southern and northwestern parts of each country. Similarly, in India the three separate hotspots were located in the northern, eastern and southern parts of the country and the federal government system meant that significant policy influence needed to take place at state level. Thus the value of these engagements lay primarily in combining forces to reach national policy audiences with a stronger more coherent voice, rather than coordinating the research or engagement activities per se.

4. Manage transaction costs

There are both benefits and costs to working in consortia and participating in arrangements for collaborative research across multiple organisations. For example, Haylor et al. (2015) identify benefits as learning management and communication skills, working with others as a source of creativity, and sharing knowledge and skills; while costs include the time required to meet administrative demands, reach common purpose and understanding within diverse teams, and to reconcile the different administrative and research systems among participating organisations.

The consortium model is just one option for designing a research programme. An alternate design could have awarded funding in smaller amounts to a larger number of more autonomous projects.¹⁵ Working in a consortium requires partners to develop and share systems to manage and coordinate research design, activities, budgeting, and reporting. In this respect, working in a consortium represents an additional “transaction cost” in terms of personnel and processes needed to administer a more complex set of activities across a larger and more diverse set of partners. All four CARIAA consortia reported difficulties related to such transaction costs.¹⁶

Having partners working in dispersed locations and operating in diverse cultural settings created difficulties for working together effectively. ASSAR members referred to the logistical challenges of working remotely, and the time required for reporting and coordination. Participants felt overwhelmed by multiple deadlines, demands, activities and information

¹⁵ CARIAA was preceded by *Climate Change Adaptation in Africa* (2006-2012) programme which supported 41 research projects. By the time of its summative evaluation, this programme had published 48 peer-reviewed texts, 205 conference presentations, 156 pieces of grey literature, 37 audiovisual outputs, 47 graduate theses and four book chapters. (Lafontaine 2012, 17)

¹⁶ Including over half of respondents in an ASSAR survey of participants (2018, 15)

overload (Scodanibbio, 2017). Among the challenges identified by PRISE (2018), logistics and language barriers were more pronounced due to how the consortium was organised. PRISE identified “logistics” as coordinating field work, meetings, teamwork, and feedback on documents. While some of these tasks were common to all consortia, the latter also connected to a centralized quality review process for PRISE publications across its seven projects. PRISE also faced unique language barriers having a francophone core partner, as well as activities in central Asia. PRISE thus operated in multiple settings where English was not the primary language in science or policy discussions, and required French within consortium management and quality review of publications. Practically speaking, communicating across time zones was found to be complicated, with one DECCMA participant stating that “being available for virtual meetings in the midst of internet connectivity challenges” was difficult to overcome.

Participants across all four consortia reported struggling with information overload and competing demands on time. Respondents noted moments of frustration when work progress was constrained waiting for contributions from other partners. Whereas they could more easily follow-up with phone calls or in-person with nearby colleagues, it was more difficult to elicit a response from partners located in other countries and time zones.¹⁷ Collaboration relies on teamwork, based on strong interpersonal relationships. With a strong base, teams could overcome different ways and paces of working, and handle differences in understanding and addressing issues. Generally, these relationships developed over the course of the project, meaning that while transaction costs were very high initially, these reduced over time and relationships and understanding between partners increased.

One aspect of transaction cost is the additional tasks required to administer a complex organisational arrangement. Yet a second aspect of transaction cost is inherent to collaborative research involving diverse partners and their interdependencies. When reflecting on transaction costs, CARIAA partners recalled both positive experiences when time was invested to establish and nurture teamwork, as well as negative experiences when such teamwork failed or failed to materialize.

The CARIAA experience suggests a number of opportunities to lighten or manage transaction costs. Within the programme, efforts were made to lighten reporting requirements near the end. Whereas the grant agreements originally required separate progress reports from each core member, at the end of the programme IDRC asked for a single consolidated final report on the consortium as a whole. This change in reporting requirement reflected a response to consortia needs to lighten their administrative burden, as well as the trust built over time by each core member. It also freed up staff to concentrate on finalizing academic outputs which, by virtue of the nature of the project, increased in quantity towards the end of the programme lifespan. In ASSAR and DECCMA one way in which email traffic was substantially reduced was through the dissemination of a weekly digest, which provided access to key documents, upcoming meetings and events, deadlines and opportunities, in one place.

The size of each level of organisation and their autonomy helped to manage transaction costs. CARIAA managed activities at distinct levels, including the overall programme, consortia

¹⁷ Participants identified factors that hinder collaboration during the third CARIAA learning review (Singh 2017, see Annex 4)

steering committee and coordination, as well as the various activities within each consortium (e.g. work packages, regions, or projects). Each level held responsibility for a certain scope or portion of the programme, helping to deal with the overall complexity. Each level involved a tractable amount of individuals, which eased the challenge of keeping partners informed and hearing from all members. For example, programme management and consortium steering committees included a lead and alternate member from each of the four-to-five organisations. This meant these committees involved up to 12 individuals, a number that could meaningfully engage in meetings or discussions without becoming overwhelming or ignoring some voices. Having a modest number of people involved heightened the opportunity to build interpersonal relationships over time, coming to refer to each other on a first name basis and having a deeper appreciation of each other's perspectives and contributions. Having just four consortia meant CARIAA was able to include representatives from each consortium in all layers of collaboration, such as working groups and planning for learning reviews (figure 2).

The transaction cost of coordinating a consortium is subject to a network effect. Assuming a uniform level of effort is required for each participant to understand and communicate with every other member of the consortium, such transaction costs will accumulate rapidly as the number of partners increases. Thus transaction cost is proportional to size of membership¹⁸, and further increased by factors such as geographic distance, language barriers, complexity of research design, and differences in cultural and academic practices. While CARIAA did not measure this workload, the presence of network efforts (along with anecdotal evidence from consortia) suggests that transaction costs rise precipitously rather than in linear fashion. Modelling these factors is beyond the scope of this paper, yet reflecting on the CARIAA experience suggests an unconscious 'rule of thumb' or heuristic of six, keeping the number of elements involved in each level of organisation to this limit (see table 1 and figure 3). Keeping each committee or collaborative activity to 12 or fewer individuals, and including representatives from each of the four consortia, proved conducive to reaching decisions and fostering trust.

¹⁸ Cooke et al. (2015, 6) note "Larger size can enhance productivity by distributing the work across more individuals, but it also magnifies the burden of communicating and coordinating tasks among a larger number of individuals. Scientists participating in larger groups have fewer opportunities than those working in smaller teams to meet and work with other group members face-to-face in ways that build trust and shared understanding of project goals and the roles of other group members."

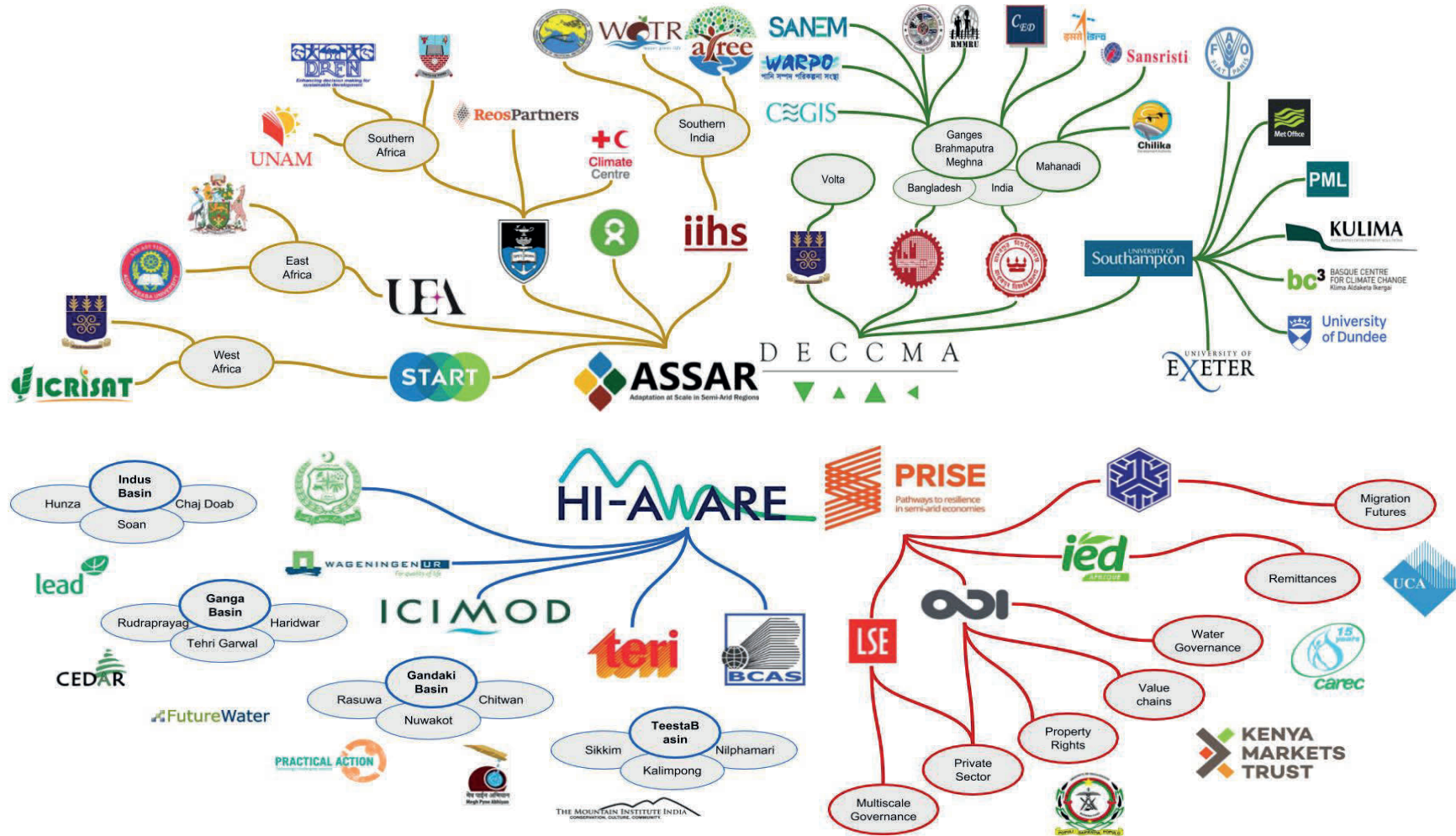


Figure 3: Network of CARIAA structure Each of the consortia involved steering committee of core partners, overseeing diverse activities grouped by either four geographic nodes, or seven research projects (in case of PRISE).

5. Implications for the potential of research consortia

The introduction to this paper identified a set of expectations and learning questions defined early in the programme. Under the theory of change, CARIAA assumed that the size of consortia would increase the chance for research uptake and impact; consortia would facilitate collaboration and knowledge sharing among participants; and consortia would reduce the transaction costs of research coordination and project management for the funders. Meanwhile, the programme's learning strategy asked what were the strengths of the consortium model, how did the consortia manage project coordination, and how to foster collaborative transdisciplinary research. While other efforts have addressed the third question (Cochrane & Cundill 2018; Cundill et al. 2018), this discussion aims to answer the first two by drawing from the lessons above to provide three insights on the potential of research consortia.

Despite the size and scope of the programme, this paper is obviously limited to a sample of four consortia within a common programme. Caution is warranted in drawing general design principles across such a limited sample. Theme, topic and nature of research all matter in choosing the most appropriate design of organising and funding science. CARIAA demonstrates the value of diversity, rather than pursuing an ideal model. Each consortium reflected a unique crafting of partner organisations and structure, tailored to particular purpose and function, mediated by opportunity and constraints in time, funding, and personnel. As such, these insights reflect how one particular programme was implemented, and will not necessarily hold for other research consortia operating in different contexts.

Consortia increased research uptake and impact by external actors

There is some evidence to support this assumption. Based on a partial sampling of activities, the summative evaluation identified that CARIAA contributed to the development of over 20 local or national plans and strategies, and to over a dozen policies in 11 countries that now are using research and credible evidence for decision making (Lafontaine et al 2018). Meanwhile, programme staff compiled a list of over forty outcomes, including: piloting adaptation technologies such as flood-resistant housing, informing the Bangladesh delta plan 2100, enhancing the capacity for vulnerability and risk assessment at the district level in Botswana, identifying investments to improve climate-resilience in livestock value chains, and distinguishing the different impacts of +1.5C and +2C warming in hotspots (see Prakash et al. 2019).

These outcomes speak to uptake of the research results by external actors, which were enabled by consortia investing significant time in engaging various external actors. PRISE adopted a 'policy first approach' which sought to base its research agenda on the knowledge gaps and needs of decision makers in government and private sector. All four consortia held numerous engagement events with diverse stakeholders ranging from local communities to national policymakers and international fora. Including think tanks, NGOs, and/or government agencies (as in-country core or strategic partners) was instrumental to this engagement, by drawing on existing relationships with stakeholders and/or their ongoing presence in communities, policy and practice. DECCMA and HI-AWARE also drew on previous experience of collaboration among

core partners, which effectively provided a head start in terms of interpersonal relationships among participants and with stakeholders.

Importantly, CARIAA went beyond achieving impact, and actively documented the cross-consortia learning on how to pursue research impact (Prakash et al. 2019). This learning activity, and the outputs, are a significant added-value of the consortium model. CARIAA's design enabled the research impact leaders from across the consortia to meeting face to face several times in order to learn from another about how to pursue impact more effectively.

The size, authority and duration of the consortia contributed to research uptake and impact. Consortia were obviously "large scale" in terms of research activities or diverse geography. Yet equally important was the scale in terms of the number of partners, and their standing in the communities of research and practice. Participants not only enriched consortia with their skills and expertise, but their reputations and access to diverse communities and stakeholders. For example, collectively consortia partners had ready access to villagers in remote locations as well as national officials in diverse countries. The sizable budgets and five-year duration of the projects also helped to build and sustain relationships with external actors over time, which does not happen overnight.

Consortia facilitated interaction across diverse activities and teams

Consortia enabled CARIAA to realize the benefits of interactions of disparate activities across a research portfolio. An alternative programme design could have involved several discrete projects with little interaction among individual teams. In contrast, consortia created large communities that connected various activities and teams, enabling them to speak to and learn from each other. Beyond mere organisational arrangements, consortia framed overarching adaptation research and policy questions. These provided a cohesion and common logic, or "interoperability" across disparate research activities, that allowed findings to contribute towards a larger, collective mass of evidence that drew from the experience of diverse locations. For example, a collaborative subproject compiled over twenty case studies across the three hotspots and two continents that generated insights on what enables or constrains women's agency and the implications for adaptive capacity (Rao et al forthcoming). Such work might have been unrealized or fragmented in alternative programme design.

Each consortium became more than the sum of its parts. The outcomes surpassed the scope of individual activities and realized the ambition for results "at greater scale and over longer-term" (IDRC 2015). Participants readily acknowledged that working in a consortium involved substantial additional burden in terms of administration and coordination. Yet more than 80% of ASSAR and DECCMA respondents rated the consortium as extremely important or important in terms of being beneficial to their work.¹⁹ Meanwhile 93% of PRISE respondents agreed that building resilience in climate change hotspots requires a scale of effort that exceeds what individual organisations can achieve working in isolation.

¹⁹ In ASSAR, in a mid-term survey in 2016, 80% of respondents rated the consortium as important or extremely important. This rose to 88% in the survey at the end of the project in 2018.

Achieving such benefits clearly involved transaction costs in managing diverse activities and facilitating communication and learning among numerous researchers. The CARIAA experience suggests that while the funder reduces such transaction costs, research team pick them up. Transaction costs were significant and were largely borne by consortium leadership, particularly principal investigators in the 18 core partners, the consortium coordinator in each of the four lead organisations, and the lead researchers at the activity level. Convening and arranging consortium meetings and annual learning reviews represented additional efforts on top of an already substantial workload for the day-to-day operation of each consortium. The individuals involved in these positions report dedicating a large portion of their time to such tasks, exceeding the amount allocated in consortium budgets or provided by their home organisations. That these people were willing to contribute such effort reflects their dedication and passion, yet also pushed people towards stress and exhaustion near the end.

Moving forward, this expectation could be restated to define the benefit expected to be gained, and identify who bears the related transaction costs. A clear benefit of consortia was their ability to enable interaction among and learning across projects, managing the program as a portfolio of interconnected activities. Yet creating this benefit involved transaction costs that were borne by consortia personnel. Communication is pivotal yet challenging. Implicit in the original assumption was that consortia leadership were better positioned to realize this benefit. Having their own standing in the academic and practice communities, and as partners within their own consortia, PIs and coordinators were well positioned and highly effective at rallying participants and peers. Without consortia, the research funders (IDRC and DFID) would have had sole responsibility for managing the interaction among activities. In contrast, consortia permitted these funders to transfer transaction costs onto consortia leadership as grant recipients. Arguably CARIAA achieved its overall benefit through the combination of programme-wide and within-consortium collaboration, drawing on the complementary efforts of programme management and consortia leadership.

A survey conducted among the ASSAR consortium at the end of the project indicated that 78% of respondents were highly or very highly satisfied with what they personally achieved in the project citing their professional growth, increased skills and knowledge, and ability to deliver on what had been committed as the top reasons for satisfaction. As mentioned earlier, the most useful aspects of working in a consortium were tied to the multi-disciplinary collaborative design, the ability to exchange perspectives and approaches across different geographical regions, and the networks established with researchers across the world (Scodanibbio & Cundill, in prep).

Consortia managed projects through nested levels of coordination

Nested levels of management provided the key for coordinating a diverse portfolio of research activities. At a programme level, the management committee brought together the principal investigators from the four consortia, to shape the agenda for an annual learning review and to decide on collaborative subprojects. The use of Google suite at the programme level created a common knowledge management platform that facilitated sharing of documents within and across consortia and enabled communication among working groups and/or all participants.

At the consortium level, the steering committee brought together the co-principal investigators from the core partners to oversee budgeting and to monitor the implementation of diverse activities. The coordinator position was vital to the day-to-day operation of each consortium, effectively acting as managers with diverse responsibilities ranging from planning research impact to facilitating and overseeing communications. Each coordinator proved to be an effective leader: helping bring partners together, often whilst bridging cultural diversity and geographical dispersal, serving as a voice for their consortium, and actively participating in cross-consortium arrangements for collaboration and knowledge sharing.

At the activity level, each of the core partners convened a set of subgrantees or in-country strategic partners to coordinate work and engage stakeholders. While each consortium adopted a distinct approach to organising its activities, all four subdivided their activities among different geographical regions. Each consortium provided their core partners a degree of autonomy for implementing activities whether within each river delta in DECCMA, the basins and field sites in HI-AWARE, or the regional nodes in ASSAR and PRISE. The combination of geography and work package permitted consortia to structure their work into manageable pieces.

Together these nested levels of coordination created a pattern of relationships akin to a scale-free network (figure 3, Barabasi 2009). Each node or partner had detailed information from one level down, understanding a discrete set of activities and strategic partners. These subsidiary levels also enjoyed some autonomy, while higher levels assembled the larger picture of consortium- and programme-wide progress. As stated earlier, each node also tended to have less than six edges or links downwards which helped to manage complexity and keep the scope of work tractable. At the same time, it can be useful to protect a portion of people's time with the intention of responding to opportunities for collaboration. Otherwise the presence of additional funding will be ineffective if personnel are already fully committed.

Fostering collaborative transdisciplinary research lay at the heart of the focus and methods of each consortium. By design, CARIAA sought to generate and share new knowledge on vulnerability and adaptation in hotspots; build new capacities by strengthening expertise among researchers, policymakers, and practitioners; and inform better policy and practice through engagement. In responding to these objectives, consortia and their activities weaved together research questions and approaches that drew on different disciplines and diverse participants. Yet rather than working in isolation with each activity, layers of collaboration within and across consortia created additional linkage among participants. Whilst it is important to recognise and resource the additional transaction costs, nested levels of coordination and layers of collaboration provided a structure that facilitated the consortia and programme to function. Thus practical elements of consortium design that can create opportunities for collaborative transdisciplinary research to emerge.

Given these insights, the CARIAA experience begs two additional questions that warrant further study.

The first question is to identify the optimal level of structure to facilitate coordination and foster collaboration. On the one hand, CARIAA might have been over-engineered, with some redundancy among the levels and layers (at least at certain times in the programme lifespan).

We do not know the minimum amount of such linkages required for a consortium to function well and obtain the benefits from working as such. On the other hand, the linkages emphasized internal ties, albeit not just within consortia, but within the CARIAA programme. Some of the layers and levels could have been re-engineered to bring in more external perspectives, whether in terms of collaboration with other research programmes or to provide an enhanced role for stakeholders such as policymakers or private sector representatives.

The second question is to identify the threshold at which a research consortium surpasses an optimal size. Beyond what point are the benefits of complementary knowledge and skills, interaction and learning outweighed by the transaction costs involved in coordinating numerous partners? Or beyond what point is the potential gain from working on an ambitious agenda outweighed by the rising complexity of process management within a research consortium?²⁰ CARIAA showed signs of having reached such a threshold, as demonstrated by a need to lighten reporting requirements over time and the unsustainable workloads experienced by some key personnel. One respondent pondered whether their consortium was simply too big, “perhaps something half the size might have hit the sweet spot in terms of advantages of consortium work versus advantages of being small and nimble and manageable” (Scodanibbio 2017). The four consortia officially dissolved in late 2018 after nearly five years, although many partners continue to work together and collaborate under the guises of different projects. If CARIAA had continued it could have experimented with streamlining its structural design or providing greater time and resources for coordination. Alternatively, CARIAA could have reconfigured its grant making around emerging cross-programme themes and the collaboratives subprojects.

Research consortia are not a panacea, and choice of grant size and the complexity of research effort should be fit-for-purpose with the scale of ideas coming from the research community, the potential to make meaningful scientific progress, and the opportunities to contribute towards climate action on the ground. As research agendas continue to promote transdisciplinary communities to address real world “wicked” problems, such as those posed by climate change, these learnings are important to improve the efficiency and effectiveness of future consortium-based projects (Cundill et al. 2019).

6. Conclusions

This paper identifies lessons and insights from a set of four transdisciplinary research consortia as part of the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA). Each consortium included a different set of partners and field sites, a unique approach to organising its research activities, and produced a distinct combination of outputs. Some partners had worked together previously, yet all four consortia represented a new level and intensity of

²⁰ In a study of National Science Foundation-funded research groups, Cummings et al. (2013) found that the productivity as measured by number of publications increased with the size of research groups, yet the marginal productivity of larger groups declined as they became more heterogeneous, either by including experts from more disciplines or from more institutions.

collaboration, which ultimately required members to negotiate roles, and design systems to manage and coordinate themselves. The programme also sought to foster collaboration around cross-consortia functions, in-country engagement, and specific research ideas that emerged during implementation aided by a dedicated budget for collaborative activities among consortia.

Drawing on participant survey, technical reports, and focus groups, the bulk of the paper delved into seven lessons.

The first three lessons are to seek diverse partners, invest in leadership and coordination, and strengthen relationships among partners. Consortia bring together diverse partners with competencies required to bridge science, geography and practice. The principal investigator and coordinator positions are vital and require individuals able to demonstrate leadership and dedicate sufficient time. PIs and coordinators needs to be empowered with ready access to financial information and the ability to deal with performance issues. Partners need to be accountable to each other and to leadership within a consortium. Consortia confront different levels of capacity among its partners, as well as diversity related to culture, gender, age, hierarchy, professions, and expertise.

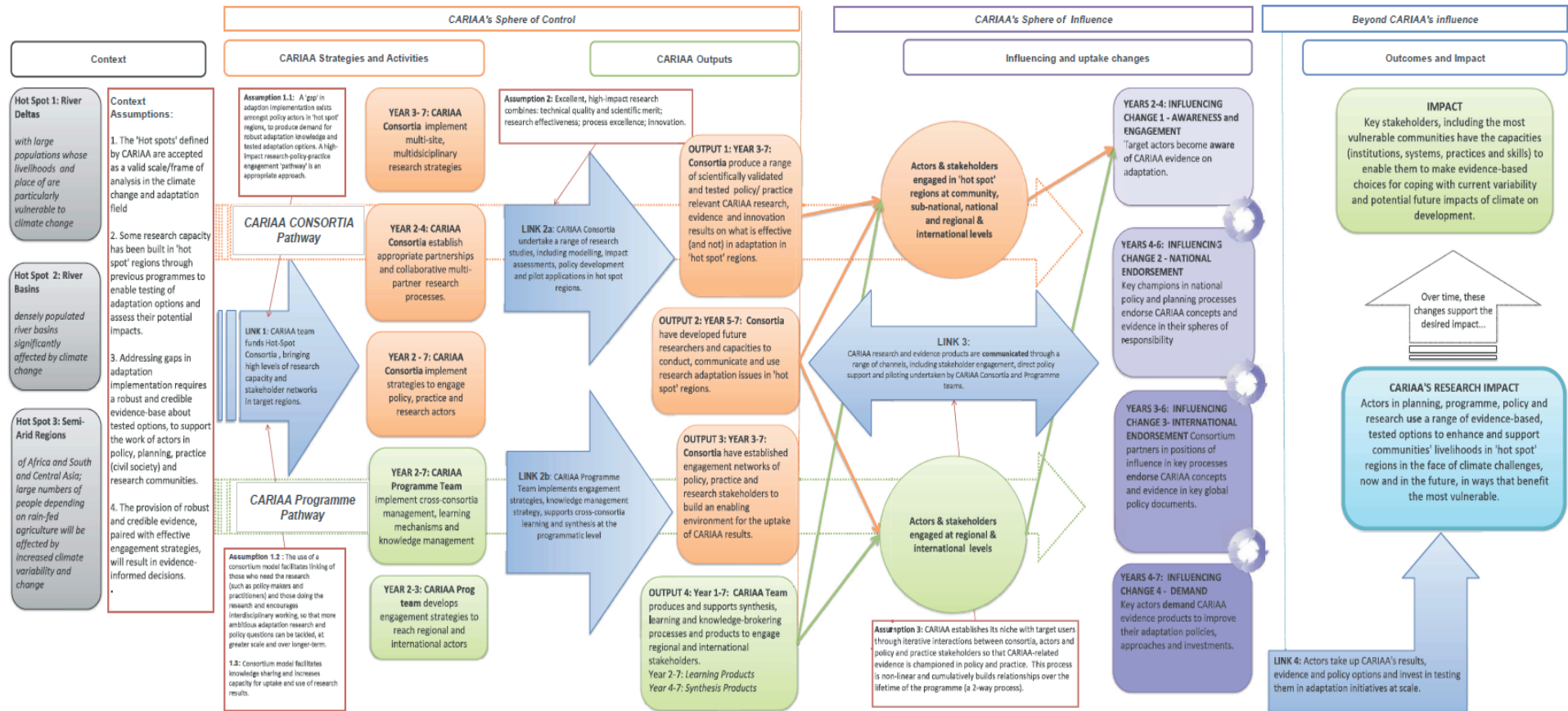
The next three lessons are to nurture teamwork, foster collaborative management, and enable collaborative research. Foster norms of behavior or working practices among participants, and understand and respond to various incentives that motivate different partners. Power dynamics shape various issues consortia needed to confront through careful work planning and defining each partner's role. Periodic consortium meetings or learning reviews can bring participants to build relationships, identify synergies, and to identify opportunities to pursue research impact. Having a shared knowledge management platform and regular internal communication fosters transparency and a sense of belonging among participants. Nested levels can help to manage the complexity of a consortium, providing a distinct set of responsibilities and creating some degree of autonomy for lower levels. There are advantages to providing funding directly to each partner, while also fostering a willingness to share resources across the consortium. Consider different layers of collaboration, such as thematic working groups, additional funding for emergent subprojects, and common platforms for engaging stakeholders.

The third set of lessons concern how to manage transaction costs. There are benefits and costs to working in consortia. Bigger is not necessarily better, as the complexity of coordinating a consortium increases with the number of partner organisations or participating individuals. Having partners working in dispersed locations and operating in diverse cultural settings creates difficulties for working together effectively. Consortia can manage the transaction costs of coordination by limiting the size of each level of organisation.

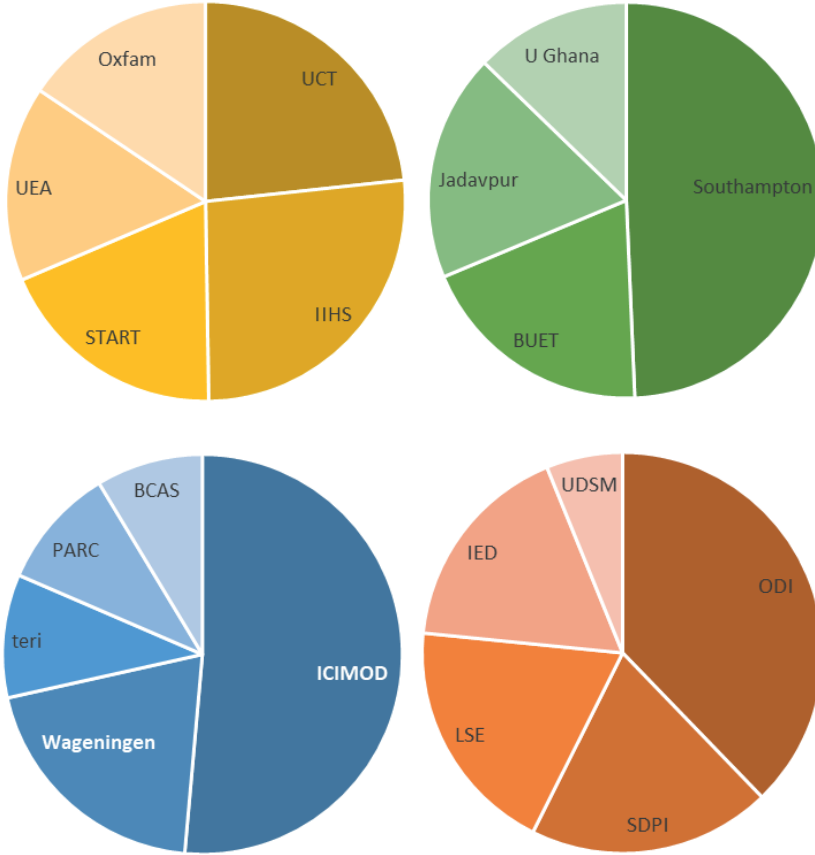
Revisiting programme expectations and learning questions, the CARIAA experience provides additional insights on the potential of research consortia. The size, authority and duration of the consortia contribute to research uptake and impact. Consortia facilitate interaction across a research portfolio, providing an overarching framework that enabled disparate activities to contribute towards a common agenda. Nested levels of management permit consortia to coordinate diverse partners across multiple countries. Moving forward, further study of research consortia can seek to identify how much structure is required to foster collaboration, and detect when a research consortium has reached or surpassed an optimal size.

7. Annexes

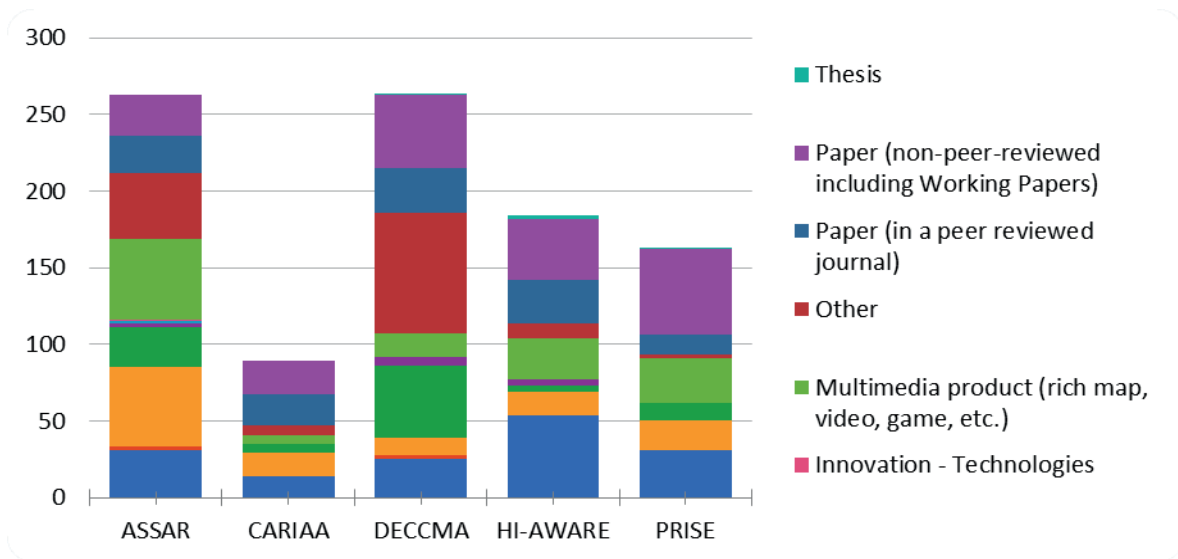
Annex 1: CARIAA Theory of Change



Annex 2: Lead partner held over one-third of the budget in three consortia (ASSAR in yellow, DECCMA in green, HI-AWARE in blue, and PRISE in red)



Annex 3: Each consortium produced a different combination of outputs (vertical axis represents number of outputs reported by Dec 2018)



Annex 4: Hindrances to collaboration (Singh 2017)



Annex 5: Feedback on consortia model. Top five responses on what to start, stop, and continue in future programs, gathered during the 2018 learning review

START	STOP	CONTINUE
Specific funds for action on the ground	The rigid structures. Allow new members to join and old ones to exit	Cross consortia collaboration & learning for synthesis through multiple partnerships
Stronger body coordinating cross-consortia themes	Untimely payment and inflexible budgets	Research for Impact methodology
Flexibility in workplans and composition of partners	Expecting more than resources permit	Sustain momentum and networks for impact
Transboundary research	Stop treating RiU and gender as ornaments	Opportunities & synergies fund
Translate into curriculum and training	Stop high level messaging - leads to generalisation	Capacity building - networks, learn from each other, collaborative research, early-career researchers

Annex 6: Collaborative sub-projects across consortia

Supporting Open Access Publications (107857)
 Supporting and convening CARIAA-related learning events (107998)
 Support for Gender Training for researchers (108063)
 Promoting Research into Use - Ghana Country Engagement (108146)
 2nd Annual Learning Review (108289)
 Support to develop stories of change (108327)
 Cross-consortia research-into-use learning framework (108328)
 Cross-consortia in-country engagement in India (108361)
 Research-policy engagement in Pakistan (108380)
 Contribution to IPCC special report on impacts of +1.5C warming (108387)
 Research-into-use focal point for Bangladesh (108388)
 Economics training and dialogue (108431)
 Meta-synthesis of gender, social differentiation and inclusion in adaptation (108459)
 Migration in climate hot spots in South Asia (108518)
 3rd Annual Learning Review (108537)
 Leveraging CSIRO expertise for adaptation pathways in Africa and Asia (108554)
 Capacity to conduct systematic review of climate change research (108849)
 4th Annual Learning Review (108850)
 Enabling near-term results for climate adaptation (108987)

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