

COLLABORATING FOR ADAPTATION

Findings and Outcomes of a Research
Initiative Across Africa and Asia



Authorship and Contributors

This synthesis report was authored by Mary O'Neill (Lost Art Media, Canada), with input from Sarah Czunyi, Bruce Currie-Alder, Georgina Cundill-Kemp, Michele Leone (IDRC, Canada) and Katharine Vincent (Kulima Integrated Development Solution, South Africa).

For more information:

International Development Research Centre
PO Box 8500, Ottawa, Ontario
Canada K1G 3H9

Phone: (+1) 613-236-6163

idrc.ca | info@idrc.ca

Copyright

© International Development Research Centre, 2020



This work is licensed under the Creative Commons Attribution License 4.0 International Licence (CC BY 4.0), which permits unrestricted use, distribution, and reproduction, provided the original work is properly cited.

Recommended citation: International Development Research Centre. 2020. Collaborating for Adaptation: Findings and Outcomes of a Research Initiative Across Africa and Asia. Ottawa, Canada.

Design

Creatrix Design Group

Cover Photo

Right: ©EU/ECHO/Anouk Delafortrie

"Ethiopia: worst El Niño induced drought in 50 years" by Anouk Delafortrie is licensed under [CC BY-NC 2.0](https://creativecommons.org/licenses/by-nc/2.0/).

Left: ©UN Women/Mohammad Rakibul Hasan

"Bangladesh - Flooding, 2019" by Mohammad Rakibul Hasan is licensed under [CC BY-NC-ND 2.0](https://creativecommons.org/licenses/by-nc-nd/2.0/).



Canada



The Collaborative Adaptation Research Initiative in Africa and Asia program was jointly funded by the UK's Department for International Development and Canada's International Development Research Centre.



About CARIAA

The Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) was a seven-year program (2012–2019) jointly funded by Canada's International Development Research Centre (IDRC) and the UK's Department for International Development (DFID).

CARIAA was dedicated to building the resilience of vulnerable people and their livelihoods in three types of climate change hotspots in Africa and Asia: deltas, semi-arid lands, and glacier- and snowpack-dependent river basins.

About this report

This report builds on the accumulated knowledge and evidence produced by CARIAA research teams. It presents insights, outcomes, and findings to enhance the resilience of people living in high-risk climate hotspots in Africa and Asia.

The work is presented in five key areas:

- Identifying the hotspot effects of 1.5°C global warming
- Strengthening adaptation
- Addressing gender and social inequality through inclusive adaptation
- Understanding migration in the context of adaptation
- Strengthening resilience through private sector adaptation

In addition to CARIAA's key outcomes and lessons, the report's conclusion outlines implications for the climate change research community at large.



CONSORTIUM	COUNTRIES
ASSAR	Botswana, India, Ethiopia, Ghana, Kenya, Mali, Namibia
DECCMA	Ghana, India, Bangladesh
HI-AWARE	India, Bangladesh, Nepal, Pakistan
PRISE	Burkina Faso, Senegal, Kenya, Kyrgyzstan, Tanzania, Pakistan, Tajikistan



Contents

Introduction.....	2
1. Identifying the hotspot effects of 1.5°C global warming.....	8
2. Strengthening adaptation.....	13
3. Addressing gender and social inequality through inclusive adaptation.....	18
4. Understanding migration in the context of adaptation.....	23
5. Strengthening resilience through private sector adaptation.....	29
Conclusion.....	34
References.....	35

INTRODUCTION

More than one billion people live in climate “hotspots”. These areas experience significant effects of climate change and they are home to a large concentration of vulnerable, poor, or marginalized people (De Souza et al., 2015). The areas that are most vulnerable to climate change include deltas, semi-arid lands, and glacier-dependent basins in Africa and Asia.

Human vulnerability to climate change is affected by a range of economic, physical, and sociocultural factors. People who are among the most vulnerable live in high-risk climate change hotspots where livelihoods are directly threatened by dependence on the immediate environment. The International Development Research Centre (IDRC) and the United Kingdom’s Department for International Development (DFID) formed the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) to help build resilience for people who live in these hotspots. CARIAA sought to inform adaptation policy and practice through collaborative research on climate change adaptation.

CARIAA had three main research objectives:

- ❶ **Generate and share new knowledge on vulnerability and adaptation in hotspots;**
- ❷ **Build new capacities by strengthening expertise among researchers, policymakers, and practitioners; and**
- ❸ **Inform better policy and practice through engagement.**

Consortia model

Over seven years, CARIAA brought more than 450 researchers together from 40 institutions in 15 hotspot countries. They formed four consortia with common program links, each addressing a particular climate change hotspot. This collaborative consortia model offered opportunities for institutions with varying expertise and geographic scopes to share knowledge and experience across disciplines, sectors, and geographic areas.

CARIAA’s four consortia:

Adaptation at Scale in Semi-arid Regions (ASSAR)

ASSAR’s overarching objective was to improve understanding of the barriers, enablers, and limits to widespread adaptation in semi-arid regions. The consortium conducted research on the access, use, and management of land and water resources in water-stressed environments, in addition to the socio-ecological risks and dynamics of transitioning livelihoods.

Deltas, Vulnerability and Climate Change: Migration and Adaptation (DECCMA)

DECCMA’s aims were to evaluate the effectiveness of adaptation options in deltas in Africa and Asia and to deliver policy support for sustainable, gender-sensitive adaptation. The consortium used surveys, participatory research, and econometric methods to study the evolving morphology and hydrology of deltas, analyze the impacts of climate change, and understand migration processes.

Himalayan Adaptation, Water, and Resilience Research on Glacier and Snowpack-Dependent River Basins for Improving Livelihoods (HI-AWARE)

HI-AWARE’s overall goal was to increase the climate resilience and adaptive capacities of poor and vulnerable women, men, and children living in select river basins in South Asia. The consortium conducted research and piloted interventions, enhanced capacity through different means, including training, and engaged with key decision-makers to enhance climate resilience and adaptation policies and practice to improve livelihoods.

Pathways to Resilience in Semi-arid Economies (PRISE)

PRISE aimed to strengthen the commitment of decision-makers in governments, businesses, and trade bodies to rapid, inclusive, and resilient development in semi-arid regions. The consortium generated new knowledge about making economic development in semi-arid regions more equitable and resilient to climate change. This knowledge was



Vulnerability to climate change is heightened in hotspots, including deltaic environments such as Bangladesh.

© Rafiqur Rahman Raqu/DFID

used to deepen decision-makers' understanding of the threats and opportunities facing semi-arid economies in relation to climate change.

Please refer to Figure 1 for more information about the consortia, including geographic focus and member institutions.

Collaboration

CARIAA's consortium model was designed to foster innovation and provide opportunities for sharing knowledge and experience across disciplines, sectors, countries, and continents. With guidance from IDRC, CARIAA's architecture supported cross-consortia [collaboration](#) that enabled shared learning, joint activities, and the coordination of communications and stakeholder engagement at the national, regional, and international levels (Cundill et al., 2018). The model also facilitated the co-production of knowledge and [syntheses](#) on cross-cutting themes (Cochrane & Cundill, 2018) such as climate science, gender and equity, migration, and research-into-use.

Despite working across different countries and continents, each consortium was able to select study areas with geographic and social similarities in the way they experienced climate change. This model encouraged the exchange of knowledge across disciplines, sectors, and geographic areas and among institutions with varying expertise and geographic scopes. CARIAA used this experience

to reflect on the current and future implications for researchers and donors in this new era of collaboration (Cundill, Currie-Alder & Leone, 2019).

Capacity

CARIAA provided research opportunities for early career scientists and masters and PhD students. The program also trained a range of stakeholders, including local, district, and national government officials. In addition, CARIAA helped some consortia and partner organizations hone their expertise on topics that were new to them, such as gender and the links between climate change and migration.

COLLABORATION FOR IMPACT



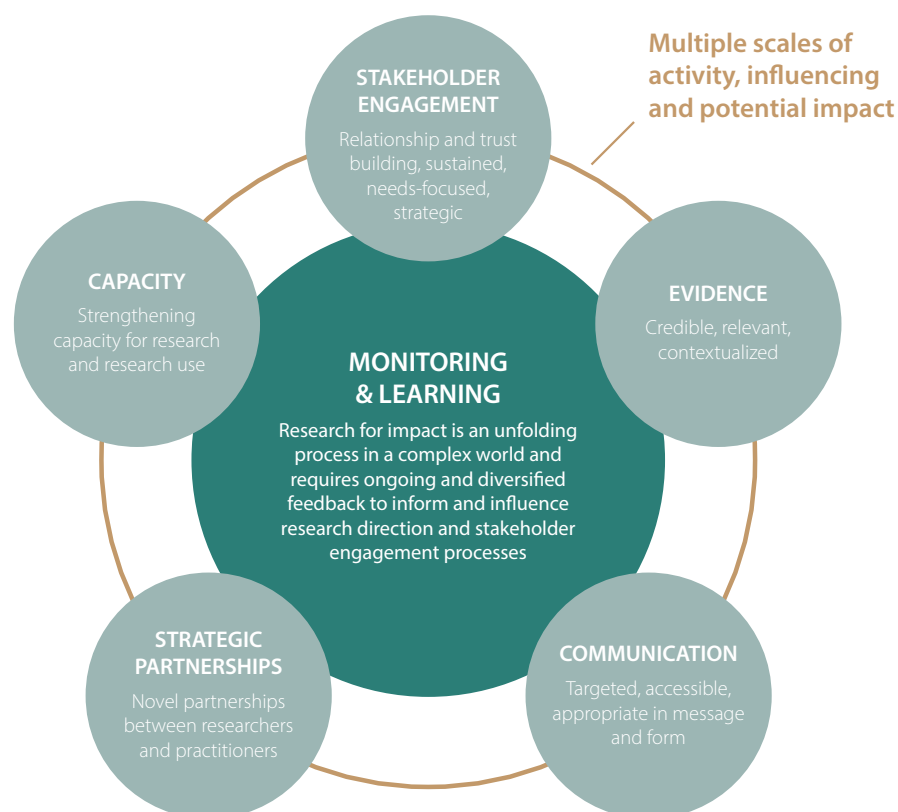
CARIAA researchers address the importance of collaboration to tackle the complexity of climate change adaptation.

Figure 1: CARIAA consortia

CONSORTIUM	GEOGRAPHIC FOCUS	CORE MEMBERS
<p>Adaptation at Scale in Semi-arid Regions (ASSAR)</p> <p>Lead institution: University of Cape Town, South Africa</p>	<p>Semi-arid areas of Botswana, Ethiopia, Ghana, India, Kenya, Mali, Namibia</p>	<ul style="list-style-type: none"> • Indian Institute for Human Settlements, India • International START Secretariat, USA • Oxfam, UK • University of East Anglia, UK
<p>Deltas, Vulnerability and Climate Change: Migration and Adaptation (DECCMA)</p> <p>Lead institution: University of Southampton, UK</p>	<p>Ganges-Brahmaputra-Meghna delta in Bangladesh and India; Mahanadi delta in India; Volta delta in Ghana</p>	<ul style="list-style-type: none"> • Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Bangladesh • Jadavpur University, India • University of Ghana, Ghana
<p>Himalayan Adaptation, Water, and Resilience Research on Glacier and Snowpack Dependent River Basins for Improving Livelihoods (HI-AWARE)</p> <p>Lead institution: International Centre for Integrated Mountain Development, Nepal</p>	<p>Mountains and flood plains of the Indus, Ganges, and Brahmaputra river basins in Bangladesh, India, Nepal, and Pakistan</p>	<ul style="list-style-type: none"> • Alterra, Wageningen University and Research Centre, Netherlands • Bangladesh Centre for Advanced Studies, Bangladesh • Climate Change, Alternate Energy and Water Resources Institute of the Pakistan Agricultural Research Council, Pakistan • The Energy and Resources Institute, India
<p>Pathways to Resilience in Semi-arid Economies (PRISE)</p> <p>Lead institution: Overseas Development Institute, UK</p>	<p>Semi-arid areas of Burkina Faso, Kenya, Kyrgyzstan, Pakistan, Senegal, Tajikistan, Tanzania</p>	<ul style="list-style-type: none"> • Grantham Research Institute, London School of Economics, UK • Innovation, Environnement et Développement en Afrique, Senegal • Sustainable Development Policy Institute, Pakistan



Figure 2: CARIAA's Research for Impact lessons
(Prakash et al., 2019)



The collaborative structure of the consortium model helped some partner organizations gain international exposure and experience and improve their research quality to meet global standards. Consortia contributed to developing training materials for different stakeholders, university curricula, and a [Massive Open Online Course](#) that draws on CARIAA's experience in making research more accessible to influence policy, practice, behaviours, and attitudes.

Impact

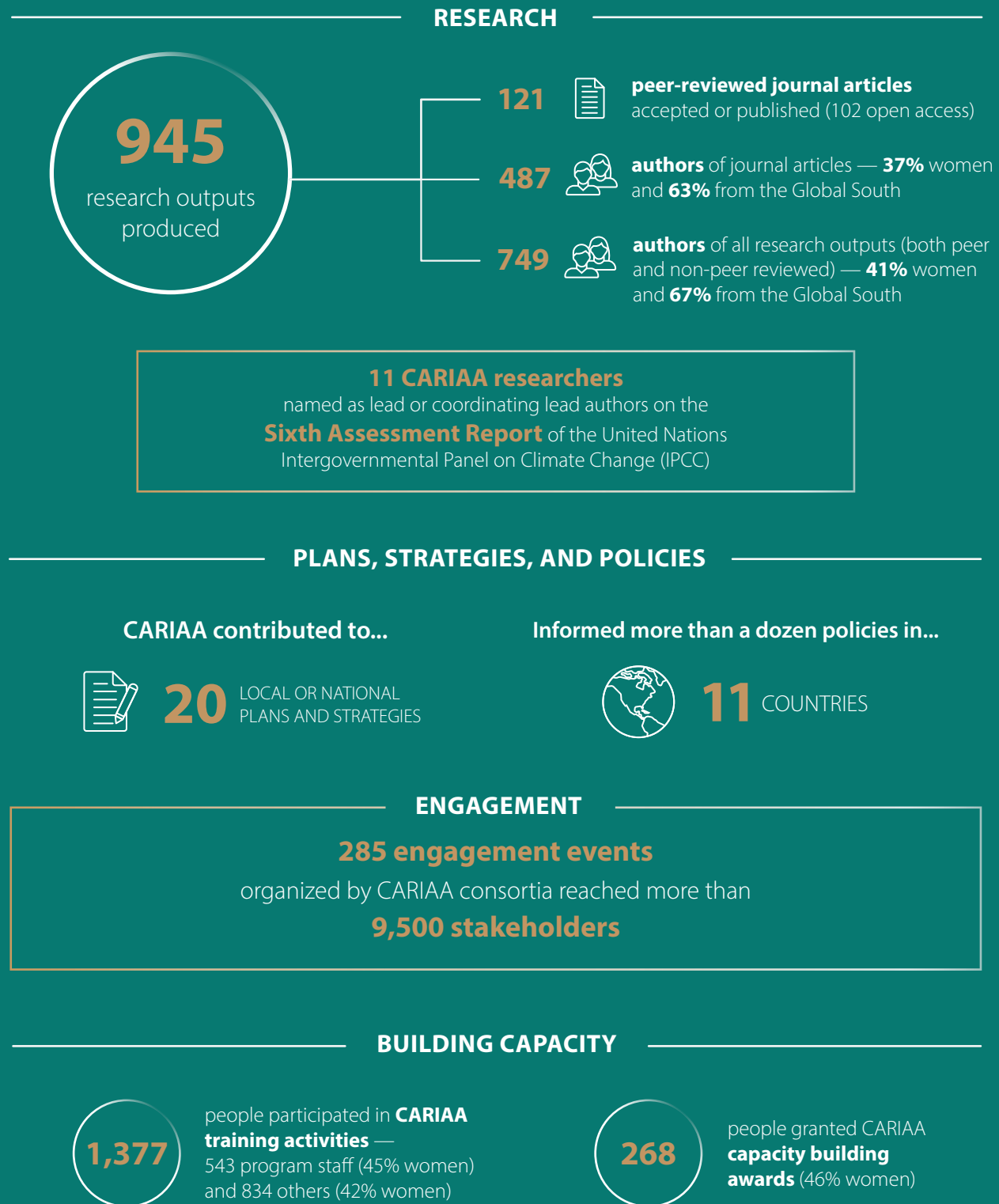
In addition to generating new and sound evidence, CARIAA also pursued strategies to improve research uptake through new and strengthened relationships with key stakeholders and networks. Each consortium pursued strategies that explicitly targeted research uptake, and through a working group, a community of practice was developed that actively shared lessons about effective approaches to uptake. These strategies included connecting with policymakers early in the research process to raise awareness of the

urgency of adaptation; providing technical advice to different stakeholders, including governmental and non-governmental; facilitating community input; and in some cases, working with “champions” who could spearhead the use of evidence in plans and policies.

As of July 2019, there were more than 30 documented examples of contributions to policy and planning activities at local, national, and international scales. These include technical inputs to national adaptation plans and novel scientific contributions to international reports. Lessons from CARIAA's experience in research for impact were captured in a [working paper](#) (Prakash et al., 2019).

CARIAA also made a significant contribution to scientific literature by generating new evidence on the impacts of climate change and adaptation options in the three hotspot regions. This includes the publication of articles by CARIAA authors in several highly regarded journals, including *Nature*, *Nature Climate Change*, *Global Environmental Change*, *The Cryosphere*, *Science of the Total Environment*, and *Current Opinion in Environmental Sustainability*.

Figure 3: CARIAA by the numbers: measuring impact on knowledge, capacity, policy and planning¹



¹ As of July 2019



Participants from all consortia gathered at CARIAA's third annual learning review in Nepal.

© Jitendra Raj Bajracharya/ICIMOD

What CARIAA has learned

CARIAA made significant contributions in five key areas to enhance the resilience of people living in climate hotspots:

- ❶ **Identifying the hotspot effects of 1.5°C global warming**
- ❷ **Strengthening adaptation**
- ❸ **Addressing gender and social inequality through inclusive adaptation**
- ❹ **Understanding migration in the context of adaptation**
- ❺ **Strengthening resilience through private sector adaptation**

The following sections of this report draw on evidence produced by CARIAA research teams. The instances of influence on policy and practice cited in this report are largely drawn from the final reports of consortia partners and an external summative evaluation of CARIAA (undertaken in 2018).

The report's conclusion outlines implications for the climate change research community at large, in addition to CARIAA's key outcomes and learnings. A full list of references is provided at the end of this report.

1. IDENTIFYING THE HOTSPOT EFFECTS OF 1.5°C GLOBAL WARMING

Human-induced global warming has already increased the global temperature by roughly 1.1°C above pre-industrial levels.² Unless urgent action is taken to cut emissions, the United Nations' Intergovernmental Panel on Climate Change (IPCC) projects that average global temperatures will continue to increase by 0.1°C–0.3°C per decade.³

Parties to the 2015 Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC) recognized the catastrophic effects of unchecked global warming, and they committed to limiting the increase in global average temperatures to “well below 2°C” and “pursuing further efforts to limit the temperature increase to 1.5°C.”⁴

In 2015, there was little information about how these temperature increments would affect specific regions and the difference that half of one degree could make. To help countries plan for a world rapidly moving towards 1.5°C warming, the IPCC published its *Special Report: Global Warming of 1.5°C* in 2018. Building on the latest scientific literature on the implications of, and contrasts between, 1.5°C and 2°C of warming, the report provided the clearest picture to date of what can be expected in the 21st Century. These projections continue to evolve at a rapid pace.

In the lead-up to the IPCC report, the CARIAA community organized a special working group to ensure their research could make important contributions (Kituyi, 2017). The resulting research produced new insights about the potential effects on the three hotspots under study. It suggests that these hotspots are warming faster than the global average, with climate models predicting that the 1.5°C limit will likely be reached in the hotspots within a decade. The research also highlights the serious impacts that seemingly small differences in global warming could make in these vulnerable settings. With 1.5°C and 2°C increases expected soon, there is an urgent need for local adaptation strategies.

CARIAA researchers downscaled the projected global impacts to the regional level. This localized climate

IN SUMMARY

CARIAA enhanced scientific understandings of the likely impacts of global warming of 1.5°C and greater

- All hotspots studied are warming faster than the global average
- Semi-arid lands will experience high variations in precipitation
- At 1.5°C of global warming, 29–43% of the ice mass in the high mountains of Asia will be lost
- In the deltas studied, a rise of 1.5°C–3°C will increase flooding by a factor of 2.5

research made it possible, for the first time, to grasp how global warming would likely affect glacier-fed river basins, coastal deltas, and semi-arid regions in Africa and South Asia. It has been referenced in global assessment reports and put into practice in national science frameworks, local and national development plans, groundwater management, crop planning, and in university curricula in several African and South Asian countries. Research users, who ranged from affected communities to local and national decision-makers, benefitted not only from CARIAA's new insights on the implications of global warming, but also from their involvement in participatory research processes to investigate local impacts and adaptation options.

While it may be impossible to avert a temperature rise of 2°C in these hotspots, investing in global action to adapt while slowing the pace of warming may buy local communities time to increase their resilience. CARIAA findings in each area are helping

² World Meteorological Organization, 2019. The Global Climate in 2015–2019: https://library.wmo.int/doc_num.php?explnum_id=9936

³ IPCC, 2018. Chapter 1, Executive Summary: <https://www.ipcc.ch/sr15/>

⁴ The Paris Agreement, Article 2, 1a: https://unfccc.int/sites/default/files/english_paris_agreement.pdf



Semi-arid regions such as in Kenya will face increased water scarcity and stress in a warmer world.

© Jervis Sundays/Kenya Red Cross Society

policymakers begin the vital process of planning for these changes so that affected communities can be prepared to withstand the impacts of climate change.

In semi-arid regions

People living in semi-arid regions who rely on climate-sensitive livelihood activities (such as rain-fed farming and pastoralism) are especially vulnerable to the impacts of global warming. For most countries studied by CARIAA partners, impacts have a high degree of variability and will include longer heatwaves, hotter days, significant changes in rainfall, and more intense storms and rainfall events. Water scarcity and water stress will increase with each increment of warming, threatening community livelihoods, health, and wellbeing.

Research results show there is considerable climate variability across semi-arid regions. CARIAA research sought to inform national and local decision-making, policies, and planning by examining and contrasting the effects of temperature increases in India and [Botswana](#), [Ethiopia](#), [Ghana](#), [Kenya](#), [Mali](#), and [Namibia](#) (ASSAR, 2019b). The research focused on identifying the likely changes in temperature, rainfall, and climate extremes that each country would experience at various intervals of global temperature increase. It also explored how these changes would affect agriculture, water, health, and fisheries.

In Botswana, for example, CARIAA research suggests that 1.5°C of global warming will translate into a 2.2°C increase in mean local temperature. This will translate to more heatwave days (in excess of 44 days), and a 5% mean annual decrease in rainfall, which is already scarce. If global warming increases by 2°C, local temperatures will rise by 2.8°C, the number of heatwave days will exceed 73 days, and precipitation will fall by 9%.

Many semi-arid regions depend on water sources in wetter adjacent areas. With warming of 1.5°C and above, inland deltas, rivers, dams, and groundwater will be adversely affected, and declining groundwater stocks will pose significant challenges to semi-arid communities. In the Klela basin in Mali, for example, groundwater recharge will drop by 38% at 1.5°C of warming. By 3°C of warming, it will reach zero net recharge, which would deprive local communities of a key water source.

CARIAA projections suggest that some of the semi-arid regions studied in Kenya, Ethiopia, and Ghana will actually experience an increase in precipitation. The warming and associated changes in rainfall will have profound impacts on livelihoods, with agricultural and livestock productivity expected to decline.

Additional CARIAA research focused on the economic impacts of climate change and building household resilience in semi-arid regions of Africa and Central Asia. The countries under study included Burkina Faso, Kenya, Kyrgyzstan, Pakistan, Senegal, Tajikistan, and



The Hindu-Kush Himalayan region will warm faster than the global average.

© Jitendra Bajracharya/ICIMOD

Tanzania. This research found that at least 44 African countries will warm by more than the global mean increase of 1.5°C, with 11 warming by more than 25% over the global mean change. Even at 1.5°C global warming, the research projects that 14.3 million livestock holder families in East Africa will experience falling productivity related to heat sensitivity.

The health and wellbeing of people living in semi-arid communities will also be adversely affected by warming. Added heat stress will exacerbate health risks and the distribution of malaria will likely shift. With 3°C of global warming, each of the regions studied will experience year-round risks of heat exhaustion.

In glacier-fed river basins

The glacier- and snow-capped mountains of the Hindu-Kush Himalayan region serve as a vital store of water for downstream communities, with supply modulated by winter freezing and spring thaws. In grappling with the regional impacts of global warming, scientists and decision-makers have had to contend with gaps in evidence because of the difficulty of modeling and formulating scenarios in mountainous regions.

CARIAA research focused on the glacier-fed Indus, Ganges, and Brahmaputra river basins that are home to more than 900 million people. To shed light on how the expected warming would interact with water supply and demand, researchers downscaled

relevant climate models to make them suitable to project impacts in these basins. Next they used state-of-the-art hydrological models to project future changes in snow and ice reserves, water availability, and changes in river flows. Research results showed that at 1.5°C global warming, this hotspot can expect average regional warming of 2.1°C, while 2°C in global warming will produce an increase of 2.7°C. At higher altitudes, the gap between global and hotspot temperatures is even greater.

With just 1.5°C of global warming, an estimated 29–43% of the ice mass in Asia's highest mountains will be lost (Kraaijenbrink et al., 2017). These changes will lead to seasonal shifts in water availability, with grave consequences for families and communities that are dependent on glacier- and snow-melt for their livelihoods. In the Indus basin, water availability stands to be severely threatened if current trends continue. Up to 60% of irrigation withdrawals outside of the monsoon season are dependent on snow- and glacier-melt, and the waters contribute an additional 11% to total crop production (Biemans et al., 2019). Global warming of 1.5°C will also lead to increased precipitation extremes and floods, heat stress, and droughts in the region. These phenomena will be further exacerbated by 2°C warming, affecting human health, agricultural production, and the generation of hydro power.

CARIAA's analysis of the likely climate change scenarios specific to these river basins suggests that by the end of



Low-lying deltas will be exposed to significant flooding without mitigation and adaptation measures.

© Rafiqur Rahman Raqu, DFID

“All projections point to more extreme climate events, with increasing droughts, floods, and other climate hazards that put pressure on food security and human health.”

the 21st Century, regional temperature increases will average between 3.5°C and 6°C. Overall conditions will be wetter, with more extreme precipitation events. Depending on warming scenarios and the impact on water flows, 36–65% of the glacier mass will disappear (HI-AWARE, 2018b). All projections point to more extreme climate events, with increasing droughts, floods, and other climate hazards that put pressure on food security and human health.

In low-lying delta regions

The dynamic nature of coastal deltas means the impacts of global warming will be less acute than in other hotspots in the short to medium term, but CARIAA research found that under a high emissions scenario, nearly all delta regions will be exposed to significant flooding by 2200 unless mitigation and adaptation measures are taken.

CARIAA research focused on three deltas: the Mahanadi delta in India's Odisha state; Ghana's Volta delta; and the transboundary Ganges-Brahmaputra-Meghna — the world's largest and one of the most heavily populated deltas — which was studied as two separate sites in Bangladesh and India. Research found that until 2040, the effects of 1.5°C and 2°C global warming on sea level rise and increased river flows will be hard to detect, mainly because of year-to-year variability.

Researchers modeled the effects of sea level rise across much of coastal Bangladesh to determine the likely depth and area of flooding and the effects of global mean temperature rises of 1.5°C, 2°C, and 3°C on the population. Parts of Bangladesh are protected against tidal flooding and salt intrusion by a series of polders (low-lying areas walled by dykes or other embankments). Model results show that the average depth of flooding in protected areas would double when temperatures increase by 3°C, compared with a 1.5°C rise. In unprotected areas, the depth of flooding is projected to increase by approximately 50%. On average, the area of expected flooding would increase 2.5 times, from 5% to 13% of the region in the same temperature frame (Brown et al., 2018a).

The team also mapped and analyzed the rise in hazards and risks associated with [increased salinization in coastal Bangladesh](#), identifying 17 hotspots where the risk of salinity will increase in the future (DECCMA, 2018b). The country's central and northeast regions

will be most vulnerable to these changes because there are fewer flood-controlling polders compared to the country's western region. The urban areas of Khulna and Barisal are projected to be flooded, which will affect large numbers of people.

Economic modeling by CARIAA partners shows that by 2050, impacts will be felt in agriculture, fisheries, and infrastructure across all four study sites. In the Mahanadi delta, infrastructure losses will account for an 11% loss in GDP per capita, while in the Ganges-Brahmaputra-Meghna, the most significant losses will be in agriculture, with a fall in GDP per capita of 8-11%. In the Volta delta, losses in agriculture will range from 4-7% (DECCMA, 2018a).

Filling knowledge gaps on the impacts of global warming

CARIAA research filled crucial knowledge gaps in the scientific literature by highlighting the likely impacts of global warming on the environment and on human activities in little-understood hotspots. Peer-reviewed evidence from CARIAA was included in major global reports that guide advocates, planners, and policymakers working on mitigation and adaptation. In several countries, this new knowledge was packaged in accessible ways to inform national decision-makers.

- CARIAA's research on the likely impacts of warming on low-lying coastal regions informed IPCC's 2018 **Special Report: Global Warming of 1.5°C**. This new knowledge, under-represented in previous IPCC reports, provides greater precision and a base for decision-makers to develop policies and plans. In addition to citations of CARIAA research outputs in the report, several CARIAA-affiliated researchers from all four consortia were either lead, contributing, or coordinating lead authors for the report itself.
- The 2019 IPCC **Special Report on Climate Change and Land** reflects CARIAA input on land degradation and risk management. Three consortia members served as lead, contributing, or coordinating lead authors.
- CARIAA research cited in the 2019 IPCC **Special Report on the Ocean and Cryosphere in a Changing Climate** highlights the role of water reservoirs in high mountains in alleviating seasonal water scarcity. The report also cites CARIAA research on sea level rise and flood risks in low-lying coastal areas.
- A new **Delta Portal** was created to communicate and share spatial data and other delta-related research. It offers access to a wide range of data sets including household surveys, climate scenarios, modelled hydrology, and rankings of hazards in the deltas under study. The portal was based on GeoNetwork, part of a broader data-sharing network designed to maintain an up-to-date online repository of the latest delta research outputs.
- **Infographic briefs** have made CARIAA findings on the implications of 1.5°C global warming accessible and relevant to local and national decision-makers. Each brief was tailored to the specific contexts of **Botswana, Ethiopia, Ghana, Kenya, Mali, and Namibia**. The findings informed Namibia in its negotiations at the 2018 Katowice Climate Change Conference (COP 24).
- Research helped embed the terminology and the idea of "research-into-use" (research uptake) within two science and technology frameworks — the **National Science Technology and Innovation Policy** in **Ghana**, and the **New Directions initiative** of the Earth System Governance program.

2. STRENGTHENING ADAPTATION

The vulnerable populations living in hotspots and the rapid pace of warming underscores the urgency to adapt. A global goal on adaptation was established in Article 7 of the Paris Agreement, yet there is surprisingly little consensus on what effective adaptation looks like, whom it should benefit, or how it should be approached and measured (Tompkins et al., 2018).

CARIAA contributed new thinking on these fundamental questions. This thinking was grounded in the diversity of the research teams, including their approaches to vulnerability assessments; adaptation testing in communities; work with governments, businesses, and other stakeholders to inform adaptation plans and priorities; and their critical reflections on the challenges in this field.

The program's contributions to the field of adaptation are evident in a wealth of peer-reviewed literature, much of it translated into more accessible formats for greater reach. The research results are also prevalent in new strategies and action plans that are evolving at national and local levels to increase community resilience to heat stress, flooding, and other effects of climate change, and in climate-smart practices and technologies piloted on the ground.

Understanding what makes adaptation effective

With many conflicting interpretations and approaches, the challenge of advancing adaptation prompted critical reflection across CARIAA consortia. Their insights underscore that adaptation is far more than a technological challenge. Fundamentally, it is a social process that must be rooted in specific contexts and informed by the needs and aspirations of those who are most affected.

In Africa and South Asia, the burden of a changing climate falls most heavily on populations that are already disadvantaged by poverty and powerlessness. This indicates that adaptation is inseparable from questions of equity and justice, such as who will benefit, and when; who will pay for adaptive measures; and who will have a voice in shaping adaptation strategies. CARIAA's reflections on effective adaptation stress the need to include many voices, and that plans and policies reflect the

IN SUMMARY

CARIAA research suggests that effective adaptation must:

- Focus on the vulnerabilities, abilities, and aspirations of affected people;
- Address the multiple intersecting barriers that are specific to each place; and
- Demand top-down and bottom-up approaches.

unique context of each community, including local vulnerabilities, capacities, barriers, and enabling factors.

Given that adaptation is inherently local and that it is never truly complete under changing climatic conditions, there may be no satisfactory universal measure of adaptation effectiveness. CARIAA reflections on whether [adaptation success is a flawed concept](#) suggest that people must be empowered to define measures of success that are most meaningful to them (Dilling et al., 2019). Societies, meanwhile, must develop their capability to adapt over the long-term, such as investing in health, education, and access to technology.

Research in coastal deltas also explored the societal response to changes that are underway, how [people and policies are implicated](#), and the challenges for future adaptation (Tompkins et al., 2020). The varying capacities and incentives of different groups of people to adapt, and the fact that many are excluded from official strategies,

“Adaptation is a social process that must be rooted in specific contexts and informed by the needs and aspirations of those who are most affected.”



Participatory approaches to adaptation are key to success, including in agriculture.

© Prathigna Poonacha/IIHS

highlights the need for greater inclusion in shaping current policy directions. It also points to the challenges governments face in determining whose voices count, and what trade-offs are acceptable.

Work on adaptation in semi-arid regions of Africa and India drew lessons on [how multiple barriers and enablers intersect](#) to impede or enhance adaptation (Few et al., 2018). Water availability, for example, can be increased by infrastructure investments, but restricted by weak governance rules. Case studies highlight the value of mapping and addressing these potential interactions when designing adaptation interventions. Related research analyzed the specific intersecting [barriers to adaptation in Namibia](#), such as a lack of coordination and planning between the national and local levels, the limited capacity of communities to adapt, and their high dependence on natural resources (Davies et al., 2018).

Researchers emphasize that [adaptation is about people](#). Participatory approaches to adaptation are based on input from local inhabitants, as opposed to techno-centric approaches to adaptation that are often imposed from the outside (Scodanibbio & Morchain, 2019). In addition to understanding local vulnerabilities, abilities, and barriers or enablers such as power structures, access to capital, laws, and social norms, researchers argue that it is crucial to be aware of people's aspirations.

ADAPTATION IS ABOUT PEOPLE



An analysis of four CARIIA case studies that explored risk, vulnerability, and adaptation highlights the benefits of matching top-down and [bottom-up assessments of climate risks and impacts](#) in climate-sensitive regions (Conway et al., 2019). The analysis acknowledges that pairing these approaches is complex, but they conclude that people-centred, bottom-up processes provide critical and practical information to inform adaptation.

“Too often, [adaptation options] are implemented top-down, ignoring how relevant or culturally acceptable they may be for the intended users.”

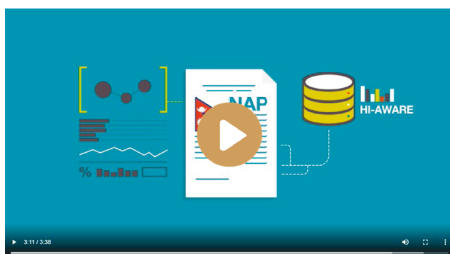
— Lucia Scodanibbio and Daniel Morchain,
from *Adaptation is about people*

Informing adaptation plans and policies

New evidence generated by CARIAA helped to inform a range of adaptation plans and policies across regions through both top-down and bottom-up methods. Evaluators noted that by the end of 2017, more than 20 local or national plans and strategies and over a dozen policies in 11 countries were using CARIAA research — an influence characterized as “remarkable” (Le Groupe-conseil Baastel Itée., 2018).

- In **Nepal**, researchers provided technical assistance to help prepare **national adaptation plans**. They tailored climate data for Nepal’s climate trend scenarios and helped conduct vulnerability and risk assessments in the water, energy, forest, and biodiversity sectors. They also supported the analysis of gender and social inclusion, and livelihoods and governance.

STRENGTHENING ADAPTATION PLANNING IN NEPAL



- CARIAA research expertise was also sought by the government of **Gilgit-Baltistan**, a region of Kashmir administered by Pakistan. They used CARIAA-supported hydrological modeling in their adaptation planning.
- In **India**, research informed the implementation framework of the **Maharashtra Groundwater Act**, which demands that clusters of villages work together to develop crop plans and manage shared water resources. CARIAA partners mobilized communities to manage groundwater using techniques such as transformative scenario planning, which helped villagers understand the fragile state and shared nature of their aquifers and identify solutions such as water- and nutrient-preserving micro-irrigation. Partners also contributed to a **National Science Plan for India**.

- Detailed inventories of existing adaptation measures across **Bangladesh** helped to inform the country’s **National Adaptation Plan**. CARIAA researchers compiled a national inventory, complete with details on adaptations across 19 coastal districts, to map and categorize these measures. Through engagement with the national planning commission, this research informed Bangladesh’s recently approved **Delta Plan 2100**, which brings gender and economic dimensions to a delta management process that will support climate change adaptation.
- CARIAA researchers contributed to drafting the **Windhoek Declaration for Enhancing Resilience to Drought in Africa** to address the increasing frequency and duration of droughts, a major concern across **Africa**.
- CARIAA assisted the Government of **Botswana** as they prepared a **National Drought Management Strategy**. CARIAA partners prepared a [background paper](#) (Davies et al., 2017) that details regional impacts of global warming, identifies economic impacts, and outlines a series of people-centred principles to guide the country’s drought management efforts.
- Researchers also contributed to **Namibia’s National Climate Change Strategy and Action Plan**. They provided guidance to its National Climate Change Committee about enablers and barriers to adaptation to help them prepare Green Climate Fund proposals.
- CARIAA research partners in **Senegal** influenced both national and local development plans by deepening their use of climate data and participatory methodologies to ensure more inclusive planning processes. Researchers were invited to help integrate climate change resilience into efforts to align the country’s new national development model, **Plan Sénégal Émergent**, with **local development plans**. The plan lays out an implementation framework for Senegal’s Vision 2035, which guides medium- and long-term sustainable development planning. Researchers teamed with the Government of Senegal to create a multi-stakeholder taskforce that drew strong participation from mayors and other local leaders. As a result, several municipalities have been developing local development plans that integrate climate change, gender, migration, and nutrition as cross-cutting dimensions.



The EcoSan toilet piloted through CARIIA proved successful by remaining accessible during a flood that inundated Kairi village in Pashchim Champaram, India.

© Aparna Unn

Testing adaptation practices and technologies

While all CARIIA consortia informed adaptation plans and policies, research in Himalayan glacier and rain-fed river basins also actively tested options to enhance household resilience. Pilot interventions were informed by climate projections that were downscaled to focus on specific geographic areas. These interventions revealed with new precision the rapid changes these communities are facing and their potential impacts on health and livelihoods. While [these pilots were small in scale](#), they revealed some solutions with the potential for further exploration and scaling up, including climate-smart agriculture practices, innovations to make housing and sanitation more flood-proof, and roofing designs to manage heat stress as temperatures rise (HI-AWARE, 2018c).

In India, 77% of the North Bihar region is vulnerable to flooding. Villagers living on the banks of the Pandai River in West Champaran have lived without toilets for generations, but increased flooding poses major health risks from contaminated waters (Dasgupta et al., 2019). One of the CARIIA pilot interventions, the EcoSan toilet — which sits on a high platform so that it can be used during floods — was tested in this area and withstood extreme flooding in 2017. To increase their appeal to small farmers, the EcoSan's double chamber design converts solid waste to “humanure” that can be used to fertilize fields, thereby reducing demand for

unaffordable commercial fertilizers. It also inhibits the spread of disease, produces fewer greenhouse gases, and uses less water than flush toilets. Adaptation cost curves also showed the potential for major savings in cost and convenience by ensuring access to toilets (Dasgupta et al., 2019). The EcoSan toilet has now been recognized by the state government's JEEVIKA Programme (a World Bank-assisted rural livelihoods project) and UNICEF's Bihar office is promoting it as safe sanitation technology for flood-prone regions.

On the outskirts of Delhi, another housing innovation was tested to reduce household exposure to heat stress. Many houses in the district use heat-absorbing corrugated cement or metal, which can make the inside of homes considerably hotter than the outdoor air temperature. Modified roofs were installed in five households as part of a pilot project. While residents reported greater comfort, their perceptions did not match field measures, suggesting that further testing is needed.

“The most striking result we had was in the differences between rich and poor neighbourhoods. The poor neighbourhoods were about three to four degrees warmer.”

— Researcher Tanya Singh,
on heat stress findings in Delhi



Solar power is becoming an important tool for rural adaptation solutions.

© Abbie Trayle-Smith/Panos Pictures/DFID

In Bangladesh, which lies downstream of the Ganges, Brahmaputra, and Meghna rivers, there is an urgent need for housing solutions that are resistant to flooding and other climate impacts. In the lower Teesta basin in the country's northwest, CARIAA partners piloted climate- and flood-resilient housing that was raised on pedestals and accounted for socio-cultural preferences, water sanitation, and grain storage during flooding. Research demonstrated that these low-cost houses can build community resilience against floods, soil erosion, heat, and cold, and provide more secure and dignified living conditions for poor and vulnerable groups living on floodplains and sand bars. Communities and local leaders, including members of parliament, responded positively to the innovation, and local and national officials are exploring the role they might play in housing schemes for the poor.

Lastly, farming communities in semi-arid regions of Pakistan face major hurdles because of their lack of irrigation planning, heavy dependence on rainfall or

groundwater, and difficulty accessing markets. In the Soan river basin, the climate challenge for farmers is compounded by mono-cropping, which tends to be practiced instead of crop rotation. Working with farmers in Chakri village in Rawalpindi district, CARIAA researchers field-tested a package of climate-smart agriculture practices to increase their resilience. These included using fixed and portable solar water pumps together with integrated water resource management practices such as greenhouse-like tunnel farming and high-efficiency irrigation systems. Diversifying crop choices led to improved crop productivity and better use of scarce water. The package of climate-smart agriculture practices is being scaled by the government to reach 30,000 farmers (CARIAA, 2018b). This success has spurred requests for input on climate-smart agriculture from Punjab province and the International Fund for Agricultural Development. Pilot results are helping to reinforce climate-smart agriculture in Pakistan's National Climate Change Policy.

3. ADDRESSING GENDER AND SOCIAL INEQUALITY THROUGH INCLUSIVE ADAPTATION

The burden of climate change is felt differently by various groups, in part because their vulnerability depends on the resources and abilities they have to adapt and their agency over crucial decisions. CARIAA research shed new light on how the experiences of men and women may differ and intersect with other factors that either heighten or diminish their resilience. New findings challenge the notion that all women are inherently vulnerable. An intersectional approach, which considers how gender and other factors such as age, caste, and ethnicity intersect to augment or diminish vulnerability, can illuminate nuances in responses to climate change.

Research demonstrates that while some responses to climate change could actually increase the burden on some women, adaptation also has the potential to

IN SUMMARY

Gender and social inequality research reveals:

- Environmental stress and some responses, such as migration, increase the burden on women.
- Adaptation can drive social transformation, offering new roles and opportunities to men and women.
- Investments in household resilience can help unlock the adaptive capacity of women entrepreneurs.

Figure 4: Challenging assumptions about gender and climate adaptation
(ASSAR 2018a)



transform social relations and propel new roles and opportunities for both men and women.

CARIAA research teams have engaged with communities and decision-makers to share their findings on the gender dimensions of adaptation. These efforts were made to ensure that the different needs and experiences of men and women are reflected in national and local-level adaptation plans and actions. CARIAA's insights on the intersectional nature of vulnerability have challenged stereotypes about gender and climate change and they have been widely shared through leading journals, international media, and in key fora such as the UN Commission on the Status of Women.

A growing burden on women across hotspots

From the arid lands of Kenya and Ethiopia to the river basins of the Himalayan mountains and the deltas of Bangladesh, India, and Ghana, families are increasingly at the mercy of floods, droughts, landslides, or extreme weather and unpredictable weather patterns. In response, there has been a significant increase in the number of men who are forced to migrate to make a living to sustain their families. Their wages may be vital to family survival, but their absence increases the daily burden on women, who provide most of the care for children, the elderly, farms, and livestock.

Drawing on data from 25 case studies across the three hotspots in Africa and Asia, CARIAA's analysis found that climate- or weather-related environmental stress reduces women's capacity to act independently or make their own choices, even when household structures, laws, and social norms are supportive (Rao et al., 2019). Extreme weather and unpredictable seasons are disproportionately hindering women's search for decent work, even as gender roles are shifting and presenting more opportunities for women after decades of reform and activism.

Gender roles and norms continue to trap impoverished women in a vicious cycle of low productivity, indebtedness, and food insecurity as crops and livestock fail. While the specifics of gender relations vary in each location, as environmental stresses accumulate, community support networks tend to break down. Across the locations studied, most women reported reduced leisure time, with negative consequences on their own wellbeing and on household health and nutrition (Rao et al., 2019). To help vulnerable communities adapt,



Women experience the burdens of climate change differently from men.

© Jitendra Bajracharya/ICIMOD

decision-makers need to look to predictable means of support such as public food distribution, social grants, and other social safety nets, along with fair wages and just working conditions, instead of stop-gap solutions such as shelters or drought relief. Addressing the barriers to women's agency also requires transforming the gender relations that give rise to inequality.

"It's not just women or men as a category, but which women and men are we talking about? We can look at class, or wealth. We can look at ethnicity and caste. We can look in Africa particularly at age or generation, which become a very important marker of women's status, but also of women's rights to exercise decision-making."

— Nitya Rao, professor of gender and development at University of East Anglia, on the [climate impacts of women's agency](#)

Moving beyond seeing women as victims

Research in semi-arid lands explored how and why vulnerability varied between and within communities and households and what these differences mean for coping and adaptation. Using mixed methods, including surveys, focus group discussions, and life history interviews, CARIAA researchers explored how the agency of individuals and households was affected not only by characteristics such as age, ethnicity, class, and marital status, but by overlapping systems and structures.

An examination of [gendered vulnerabilities](#) challenges the notion that women are powerless victims of climate change (Rao et al., 2017). While they may be disadvantaged relative to their male peers and doubly burdened by paid and unpaid work, women are exercising their agency by focusing on short-term survival and coping in response to environmental stress.

In looking at [gender as a factor that influences responses to climate change](#), CARIAA researchers found that it is not enough to simply compare the experiences of men and women (ASSAR, 2018c). Gender is important, but it intersects with many other variables such as age, caste, marital status, and ethnicity. For example, research on female entrepreneurs in Narok, Kenya, revealed that while social networking

through both formal and informal networks are important for women's adaptation, those who are in the best position to maximize opportunities also benefit from broader factors such as education (Atela, Gannon, and Crick, 2018). Understanding women's and men's adaptation choices demands a more nuanced understanding of their status, assets, and the rules and norms under which they live.

It is also important to understand [household dynamics](#).

Evidence from six countries suggests that while increasing climate risks can drive conflict within households, new forms of cooperative behaviour are also emerging (Rao et al., 2020). Within agrarian families, men and women typically play different roles that can also be complementary in helping families increase their resilience, which could mean diversifying livelihoods, migration, adopting new farming practices, or accessing social supports. Research highlights diversification as an important household coping strategy. Gender norms shape the options available to men and women within households and communities. In the Upper West region of Ghana, for example, men often migrate during the dry season while women supplement their income by selling firewood or making shea butter or soap. A key lesson for policymakers is to facilitate cooperation within households and communities, rather than targeting men or women alone.

Overall, these findings suggest that interventions to increase resilience should consider how they will affect women and men, and whether they inadvertently create winners and losers. For example, an [examination of cash subsidies](#) to improve farming practices and promote a shift to cash crops in India's Tamil Nadu region revealed a number of unintended consequences such as groundwater depletion, increased competition over water, and

"By moving past focusing solely on women, ASSAR has brought to the forefront other important issues such as the vulnerability of young men in drylands. [K]nowledge sharing between sites and regions allowed us to develop a multi-perspective approach to understand the gendered realities of the impacts of climate change."

— Divya Solomon, PhD student, University of Michigan, Ann Arbor, School of Environment and Sustainability



Many micro businesses are led by women and face higher exposure to climate impacts, such as in rural Tanzania.

© Rajeshree Sisodia, ODI

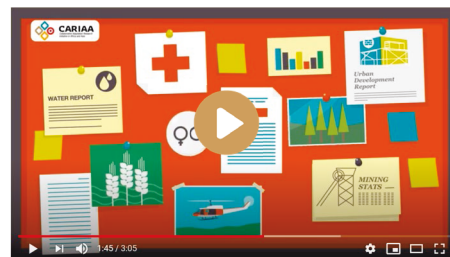
further marginalization of women. Failing borewells are undermining agricultural productivity and livelihoods, trapping entire communities in debt cycles that have increased the workloads of both men and women. While men's mobility allows them to find better-paying work, women then shoulder the bulk of paid and unpaid farm work.

Finding new opportunities as gender roles evolve

Across Africa and Asia, a high proportion of micro and small businesses are female-led and face high exposure to climate risk. Strong gender norms surrounding roles and access to resources confine women-led businesses to climate-exposed sectors, primarily in agriculture, and they also prevent women from building resilience within their businesses.

[Research in Kenya](#) illustrated that gender-based financial and legal barriers can force female entrepreneurs into unsustainable forms of coping, such as stock reduction during times of water scarcity, that can reduce profits and even lead to a loss of business (Atela, Gannon & Crick, 2018). However, CARIIA analysis of the influence of gender on adaptation responses and opportunities revealed that despite limited access to finance and few legal protections, women entrepreneurs can harness significant adaptive capacity. Supporting women's adaptation will be key to

ENHANCING GENDER ANALYSIS IN THE ODISHA STATE ACTION PLAN ON CLIMATE CHANGE



promoting resilience across semi-arid lands. In addition to addressing inequalities, research suggests that building resilience at the household level could support adaptive capacity among female-led businesses.

In a special issue of [Environmental Development](#), CARIIA researchers shed light on gendered vulnerabilities to climate change in the mountains and river basins of the Hindu-Kush Himalayas (Goodrich, Udas, & Prakash, 2019a). In these glacier-fed communities, backbreaking agricultural work has long been a struggle for families. Extreme climate variability is pushing more men further afield for waged work and women's roles are rapidly changing. As they take up jobs vacated by men

who migrate to find work, women are gaining new skills and responsibilities — in microenterprises and marketing, saving and credit groups, and in dealing with disasters — all of which increase their abilities to negotiate within realms they were not able to previously (Goodrich, Udas, & Prakash, 2019b).

However, here too, rigid gender norms and unbending institutions compound the burden on women and undermine community resilience. The institutions that govern their lives and businesses remain patriarchal and male-dominated. Few women have any voice in local decision-making bodies, a common situation across different study sites in Africa and Asia. In the Gandaki basin of Nepal, for example, a combination of the effects of climate change, outward migration, and the feminization of agriculture is changing irrigation needs, yet focus group discussions revealed that local water associations are controlled by men and exclude women's insights that would adapt the design of systems to be more responsive to their needs.

Research suggests that until institutional policies and practices are reformed to encourage women's participation and leadership, the opportunities offered by these changing roles will be wasted, undermining women's vital contributions to community resilience.

Putting gender at the heart of adaptation planning

The new insights from CARIAA research on gender and climate change have informed local and national plans and policies and have also reached decision-makers at international fora.

- In **India**, engagement with government officials resulted in gender dimensions of adaptation being addressed in national and state planning. Following a presentation that provided gender analysis on the first **Odisha State Action Plan on Climate Change**, CARIAA research partners were invited by forestry and environment officials to contribute to the development of a new draft plan. With CARIAA input, the 2018–2023 State Action Plan devotes an entire chapter to gender considerations. The team also provided input on draft versions of India's 2016 **National Policy on the Empowerment of Women**, highlighting the extent and impacts of out-migration across the Mahanadi Delta.
- In **Botswana**, a partnership between the University of Botswana and Oxfam, together with a sustained relationship with government officials,

achieved significant influence on district-level development planning across the country. After contributing to the **District Development Plan** for Botswana's Central District, the team was invited to scale up participatory vulnerability and risk assessment methodology nationwide. With co-funding from the government, economic planners and development officers in all 16 districts are now trained to work with communities to manage climate risks and to reach the most vulnerable, including girls. This approach, described by Botswana's Assistant Minister for Presidential Affairs Governance and Public Administration as "what the doctor ordered for community engagement", has been highlighted as a best practice in inclusive adaptation by the United Nations.

- CARIAA's gender focus also informed international negotiators within the **UNFCCC**. Based on research across hotspots, a series of infographics that [challenge assumptions about gender](#) (ASSAR, 2018a) and situate it as one of many [factors that influence how we respond to climate change](#) (ASSAR, 2018b) were shared at the Commission on the Status of Women at the UN headquarters in New York in 2018. The infographics prompted a request from the UNFCCC's Gender Focal Point for more details on CARIAA findings on gender and social difference.
- In **Canada**, CARIAA research on gendered vulnerabilities to climate change helped to inform the **Environment and Climate Action priority area** of the government's Feminist International Assistance Policy.

GHANA: EMPOWERING WOMEN AS LEADERS IN CLIMATE CHANGE ADAPTATION



4. UNDERSTANDING MIGRATION IN THE CONTEXT OF ADAPTATION

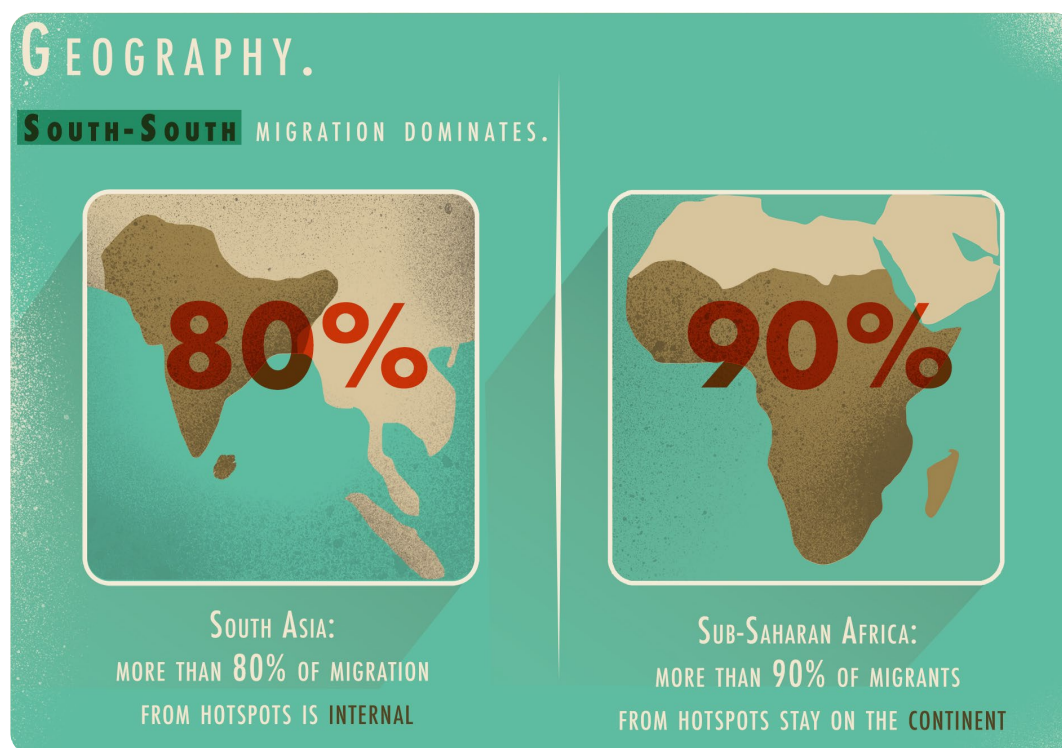
As droughts, floods, and other extremes intensify in climate hotspot regions, migration has largely been understood as a direct consequence, fuelling concerns of a widescale exodus of “climate refugees” from affected regions. But the vast majority of people on the move remain within national borders or regions. In South Asia, more than 80% of migration is internal (Safra de Campos et al., 2020), while more than 90% of migrants from African hotspots remain on the continent (CARIAA, 2018d). The World Bank estimates that without climate and development action, by 2050 more than 143 million people in vulnerable areas of sub-Saharan Africa, South Asia, and Latin America could be forced to move within their own countries to escape the slow-onset impacts of climate change (Kumari Rigaud et al., 2018).

IN SUMMARY

Migration in hotspots

- While most migrants seek better opportunities, environmental degradation is the underlying cause of migration because it undermines livelihoods.
- Migration does not always lead to a better life for those facing multiple exclusions.
- Migration can enhance resilience, but it must be supported by planning and investment that benefits migrants and communities at their destination.

Figure 5: Geography of migration in South Asia and sub-Saharan Africa
(CARIAA 2018e)





Interviews with migrant households were a key part of data collection in CARIIA, shown here in a Bangladeshi village.

© Mahmudol Hasan Rocky

Thanks in part to consultations that preceded the United Nations Global Compact on Migration in 2018, insight has shifted towards a broader conception of human mobility that recognizes that the links between climate change and migration should be seen in the context of sustainable development rather than national security.

Migration is increasingly regarded as a legitimate adaptation option with the potential to increase social resilience to climate change, but how does it improve life for migrants? New evidence generated by CARIIA partners sheds light on the many forms of mobility underway and the complex motives and reasoning that drives individuals and families to uproot. It contrasts the lives of migrants and non-migrants to assess if and how mobility increases their resilience. It also highlights the risks of unplanned and unsupported migration and how it could simply compound the inequalities and exclusions already facing people who are vulnerable to climate change.

Why do vulnerable people migrate?

CARIIA findings add to a growing body of research that suggests climate change is an indirect motive for most migrants, and few identify themselves as environmental migrants. Across hotspots, people on the move are largely seeking better livelihoods and opportunities. CARIIA's research digs deeper to reveal that environmental degradation or

extreme weather has played a significant role in diminishing livelihood prospects in the first place, particularly in semi-arid regions.

Within deltas, mobility, primarily rural to urban, has long been a response to the dynamic nature of the natural environment. Migration patterns are also [strongly gendered](#). Most migrants are men seeking employment, while women tend to move for family reasons, such as to join a spouse or to marry (DECCMA, 2018d). The geography of mobility is also shaped by the gendered nature of labour markets. In the Indian Bengal delta, for example, where both men and women migrate for work, women move to the city centre to work as domestic helpers while men tend to move to the outskirts for opportunities in construction.

In research that examines [where people live and move in deltas](#) in India, Ghana, and Bangladesh, more than 30% of surveyed households reported at least one migrant, but only 2.8% of respondents attributed their move to environmental stress (Safra de Campos et al., 2020). However, these same households reported significant exposure to environmental risks and perceived that economic insecurity was associated with environmental hazards (Conway et al., 2019). One-third of all respondents had observed an increased exposure to hazards over the previous five years, including cyclones, drought, erosion, flooding, salinity, and storm surges. Similarly, across the study sites, between 40 and 80% of respondents associated environmental factors with less secure livelihoods, suggesting an



Adequate planning is needed to support successful migration.

© Asian Development Bank

“Contrary to the ‘climate migrant’ discourse, climate and environment are proximate causes of migration —altering the ability to earn a living and creating additional economic reasons to move.”

— Robert Nicholls, DECCMA Principal Investigator in [What have we learned about climate change, migration and adaptation in deltas?](#)

underlying link between environmental degradation, insecurity, and the migration of household members.

In two rural districts of India’s semi-arid Karnataka state, where mobility has long been a way of diversifying agrarian livelihoods, [research exploring migration as an adaptation strategy](#) found changing migration patterns (Singh & Basu, 2019). People in drought-prone Gulbarga district have been moving seasonally since at least the 1970s, but since 2010 a greater number of people working in agriculture have been permanently leaving rural jobs to look for work as labourers, drivers, carpenters, painters, and cooks in urban areas. Of the households interviewed, 55% identified higher-paying livelihoods as a key driver of migration. This research found that a combination of factors shape the decision to move, including livelihoods, assets, distance and connectivity, social networks, job availability, educational prospects, and personal reasons

such as marriage. While environmental factors were not cited as a main motive, erratic rainfall and higher temperatures since the 2000s have made agriculture an increasingly precarious livelihood. Water availability and landholding size were also critical drivers of migration. Increasingly, young men are giving up on agriculture altogether, finding it too difficult and unrewarding.

Assessing migration as an adaptation option

The effects of migration, both positive and negative, are felt at both ends of the equation — in migrant-sending communities and in host communities. Several studies found that migration can increase household resilience to the effects of climate change on vulnerable livelihoods, but CARIAA research also revealed that migration does not always lead to a better life. Regardless of their location, the people most vulnerable to environmental stress are often at the mercy of structural inequalities such as class, caste, or other forms of social discrimination. Without state attention to the needs of migrants or efforts to address the root causes of inequality, these exclusions can minimize the benefits of migration. At the same time, explorations of rural-to-urban migration in South Asia show how the potential benefits are undermined by a lack of planning and the explosive growth of informal settlements in cities.

As rising temperatures and more variable rainfall threaten agricultural productivity, [research in three](#)



Many migrants from rural areas end up in poor quality urban settlements, such as this one in Dhaka.

© Ricardo Safrá de Campos

USING LIFE HISTORIES TO EXPLORE MOBILITY CHOICES

Mobility in the context of climate change involves a complex set of choices that are shaped by constantly changing variables for each family. CARIAA researchers tried to improve their understanding of these motivations, and whether migration can actually increase resilience, by learning more about the hopes, aspirations, and trade-offs faced by individuals within households. However, conventional research methods have limitations in reaching people at this personal level.

Anthropology and other fields use life history interviews, but these have rarely been applied to studying risks and responses to climate change. CARIAA researchers [documented the benefits of this innovative approach](#) (Singh, Tebbboth & Spear et al., 2019) and produced a [guide for conducting life history interviews](#) to support other researchers (Davies et al., n.d.).

Deeper insight into household dynamics is one of the benefits of life history interviews. The interviews capture interactions among household members and reveal the interplay of past, present, and future motives, aspirations, and values.

[semi-arid districts of Pakistan](#) shows that rural out-migration can enhance livelihood resilience (Qaisrani & Salik, 2018). Given agriculture's high sensitivity to climate variability and change, rural households are looking to a range of strategies to diversify their livelihoods — including temporary or permanent migration, mostly by young males.

Researchers exploring the vulnerability of agricultural livelihoods found that households with at least one migrant scored higher than non-migrant households on various measures of the ability to anticipate, absorb, and adapt to climate risks. Households with migrants enjoyed higher levels of income, fewer non-working dependents, more diverse sources of income, and higher employment rates. They had better access to financial resources, more diversified household assets, and generally enjoyed a higher standard of living. They also scored higher on measures of their capacity to anticipate and prepare for threats because they were better at acquiring new skills and they had stronger social networks and more access to information.

The study concludes that migration should be promoted as part of the solution to the challenges facing rural communities, but with the important caveat that adequate state planning is needed to support successful migration. In the face of current pressures in major Pakistani cities such as Karachi and Lahore, which are overwhelmed by new arrivals and mushrooming unplanned settlements, research recommends managed migration with resettlement



Environmental degradation, such as drought, can diminish livelihoods and act as an underlying cause for migration.

© Jennifer Leavy

that is focused on secondary cities that can absorb investment and generate livelihood opportunities.

Research on rural-urban migration and commuting in India's Karnataka state did not find a straightforward answer to whether migration can be regarded as adaptation (Singh & Basu, 2019). Overall, migrants reported faring better than before, but they rarely showed upward mobility. Even when their material conditions improved, most reported a diminished sense of wellbeing due to increased drudgery, the hardships of moving, and adverse health effects. Within households, mobility reduced vulnerability for some family members while deepening it for others. The outcomes for these families varied widely depending on who was migrating, to where, and into what circumstances.

In some cases, migration can be a form of maladaptation — for example, when cities are unable to provide for highly vulnerable migrants. This is demonstrated in research with Bangalore's interstate migrant waste pickers (Michael, Deshpande & Ziervogel, 2019). India's cities have seen a rapid expansion of informal squatter settlements. For those at the lowest rung of society — primarily landless agricultural labourers, and mostly Muslims in this Hindu-majority region — scavenging for waste in landfills on the margins of these settlements offers a precarious living. Without infrastructure or state services to support them, these migrants merely transfer their vulnerabilities from one setting to another. In addition to the major

health risks their jobs entail, they have no access to basic services or to the public food distribution system, and they are further marginalized by a lack of water, energy, and sanitation infrastructure.

Government assistance and oversight is vital in instances where environmental degradation is so extensive that entire communities need to be resettled, yet planned relocation has been a contentious issue. A study examining planned relocation decisions by government agencies in India's West Bengal focused on three coastal locations that have lost significant land to erosion (Montreaux et al., 2018). Local people recognize the need for public intervention, but the responses from state authorities have been mixed. Research found that both government action and inaction are explained by a combination of political risk aversion and a lack of government accountability. It highlights that while resettlement may pose risks, the consequences of inaction can also be dire, such as when vulnerable communities are left trapped with no options and few resources.

Informing global dialogue and plans to support migrants

In several countries, the evidence base built by CARIAA researchers has helped shape adaptation and development plans so that they better recognize and support migration as a viable adaptation option.

CARIAA research also informed several global reports and emerging international action on migration. As the United Nations [Global Compact for Migration](#) was being negotiated in 2017 and 2018, CARIAA produced cross-program [syntheses](#) (CARIAA, 2018e) to convey lessons that challenged the dominant discourse on migration — which largely reflects the fears of mass migration held by developed countries. CARIAA insights underscored the need for greater assistance to countries in the Global South that are already grappling with high levels of internal migration.

CARIAA results also fed into globally-influential reports, including the [World Bank Groundswell report](#) on climate change and migration, the United Nations Conference on Trade and Development report on [African Migration for Structural Transformation](#), and the International Organization for Migration's [Atlas of Environmental Migration](#).

CARIAA evidence helped to embed migration in national and/or local policies or plans in Bangladesh, Ghana, and Tajikistan. It also raised awareness among Pakistani parliamentarians of critical gaps in state planning for migration.

- In **Bangladesh**, CARIAA's local research partner was invited to draft the **refugees and remittances policy** of the Ministry of Labour and Employment in 2015. Over the course of 2017–2018, the research partner coordinated the Bangladesh National Dialogues to inform the United Nations **Global Compact on Migration**.
- In **Ghana**, the Interior Ministry and Ministry of Local Development sought input to ensure that the national **Policy on Migration** addresses internal migration. CARIAA's research, which involved drone monitoring of coastal erosion in the Volta delta, helped to highlight the

plight of residents who are often forced to migrate because their homes are affected by frequent flooding. The powerful visual imagery added weight to resident demands for coastal protection measures or resettlement support. These demands prompted a local MP to take the issue to the District Assembly for consideration.

- Research in **Pakistan** underscored the country's lack of policy and planning frameworks to support internal migration as an effective form of adaptation. CARIAA partners engaged parliamentarians on this challenge, generating demand for further input. The parliamentary secretary to the Ministry of Climate Change sought advice in preparation for meetings of the **World Commission on Forced Displacement**, a multi-country platform seeking to expand the definition of refugees to include people who are forcibly displaced by factors such as climate change and economic insecurities. The chair of Pakistan's Standing Committee on Climate Change also asked for a summary of CARIAA findings related to climate-related migration during his participation in **COP 23**.
- Researchers' focus on how labour migration contributes to social safety nets and climate resilience informed **Tajikistan's National Adaptation Plan, National Development Strategy**, and the **National Strategy on Climate Change Adaptation** (until 2030), and the **resulting Local Adaptation Plans of Action**. Evidence underscored the role of small enterprises in increasing resilience. This includes the need for household training to use remittances to support small enterprises that can diversify family income and employment while generating funds to invest in more climate-resilient agriculture.

5. STRENGTHENING RESILIENCE THROUGH PRIVATE SECTOR ADAPTATION

From small-scale farmers and herders to market vendors, drivers, and textile workers, the people most vulnerable to climate change tend to live in semi-arid lands and are both primary constituents of, and heavily reliant on the private sector for their incomes and livelihoods. Industry value chains are an important means by which low-income countries can accelerate growth and employment, but they are vulnerable to the impacts of a changing environment. Drought, flooding, and altered rainfall patterns threaten the resources and infrastructure that underpin economic productivity because they reduce harvests and water sources and they may hinder market access.

Recognizing the vital role of the private sector in making societies more resilient to climate change, CARIAA sought to identify adaptation measures that could strengthen firms, formal and informal actors, and households in vulnerable regions. Focusing on key economic sectors in semi-arid lands, researchers used value chain analysis to identify climate risks and potential solutions. In a context where environments such as drylands are considered economic liabilities, this research has helped overturn the prevailing narrative, showing how climate-vulnerable sectors can — with the right investments and policy support — serve as economic assets that drive transformation towards greater resilience.

While climate change will force changes to production systems, CARIAA research showed that it can also lead to new possibilities for people and businesses, create openings for new products and services, and drive new funding streams and mechanisms.

Exploring value chains to harness the potential for climate-resilient economies

Using an innovative three-step methodology called [Value Chain Analysis for Resilience in Drylands](#) (VC-ARID), CARIAA research aimed to identify climate risk, adaptation options, and opportunities for private sector development in key economic sectors in five countries (Carabine & Simonet, 2018a). Based on inputs from national stakeholders, analysis focused on the value

IN SUMMARY

CARIAA research on the climate impacts of selected value chains in semi-arid countries suggests that:

- With the right support, climate-sensitive sectors can continue to play a vital economic role.
- Actors in the formal private sector see few incentives to adapt, leaving producers to bear most of the climate risk.
- Regulation and public investment are needed to incentivize sustainable forms of private sector adaptation.
- Providing early warning and other climate information services, financial services, and targeted investments could significantly increase adaptive capacity.

chains related to cotton in Burkina Faso and Pakistan, and livestock in Kenya, Senegal, and Tajikistan.

VC-ARID begins by mapping the value chain and then assesses climate risks at each level before identifying adaptation and investment options to increase value chain resilience. The mapping revealed, among other things, that dryland sectors play a significant role in their respective national economies. In the Horn of Africa, the livestock sector represents 10% of GDP and 40% of added value in agriculture. In Kenya alone, livestock contributes to approximately 12% of the country's GDP and employs roughly half of the country's agricultural workforce (PRISE, 2018). Pakistan's textile sector, including locally produced cotton, is the country's largest industry and accounts for some 40% of the industrial labour force. Research also identified significant scope for innovation across these value chains, which involve many diverse and interconnected private sector actors that both compete with one another and foster transformation.



Climate vulnerable economic sectors and actors can become more resilient, including small scale and micro producers.

© Sophie Lashford

UNDERSTANDING THE CLIMATE RISKS THAT AFFECT PAKISTAN'S COTTON-TEXTILE VALUE CHAIN



The second step, climate risk analysis, revealed that producers are the most climate-vulnerable members of the value chains in the agricultural and textile sectors. While they generally understand the risks and impacts of climate change on their production and pricing, most have limited knowledge of how to go beyond coping and move towards adaptation. This leaves their livelihoods vulnerable to shocks, such as the 2009 drought in Kenya or the 2010 floods in Pakistan.

A case study on [female-led micro, small, and medium enterprises \(MSMEs\) in semi-arid Kenya](#) suggests most are confined to agriculture — typically small-scale trade in cereals, milk, and poultry (Atela, Gannon & Crick, 2018). These enterprises are highly exposed

to the effects of climate change due to extreme temperatures, high rainfall variability, and fluctuations in grazing and water resources. Research participants linked climate impacts such as drought and some livestock diseases to reduced growth and losses for their businesses, for example, when drought lowered livestock birth rates, cut milk production, or reduced animal weights and market value.

While VC-ARID revealed many barriers to adaptation among private actors in semi-arid lands, it also demonstrated that these dryland economies feature strong social networks and diversified livelihoods that help people respond to climate variability. Research suggests that if these assets and approaches could be harnessed and scaled up, there are real opportunities for inclusive and climate-resilient economic development.

Creating an enabling environment for private sector adaptation

CARIAA research identified many common challenges to building resilience, particularly for producers, when they looked at options to strengthen adaptation across contexts and value chains. Cotton growers and pastoralists, for example, rarely have access to financial services and markets. The lack of early warning systems is another challenge that can prevent producers and small and medium enterprises from taking action to protect their interests.



Vulnerability to climate change exists along value chains such as cotton production, and access to information is key to sustainable adaptation.

© Rajeshree Sisodia

Providing climate information services, government assistance, and targeted support for adaptation could significantly increase adaptive capacity.

While VC-ARID research showed clear opportunities for climate-resilient development in these sectors, it also identified the risk of maladaptive response, such as switching to unsustainable water-intensive cash crops. Even as their sectors are exposed to climate risks, findings from all value chains suggest that those in the formal private sector are not investing in adaptation — rather, they expect producers to bear the risks (Carabine & Simonet, 2018a). This lack of private investment suggests there is a need for regulation and public investment to incentivize and steer private adaptation in environmentally and economically sustainable directions.

A [survey of 325 MSMEs in semi-arid regions of Kenya and Senegal](#) found that financial barriers and insufficient market access increases the probability of a reduction in business. Access to information, general government support, and specific adaptation assistance increase the probability of sustainable adaptation (Crick et al., 2018). The findings point to a clear role for public policy in facilitating effective adaptation, given that the ability of firms to respond to climate risks depends on factors in the business environment that are shaped through policy intervention. Moreover, the survey suggested that the benefits of intervention are both immediate and long-term: the more firms engage in sustainable adaptation behaviour, the more

likely they are to start planning for future climate change, thus reducing their long-term vulnerability.

Linking private adaptation to global goals on development and climate action

CARIAA research highlights the vital connections between global development goals and tackling climate change. Research on private adaptation points to ways that the adaptive capacity of people living in semi-arid lands has been undermined by current policies and practices. It calls for a [tailored approach to leaving no one behind](#), including through public investments in enabling environments that will help private sector actors meet the challenges and opportunities of climate change (Gannon et al., 2020).

Much of this research coincided with the lead-up to global stocktaking on both the Paris Agreement on climate action and the 2030 Agenda for Sustainable Development. Recognizing the vital relevance of the research findings on private adaptation to both processes, researchers synthesized and shared policy-relevant insights to feed into discussions.

At the UNFCCC intersessional meetings in Bangkok in 2018, CARIAA evidence informed a number of negotiations on climate finance — an important issue for low- and middle-income countries. The

World Bank asked CARIAA partners to share their methods for assessing climate resilience of value chains in small business. CARIAA partners also documented their [reflections on the merits of VC-ARID](#) to assist others (Carabine & Simonet, 2018b).

CARIAA submitted a report on measures to [unlock climate-resilient economic development](#) to the 2018 Talanoa Dialogue, where parties to the Paris Agreement reviewed their national commitments. Researchers underscored the need for targeted investments in key economic sectors; integrating the Sustainable Development Goals with climate action; and building better connections to both national and global markets (Ludi et al., 2018). In another briefing to inform the review process, researchers highlighted the important role that national governments and development partners can play in [supporting climate-resilient private adaptation](#) (Gannon et al., 2018). It outlines opportunities to create an enabling environment for adaptation by unlocking private sources of investment, such as formal and informal businesses and returning migrants. It distills broad research lessons from across semi-arid industrial sectors about the types of policies, institutions, and other public investments that can support adaptation and climate-resilient development.

Researchers recommend that governments and development partners look broadly at the needs of private actors such as MSMEs and women's and farmers' groups to support resilient economies. This demands attention to critical infrastructure, such as access to transportation, water, electricity, and communication networks. It also requires national climate information providers and extension services to better meet the data and information needs of producers and other value chain actors. Their analysis also stresses the importance of recognizing and supporting the unique characteristics of dryland economies, such as their high degree of informal activity and the mobility of producers and workers.



The informal sector plays an important role in climate-resilient economic development for semi-arid regions.

© Hillary Masundire

Catalyzing private sector engagement in climate change adaptation

CARIAA tools and methods in this area have helped to narrow the gulf that typically separates researchers, industry representatives, and government officials. Collaborative approaches and application of the VC-ARID methodology sparked wider demand for information on how to integrate adaptation with economic development objectives.

Several spin-off projects and partnerships were forged as a result. For example, the German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) funded a project using the VC-ARID methodology to identify opportunities for entrepreneurs and companies to invest in climate change adaptation to enhance the resilience of the livestock value chain in Karamoja, Uganda.

- In **Pakistan**, analysis of the country's vital cotton textile industry detailed the growing challenge of water scarcity. Collaboration with industry groups, parliamentarians, and other stakeholders resulted in signing a memorandum of understanding between **Nestlé Pakistan** and CARIAA's local partner.⁶ The memorandum commits the partners to jointly promote the responsible use of water resources in Pakistani industry and agriculture. **Pakistan's Cotton Commissioner** also shared CARIAA findings and recommendations during a high-level consultative meeting organized by the Pakistan Cotton Ginners Association, which drew a range of textile-sector experts. In 2015, the CARIAA team shared a national assessment report with the **Ministry of Climate Change** highlighting how sector-specific climate change impacts would undermine national development and deepen poverty. These insights generated further demand for evidence in three areas that were most crucial to decision-makers: migration, protecting the cotton exports

value chain, and water governance. These engagements helped researchers identify key parliamentarians who could share the evidence with others, which deepened the researchers' work on capacity-building for officials.

- In **Burkina Faso**, research findings informed a key strategic objective of the **Plan national du développement économique et social**, which aims to develop the agro-silvo-pastoral sector (which combines pastoralism and agriculture in a partially wooded environment) and the wildlife and fisheries sectors. With CARIAA input, the development plan is more market-oriented and based on the principles of sustainable development.
- Research on the beef sector in **Kenya**, which highlighted [climate risks to livestock production](#) (Abuya, 2019), had a [significant influence on policymaking at the county and national levels](#) (Said et al., 2018). At a local level, this included reinforcing the sustainability of wildlife and livestock grazing lands by integrating land use planning, drought mitigation, and land tenure reforms within **county development plans** in Kajiado, Laikipia, Makueni, and Narok. Highlighting the important role played by MSMEs in local economies and household income, research also stressed the need to invest in women entrepreneurs, who may be disproportionately affected by climate change.
- At the national level, CARIAA partners helped to update Kenya's **National Climate Change Action Plan** and informed the **National Wildlife Conservation and Management Strategy** with evidence about climate change and the economic benefits of wildlife. The resulting strategy, launched in May 2018, promotes the co-existence of livestock and wildlife grazing, thereby supporting both the cattle and tourism industries.

⁶ Nestlé Pakistan press release, Mar 24, 2017: Nestlé, SDPI to work on Water Stewardship.
www.nestle.pk/media/pressreleases/nestle-sdpi-to-collaborate-on-responsible-use-of-water-resources-in-pakistan



Collaboration and shared experiences can help to improve the future of climate adaptation research.

© Jitendra Bajracharya

CONCLUSION

This report presents findings in the key areas where CARIAA contributed new knowledge and evidence. By addressing climate-sensitive hotspots, CARIAA learned from the lived experiences of people already grappling with climate impacts. Using a hotspots research focus connects local action to national policy and regional projections and provides a robust body of evidence. Combining climate projections that are scaled down to the local level with bottom-up approaches, CARIAA contributed to state-of-the-art science on the implications of 1.5°C warming.

Adaptation is about people and their opportunities to pursue livelihoods and shape their future. Effective adaptation must include equity and justice, including diverse views and voices to generate context-specific approaches. Vulnerability to climate change is determined by multiple factors, and adaptation needs to account for intersectionality, including the different experiences of women and men, in addition to factors such as age, ethnicity, and education.

Perceptions of climate migration must evolve to meet the realities faced by migrants searching for better livelihoods and opportunities. Migration has the potential to enhance resilience or lead to maladaptation. Similarly, perceptions of semi-arid lands can evolve to recognize their economic opportunity, addressing the climate risks faced by the private sector through appropriate investments and policy support.

Beyond generating new knowledge, CARIAA fostered action to enhance the resilience of people living in climate hotspots. This report shares examples from more than 30 documented cases where research contributed to policy and planning at local, national, and international scales. The uptake of such research was not by chance, but by design. From the outset, CARIAA sought to understand the challenges facing decision-makers, craft research efforts to address those needs, and share evidence in ways that could be readily understood and applied. An integrated approach to learning, as well as the development of a strong community of practice on research-for-impact, helped to strengthen CARIAA's research uptake and produce lessons to take forward into future work.

CARIAA's focus on collaboration, capacity, and impact, which brought more than 450 researchers across 15 countries together, represented a model of research at greater scales than other climate change adaptation research programs. As we are now in the age of implementation, this collaborative experience can serve as a model for the more ambitious research needed to face new challenges. We have also entered a decade of climate action, and the urgent challenge is to transform our societies in a manner that leaves no one behind. Research must respond to demands from practitioners and decision-makers by accelerating the use of existing knowledge to inform climate action now, while also generating knowledge to inform future action — without leaving the most vulnerable behind.

REFERENCES

CARIAA evaluation and final reports

- ASSAR. 2019a. "Adaptation at Scale in Semi-Arid Regions (ASSAR): Final Report." <http://hdl.handle.net/10625/57445>.
- DECCMA. 2018a. "Deltas, Vulnerability, Climate Change, Migration and Adaptation (DECCMA): CARIAA Consortium Final Technical Report." <http://hdl.handle.net/10625/57544>.
- DECCMA. 2019. "Climate Change, Migration and Adaptation in Deltas: Key findings from the DECCMA project." <http://hdl.handle.net/10625/57543>.
- HI-AWARE. 2018a. "Himalayan Adaptation, Water and Resilience (HI-AWARE) Final Technical Report." <http://hdl.handle.net/10625/57541>.
- Le Groupe-conseil Baastel Itée. 2018. "Collaborative Adaptation Research Initiative in Africa and Asia Summative Evaluation Final Report" ii-iii. <http://hdl.handle.net/10625/57296>.
- PRISE. 2019. "Pathways to Resilience in Semi-Arid Economies (PRISE): CARIAA Consortium Report." February 2014 - November 2018." <http://hdl.handle.net/10625/58343>.

CARIAA synthesis and learning

CARIAA briefs, reports and working papers

- Prakash, A., Cundill, G., Scodanibbio, et al. 2019. "Climate Change Adaptation Research for Impact. CARIAA Working Paper no. 23." IDRC: Ottawa and UK Aid: London. <http://hdl.handle.net/10625/57489>.

Audio-visual

- CARIAA. 2018a. "Collaboration for Impact." Video, September 2017. <https://www.youtube.com/watch?v=JJ9wU-Rd7R4&feature=youtu.be>.
- University of Capetown and Oxfam. 2019. Online course. "Research for Impact: A Mass Open Online Course." <https://www.coursera.org/learn/research-for-impact>

Journal articles and book chapters

- Cochrane, L. and Cundill, G. 2018. "Enabling Collaborative Synthesis in Multi-Partner Programmes. Development in Practice." 28(7): 922-931
- Cundill, G. et al. 2018. "Large-Scale Transdisciplinary Collaboration for Adaptation Research: Challenges and Insights. *Global Challenges*." Volume 3, Issue 4. Special Issue: Interdisciplinary Research and Impact: <https://doi.org/10.1002/gch2.201700132>.
- Cundill, G., Currie-Alder, B., Leone, M. 2019. "The future is collaborative." *Nature Climate Change* 9, 343–345: <https://doi.org/10.1038/s41558-019-0447-3>.
- De Souza, K., Kituyi, E., Harvey, B., Leone, M., Murali, K. S. and Ford, J. D. 2015. "Vulnerability to Climate Change in Three Hot Spots in Africa and Asia: Key Issues for Policy-relevant Adaptation and Resilience-building Research." *Regional Environmental Change* 15: 747-753.

Commentary

- Cundill, G. 2016. "Collaborative research as collaborative learning": <https://www.cariaa.net/research/blog-collaborative-research-collaborative-learning>.

1. Identifying the hotspot effects of 1.5°C global warming

CARIAA briefs, reports and working papers

ASSAR. 2019b. "Global warming of 1.5°C and higher brings profound challenges to semi-arid regions: An ASSAR cross-regional insight." http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Legacy_chapters/ASSARs%20work%20on%20global%20warming.pdf.

CARIAA. 2018b. "Novel Insights: 1.5°C Warming." <http://hdl.handle.net/10625/57273>.

DECCMA. 2018b. "Mapping Current and Future Salinity Risks: A Pre-requisite for Defining Adaptation Requirements." http://generic.wordpress.soton.ac.uk/deccma/wp-content/uploads/sites/181/2017/02/WP2-Policy-Brief_salinity.pdf.

HI-AWARE. 2018b. "Even 1.5 Degrees is Too Much: Rising temperatures and wetter futures in South Asian glacier and snow-fed river basins." <https://hi-aware.org/wp-content/uploads/2018/10/KM1.pdf>

Journal articles and book chapters

Biemans et al. 2019. "Importance of snow and glacier meltwater for agriculture on the Indo-Gangetic Plain." *Nat Sustain* 2: 594–601.

Brown, S. et al. 2014. "Shifting perspectives on coastal impacts and adaptation." *Nat. Clim. Change* 4(9): 752–755.

Brown, S. et al. 2018a. "What are the implications of sea-level rise for a 1.5, 2 and 3°C rise in global mean temperatures in the Ganges-Brahmaputra-Meghna and other vulnerable deltas? *Reg. Environ Change* 18: 1829–1842. <https://doi.org/10.1007/s10113-018-1311-0>.

Brown, S. and R. Nicholls. 2015. "Subsidence and human influences in mega deltas: the case of the Ganges–Brahmaputra–Meghna." *Sci. Total Environ.* 527: 362–374.

Brown, S. et al. 2018b. "Quantifying Land and People Exposed to Sea-Level Rise with No Mitigation and 1.5 and 2.0°C Rise in Global Temperatures to Year 2300." *Earth's Future*. 6(3): 583–600.

Hulme, M. 2016. "1.5 °C and climate research after the Paris Agreement." *Nature Climate Change* 6: 222–224. <https://doi.org/10.1038/nclimate2939>.

Kraaijenbrink, P.D.A., Bierkens, M.F.P., Lutz, A.F., Immerzeel, W.W. 2017. "Impact of a 1.5 degrees celcius global temperature rise on Asia's glaciers." *Nature* 549: 257–260. <https://doi.org/10.1038/nature23878>.

Lutz, A.F., ter Maat, H.W., Wijngaard, R.R., Biemans, H., Syed, A., Shrestha, A.B., Wester, P., Immerzeel, W.W. 2019. "South Asian river basins in a 1.5 °C warmer world." *Regional Environmental Change* 19: 833–847. <https://doi.org/10.1007/s10113-018-1433-4>.

Lutz, A.F., ter Maat, H.W., Biemans, H., Shrestha, A.B., Wester, P., Immerzeel, W.W. 2016. "Selecting representative climate models for climate change impact studies: an advanced envelope-based selection approach." *International Journal of Climatology* 36: 3988–4005. <https://doi.org/10.1002/joc.4608>.

Nicholls, R.J. et al. 2018. "Stabilization of global temperature at 1.5°C and 2.0°C: implications for coastal areas." *Phil. Trans. R. Soc. A* 376: 20160448. <http://dx.doi.org/10.1098/rsta.2016.0448>.

Nkemelang, T. et al. 2018. "Temperature and precipitation extremes under current, 1.5°C and 2.0°C global warming above pre-industrial levels over Botswana, and implications for climate change vulnerability." *Environ. Res. Lett.* 13: 065016, 1–11.

Wijngaard, R.R., Biemans, H., Lutz, A.F., Shrestha, A.B., Wester, P., Immerzeel, W.W. 2018. "Climate change vs. Socio-economic development: Understanding the South-Asian water gap." *Hydrology and Earth System Sciences*. Under Review.

Wijngaard, R.R., Lutz, A.F., Nepal, S., Khanal, S., Pradhananga, S., Shrestha, A.B., Immerzeel, W.W. 2017. "Future changes in hydro-climatic extremes in the Upper Indus, Ganges, and Brahmaputra River basins." *PLoS One* 12: <https://doi.org/10.1371/journal.pone.0190224>.

Global reports informed by CARIAA:

IPCC. 2018. "Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In press. www.ipcc.ch/sr15.

IPCC. 2019. "Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems." [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-

- Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)). In press.
- IPCC. 2019. "IPCC Special Report on the Ocean and Cryosphere in a Changing Climate." [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press. www.ipcc.ch/srocc/.
- WMO. 2019. "The Global Climate in 2015-2019." Geneva: World Meteorological Organization. https://library.wmo.int/doc_num.php?explnum_id=9936.

Commentary

- Kituyi, E. 2017. "CARIAA Submits its Contribution to the IPCC 1.5°C Special Report." CARIAA blog: <https://cariaa.net/research/blog-cariaa-submits-its-contribution-ipcc-15degc-special-report>.

2. Strengthening adaptation

CARIAA briefs, reports and working papers

- CARIAA. 2018c. "Novel Insights: Effective Adaptation." <http://hdl.handle.net/10625/57338>.
- Davies, J. et al. 2017. "Background Paper on Botswana's Draft Drought Management Strategy." ASSAR. www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Southern_Africa/botswana/Background%20Paper%20on%20Botswana%E2%80%99s%20Draft%20Drought%20Management%20Strategy%20-%20formatted.pdf.
- Few, R. et al. 2018. "When adaptation barriers and enablers intersect: Key considerations for adaptation planning drawn from ASSAR's findings." www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Crossregion/ASSAR-Intersecting_barriers_and_enablers-Nov_2018-synthesis.pdf.
- HI-AWARE. 2018c. "Working Towards Effective Adaptation: Contributions from HI-AWARE pilots to enhancing climate resilience in the HKH region." Brief: <http://hi-aware.org/wp-content/uploads/2018/10/KM15.pdf>.
- New, M. et al. 2018. "Effective adaptation means different things to different people: An ASSAR cross-regional insight." 2018. www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Legacy_chapters/ASSARs%20work%20on%20effective%20adaptation.pdf.

Audio-visual

- ASSAR. 2019c. "Adaptation is about people." Video, www.youtube.com/watch?time_continue=1&v=3OWaO4nGKIE&feature=emb_logo.
- HI-AWARE. n.d. "From NAPAs to NAP: Strengthening adaptation planning in Nepal." Video, http://stream.idrc.ca/cariaa/Hi-AWARE_SoC.mp4.

Journal articles and book chapters

- Conway, D. et al. 2019. "The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions." *Nat Clim Change* 9: 503-511. <https://doi.org/10.1038/s41558-019-0502-0>.
- Dasgupta et al. 2019. "Cost effective adaptation to flood: sanitation interventions in the Gandak river basin, India." *Climate and Development*: <https://doi.org/10.1080/17565529.2019.1682490>.
- Davies, J.E. et al. 2018. "Avenues of understanding: mapping the intersecting barriers to adaptation in Namibia." *Climate and Development*: <https://doi.org/10.1080/17565529.2019.1613952>.
- Few, R., Morchain, D., Spear, D. Mensah, A. and Bendapudi, R. 2017 "Transformation, adaptation and development: relating concepts to practice." *Palgrave Communications* 3, article 17092. <https://doi.org/10.1057/palcomms.2017.92>.
- Morchain, D. 2018. "Rethinking the framing of climate change adaptation: Knowledge, power, and politics." In *A Critical Approach to Climate Change Adaptation, Discourses, Policies and Practices*, edited by S. Klepp and L. Chavez-Rodriguez. 77-96. London, UK: Routledge,
- Tompkins, E.L. et al. 2020. "Adapting to Change: People and Policies." In *Deltas in the Anthropocene*, edited by R. Nicholls, W. Adger, C. Hutton and S. Hanson. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-23517-8_9.
- Tompkins, E.L., Vincent, K., Nicholls, R.J. and Suckall, N. 2018. "Documenting the state of adaptation for the global stocktake of the Paris Agreement." *WIREs Climate Change*, Vol. 9, Issue 5. <https://doi.org/10.1002/wcc.545>.

Commentary

- Bosworth, B. and Zade, D. 2018. "New evidence highlights heat stress in rural India." Climate & Development Knowledge Network feature. Oct 28, 2018. https://cdkn.org/2018/10/heat-stress-rural-india/?loclang=en_gb.
- Dilling, L. et al. 2019. "Is adaptation success a flawed concept?" *Nat. Clim. Chang.* 9, 572–574. July 22, 2019. <https://doi.org/10.1038/s41558-019-0539-0>.
- Scodanibbio, L. and Morchain, D. 2019. "Adaptation is about people." Climate & Development Knowledge Network feature. September 23, 2019. https://cdkn.org/2019/09/feature-adaptation-is-about-people/?loclang=en_gb.

3. Addressing gender and social inequality through inclusive adaptation

CARIAA briefs, reports and working papers

- ASSAR. 2018a. "Challenging assumptions about gender and climate adaptation." 2018. Infographic. www.assar.uct.ac.za/sites/default/files/image_tool/images/138/webinar/gender/INFOGRAPHIC%2000%20Small.pdf.
- ASSAR. 2018b. "Gender is one of many factors that influence how we are impacted by and respond to climate change." 2018. Infographic. http://www.assar.uct.ac.za/sites/default/files/image_tool/images/138/webinar/gender/INFOGRAPHIC%2001%20Small.pdf.
- ASSAR. 2018c. "Gender is one of many social factors influencing responses to climate change: An ASSAR cross-regional insight." www.assar.uct.ac.za/sites/default/files/image_tool/images/138/Legacy_chapters/ASSARs%20work%20on%20gender%20and%20social%20differentiation.pdf.
- Atela, J., Gannon, K.E., & Crick, F. 2018. "Climate change adaptation among female-led micro, small and medium enterprises in semi-arid areas: A case study from Kenya." PRISE working paper. www.prise.odi.org/wp-content/uploads/2018/09/Climate-change-adaptation-among-female-led-Micro-Small-and-Medium-Enterprises-in-semi-arid-areas-A-case-study-from-Kenya.pdf.

Audio-visual

- DECCMA. 2018c. "Enhancing gender analysis in the Odisha State Action Plan on Climate Change. Video, August 8, 2018. www.youtube.com/watch?v=hGYu1qcSpAE&feature=youtu.be

Journal articles and book chapters

- Ahmed, A., Lawson, E. T., Mensah, A., Gordon, C. & Padgham, J. 2016. "Adaptation to climate change or non-climatic stressors in semi-arid regions? Evidence of gender differentiation in three agrarian districts of Ghana." *Environmental Development*, 20: 45-58. <https://doi.org/10.1016/j.envdev.2016.08.002>.
- Ghosh, A.K., Banerjee, S & Naaz, F. 2018. "Adapting to climate change-induced migration. Women in the Indian Bengal delta." *Economic and Political Weekly*, 53: (17). www.epw.in/journal/2018/17/review-womens-studies/adapting-climate-change%E2%80%93induced-migration.html.
- Goodrich, C.G., Udas, P.B. & Prakash, A. (eds). 2019a. "Conceptualizing and Contextualizing Gendered Vulnerabilities to Climate Variability in the Hindu Kush Himalayan Region." Special issue of *Environmental Development*, Vol. 31. Pages 1-110. www.sciencedirect.com/journal/environmental-development/vol/31/suppl/C.
- Goodrich, C.G., Udas, P.B. & Prakash, A. 2019b. "Gendered vulnerability and adaptation in Hindu-Kush Himalayas: Research insights." *Environmental Development*, Vol. 31. Pages 1-8. <https://www.sciencedirect.com/science/article/pii/S2211464518304433>
- Rao, N. et al. 2017. "Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia." *Climate and Development*. <https://doi.org/10.1080/17565529.2017.1372266>.
- Rao, N., Mishra, A., Prakash, A. et al. 2019. "A qualitative comparative analysis of women's agency and adaptive capacity in climate change hotspots in Asia and Africa." *Nat. Clim. Chang.* 9, 964–971 <https://doi.org/10.1038/s41558-019-0638-y>.
- Rao, N., Singh, C., Solomon, D. et al. 2020. "Managing risk, changing aspirations and household dynamics: Implications for wellbeing and adaptation in semi-arid Africa and India." *World Development*, Volume 125. <https://doi.org/10.1016/j.worlddev.2019.104667>.
- Solomon, DS and Rao, N. 2018. "Gender Dimensions of Groundwater Dependence Wells and Well-being in South India." *Review of Women's Studies*. Vol. 53, Issue No. 17. <https://www.epw.in/journal/2018/17/review-womens-studies/wells-and-well-being-south-india.html>.

Suckall, N., Tompkins, E.L & Vincent, K. 2019. A framework to analyse the implications of coastal transformation on inclusive development. *Environmental Science and Policy*. 96, 64–69. www.sciencedirect.com/science/article/abs/pii/S1462901118306737?via%3Dihub.

Commentary

Rao, N. December 3, 2019. "Climate crisis could reverse progress in achieving gender equality." *The Conversation*. <https://theconversation.com/climate-crisis-could-reverse-progress-in-achieving-gender-equality-127787>.

4. Understanding migration in the context of adaptation

CARIAA briefs, reports and working papers

CARIAA. 2018d. "Novel Insights Brief: Migration." <http://hdl.handle.net/10625/57301>.

CARIAA. 2018e. "Human Mobility and Resilience in Climate Change Hotspots." Infographic. <http://hdl.handle.net/10625/57324>.

DECCMA. 2018d. Gendered migration patterns and effects in the Indian Bengal Delta. 2018. Infographic. http://generic.wordpress.soton.ac.uk/deccma/wp-content/uploads/sites/181/2017/10/Migration-Infographic_IBD_final.pdf.

Davies, J. et al. (n.d.) "Conducting life history interviews: A how-to guide." ASSAR. http://www.uct.ac.za/sites/default/files/image_tool/images/138/crossregion/How-to_Guide_Conducting_Life_History_Interviews.pdf.

Fankhauser S. et al. 2015. "Climate change and migration in developing countries: evidence and implications for PRISE countries. PRISE Working Paper." <http://prise.odi.org/wp-content/uploads/2015/10/Climate-change-and-migration-in-developing-countries3.pdf>.

Siddiqui, T. et al. 2018. "Accommodating Migration in Climate Change Adaptation: A GBM Delta Bangladesh Perspective." www.rmmru.org/newsite/wp-content/uploads/2019/10/Accommodating-Migration-in-Climate-Change-Adaptation.pdf.

Singh, C., Tebbboth, M., Spear, D. et al. 2019. "Exploring methodological approaches to assess climate change vulnerability and adaptation: reflections from using life history approaches." *Reg Environ Change* 19, 2667–2682. <https://doi.org/10.1007/s10113-019-01562-z>.

Qaisrani, A. and Salik, K.M. 2018. "The road to climate resilience: migration as an adaptation strategy. PRISE brief." www.prise.odi.org/research/the-road-to-climate-resilience-migration-as-an-adaptation-strategy/.

Journal articles and book chapters

Maharjan, A. et al. "Migration and adaptation in the context of environmental change: lessons from interdisciplinary work in South Asia." Submitted to *Reg Environ Change*, September 2018.

Michael, K., Deshpande, T. & Ziervogel, G. 2019. "Examining vulnerability in a dynamic urban setting: the case of Bangalore's interstate migrant waste pickers, *Climate and Development*" 11:8, 667–678, <https://doi.org/10.1080/17565529.2018.1531745>.

Montreux et al. 2018. "Political economy of planned relocation: A model of action and inaction in government responses." *Global Environ Change* [https://doi: 10.1016/j.gloenvcha.2018.03.008](https://doi.org/10.1016/j.gloenvcha.2018.03.008).

Mukhopadhyay, A. et al. 2018. "Threats to coastal communities of Mahanadi delta due to imminent consequences of erosion – Present and near future." *Science of the Total Environment* 637–638, 717–729 (October).

Safra de Campos, R. et al. 2020. "Where People Live and Move in Deltas." in Nicholls, R.J. et al. ed. *Deltas in the Anthropocene*. Pp. 153–177. Palgrave Macmillan. [https://doi: 10.1007/978-3-030-23517-8_7](https://doi.org/10.1007/978-3-030-23517-8_7).

Singh, C. and Basu, R. 2019. "Moving in and out of vulnerability: interrogating migration as an adaptation strategy along a rural urban continuum in India." *The Geographical Journal*. [https://doi: 10.1111/geoj.12328](https://doi.org/10.1111/geoj.12328).

Singh, C., Tebbboth, M., Spear, D. et al. 2019. "Using Life Histories to Understand Temporal Vulnerability to Climate Change in Highly Dynamic Contexts." *Reg Environ Change* 19: 2667. <https://doi.org/10.1007/s10113-019-01562-z>.

Tebboth, M., Conway, D. & Adger, W.N. 2019. "Mobility endowment and entitlements mediate resilience in rural livelihood systems." *Global Environmental Change*, 54: 172–183 doi: <https://doi.org/10.1016/j.gloenvcha.2018.12.002>.

Global reports informed by CARIAA

Ionesco, D. et al. 2017. "The Atlas of Environmental Migration." *International Organization for Migration*. Earthscan Routledge Publications.

- Kumari Rigaud, K. et al. 2018. "Groundswell: Preparing for internal climate migration." Washington, DC: *The World Bank*. <http://hdl.handle.net/10986/29461>.
- UNCTAD. 2018. "Economic Development in Africa Report 2018: Migration for Structural Transformation." *United Nations*: New York and Geneva. www.un.org/africarenewal/sites/www.un.org.africarenewal/files/aldcafrica2018_en.pdf. **Commentary**
- Nicholls, R. March 1, 2019. "What have we learned about climate change, migration and adaptation in deltas?" *CARIAA blog*: <https://www.cariaa.net/research/blog-what-have-we-learned-about-climate-change-migration-and-adaptation-deltas>.

5. Strengthening resilience through private sector adaptation

CARIAA briefs, reports and working papers

- Atela, J., Gannon, K.E. & Crick, F. 2018. "Climate change adaptation among female-led micro, small and medium enterprises in semi-arid areas: a case study from Kenya." Working paper: <http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/10/working-paper-338-Atela-et-al.pdf>.
- Carabine, E. and Simonet, C. 2018a. "Value Chain Analysis for Resilience in Drylands. VC-ARID synthesis report." *Overseas Development Institute*. London. <http://prise.odi.org/wp-content/uploads/2018/08/VC-ARID-Synthesis-Low-Res.pdf>.
- Carabine, E. and Simonet, C. 2018b. "Value Chain Analysis for Resilience in Drylands (VC-ARID): Identification of adaptation options in key sectors. Reflections on VC-ARID." *Overseas Development Institute*. London. <https://www.odi.org/sites/odi.org.uk/files/resource-documents/12515.pdf>.
- Gannon, K.E. et al. 2018. "Supporting private adaptation to climate change in semi-arid lands in developing countries. PRISE policy brief." <http://prise.odi.org/wp-content/uploads/2018/06/Supporting-private-adaptation-to-climate-change-low-res.pdf>.
- Jobbins, G. et al. 2018. "Leaving no one behind' through enabling climate-resilient economic development in dryland regions." PRISE brief. http://prise.odi.org/wp-content/uploads/2018/07/Leave-No-one-Behind_low_res.pdf.
- Ludi, E. et al. 2018. "Unlocking climate-resilient economic development: pathways to a resilient world." Report submitted to *Talanoa Dialogue*. <https://www.odi.org/sites/odi.org.uk/files/resource-documents/12488.pdf>
- PRISE. 2018. "Challenging the myths around semi-arid lands." 2018. Fact sheet: <http://prise.odi.org/wp-content/uploads/2017/11/SAL-mythbuster.pdf>.
- Saeed, F. 2017. "Mapping the cotton value chain in Pakistan: A preliminary assessment for identification of climate vulnerabilities and pathways to adaptation." PRISE Working paper. *Sustainable Development Policy Institute*. Islamabad. https://www.researchgate.net/publication/317146623_Mapping_the_cotton_value_chain_in_Pakistan_a_preliminary_assessment_for_climate_vulnerabilities_and_pathways_to_adaptation.

Audio-visual

- PRISE. 2016. "Understanding the climate risks to Pakistan's cotton-textile value chain." 2016. Video, <https://www.sdpi.tv/show.php?cat=env&id=797>

Journal articles and book chapters

- Crick et al. 2018. "How do African SMEs respond to climate risks? Evidence from Kenya and Senegal." *World Development* 108 157—168 <https://doi.org/10.1016/j.worlddev.2018.03.015>.
- Gannon, K.E., Crick, F. et al. 2020. "Private adaptation in semi-arid lands: a tailored approach to 'leave no one behind'" in *Global Sustainability*. Vol. 3. <https://doi.org/10.1017/sus.2019.26>.

Commentary

- Abuya, R. January 28, 2019. "Livestock at risk in Kenya's arid and semi-arid lands. 2019." Climate & Development Knowledge Network feature. https://cdkn.org/2019/01/feature-livestock-at-risk-in-kenyas-arid-and-semi-arid-lands/?loclang=en_gb
- Ehode, L.S. et al. January 18, 2019. "How climate researchers and businesses began speaking the same language – A case from Senegal." 2019. Climate & Development Knowledge Network feature. https://cdkn.org/2019/01/feature-how-climate-researchers-and-businesses-began-speaking-the-same-language-a-case-from-senegal/?loclang=en_gb.

For more information on CARIAA, visit www.cariaa.net.

				
CORE PARTNERS	University of Cape Town Indian Institute for Human Settlements START University of East Anglia Oxfam	University of Southampton Bangladesh University of Engineering and Technology Jadavpur University University of Ghana	ICIMOD Wageningen University The Energy and Resources Institute Pakistan Agricultural Research Council Bangladesh Centre for Advanced Studies	Overseas Development Institute Sustainable Development Policy Institute London School of Economics IED-Afrique
STRATEGIC PARTNERS	Addis Ababa University ATREE Desert Research Foundation of Namibia ICRISAT Indian Institute of Tropical Meteorology Red Cross Climate Centre Reos Partners University of Botswana University of Ghana University of Nairobi University of Namibia Watershed Organisation Trust	Bangladesh Space Research and Remote Sensing Organisation Basque Centre for Climate Change Centre for Environmental and Geographic Information Services Centre for Environment and Development Chilika Development Authority Food and Agriculture Organisation Kulima Integrated Development Solutions MET Office National Remote Sensing Centre, Sansrisiti Plymouth Marine Laboratory South Asian Network on Economic Modelling University of Dhaka, Refugee and Migratory Movements Research Unit University of Dundee University of Exeter Water Resources Planning Organisation	Centre for Ecology Development and Research FutureWater LEAD Pakistan Megh Pyne Abihyan Mountain Institute India Practical Action	Kenya Markets Trust Mountain Societies Research Institute Regional Environment Center for Central Asia University of Ouagadougou



www.cariaa.net