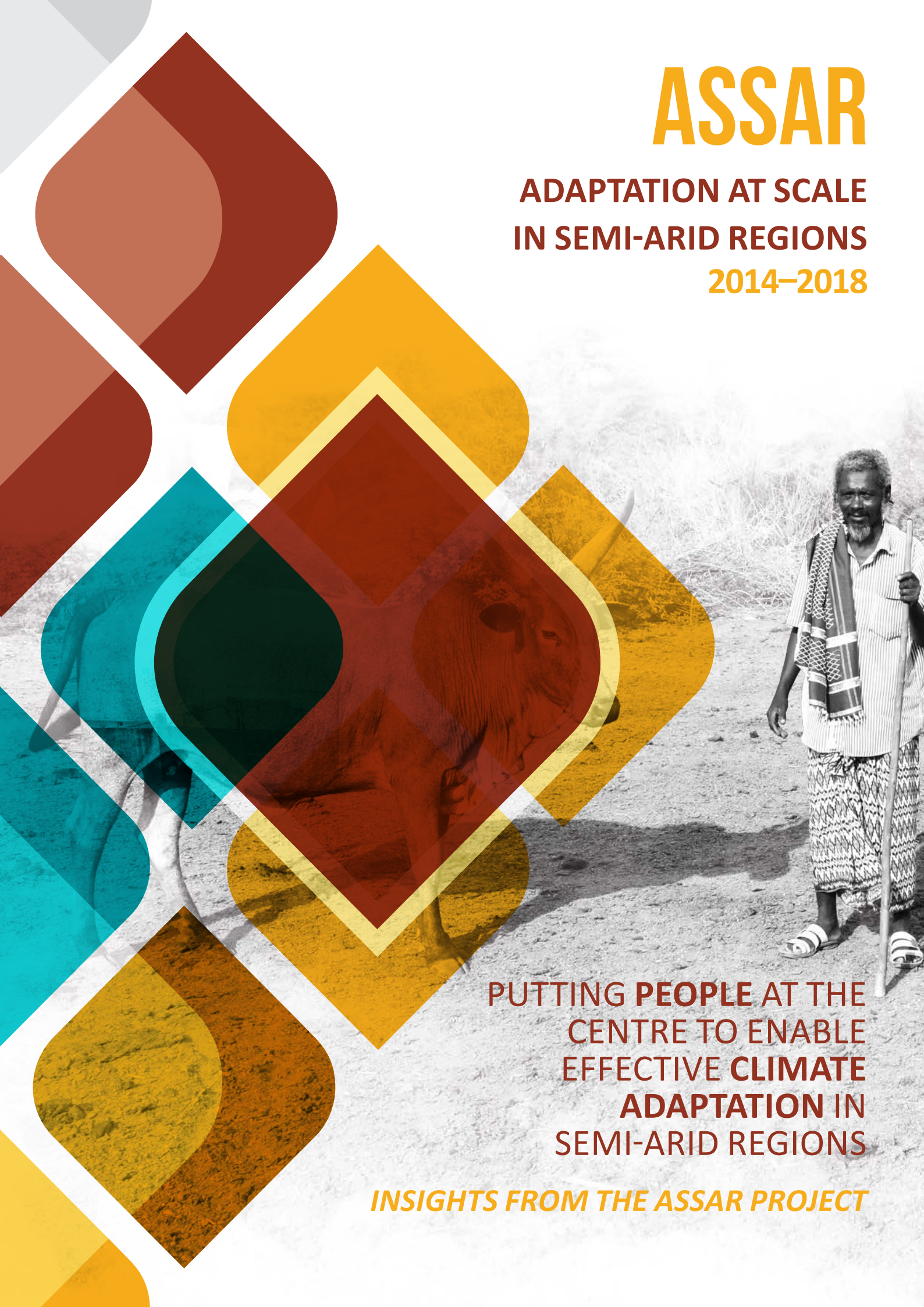
ASSAR

ADAPTATION AT SCALE IN SEMI-ARID REGIONS

2014–2018



PUTTING **PEOPLE** AT THE CENTRE TO ENABLE EFFECTIVE **CLIMATE ADAPTATION** IN SEMI-ARID REGIONS

INSIGHTS FROM THE ASSAR PROJECT

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INTRODUCTION

Photograph: Lucia Scodanibbio

ASSAR

Adaptation at Scale in Semi-Arid Regions

Working in the semi-arid regions of Africa and India, the five-year (2014-2018), multi-institutional and multi-scale ASSAR project combined interdisciplinary scientific research, capacity building, and stakeholder engagement to improve understandings of the barriers and enablers to effective climate adaptation. Our work centered on informing climate adaptation policy and practice in ways that advance the agency and long-term wellbeing of the most vulnerable.

ASSAR was a project within the CARIAA (Collaborative Adaptation Research Initiative in Africa and Asia) programme, funded by IDRC and DFID.

Why focus on semi-arid regions?

The need for effective adaptation responses has become increasingly urgent as the rate of climate change and severity of impacts has become more clearly understood. Home to hundreds of millions of people, the semi-arid regions of Africa and Asia are particularly vulnerable to climate-related risks.

These climate change hotspots are highly dynamic systems that already experience harsh climates, adverse environmental change, and a relative paucity of natural resources. Global warming is expected to make conditions in these areas more challenging in the coming decades. Even a 1.5°C increase in global temperature will result in warming in semi-arid regions that is greater than the global average. More frequent and intense extremes will have severe impacts on agriculture, health, and other vulnerable sectors.

People living in semi-arid regions also face a range of non-climatic stressors, including rapid population growth, historically-high rates of poverty, inequality, and rapidly changing socio-economic, governance, and development contexts. They are often far removed from government services and do not have the opportunity to participate in decision-making processes that can affect their abilities to adapt.

These challenges affect different people within these populations differently. Factors such as access and control over land and water resources, social and cultural norms, urbanisation, and opportunities for migration, all affect which livelihoods people can pursue, which support structures they can draw on, and ultimately how they maintain their overall wellbeing. Although many people in these regions are remarkably resilient, the rate at which these multiple and often interlocking pressures are expected to escalate in coming decades means that traditional coping strategies will be insufficient.

ASSAR's work was driven by the urgent need to accelerate regional adaptation responses in semi-arid regions to safeguard the livelihoods and wellbeing of those who live in them. From 2014-2018 we worked with a wide range of stakeholders in seven countries (Botswana, Ethiopia, Ghana, India, Kenya, Mali, Namibia) to explore the dynamics and drivers of vulnerability. At the same time, we engaged in efforts to strengthen the capacities of governments, local organisations, and people to adapt in ways that minimise vulnerability, strengthen agency, and promote long-term wellbeing.

ASSAR'S APPROACH

Researching the barriers and enablers to effective adaptation

To date, most adaptation efforts have focused on reactive, short-term, and site-specific solutions to climate-related vulnerabilities. Although important, these responses often fail to address the root causes of vulnerability and shed no light on how to spur larger-scale and longer-term adaptation that has positive effects on socio-economic development.

Using research and practice to address this information shortfall, ASSAR's primary aim was to produce future-focused and societally-relevant knowledge of potential pathways to greater wellbeing through adaptation.

ASSAR embraced a transformational philosophy to climate change adaptation, using insights from multi-scale, inter- and transdisciplinary work to improve understandings of the barriers and enablers to effective, sustained and widespread adaptation out to the 2030s. We considered adaptation through three principal research lenses. These emphasised the dynamics of ecosystem services, social differentiation, and governance. Knowledge systems and gender dimensions relate to all these lenses, and acted as cross-cutting themes throughout (please see a figure of our research framework on the following page).

This conceptual framing emphasised the need to understand climate change within an interlinked set of other dynamics in drylands – typically a combination of environmental, social, economic, cultural, political and administrative changes. This dynamic setting is particularly evident in semi-arid regions, in part because dryland populations have historically been among the most marginalised but are today increasingly exposed to mainstream influences. It is only through recognising and understanding the interlinked dynamics that shape vulnerability and adaptive capacity in semi-arid regions that the challenges and prospects for management of climate impacts can be adequately analysed and translated into adaptation policy and practice.

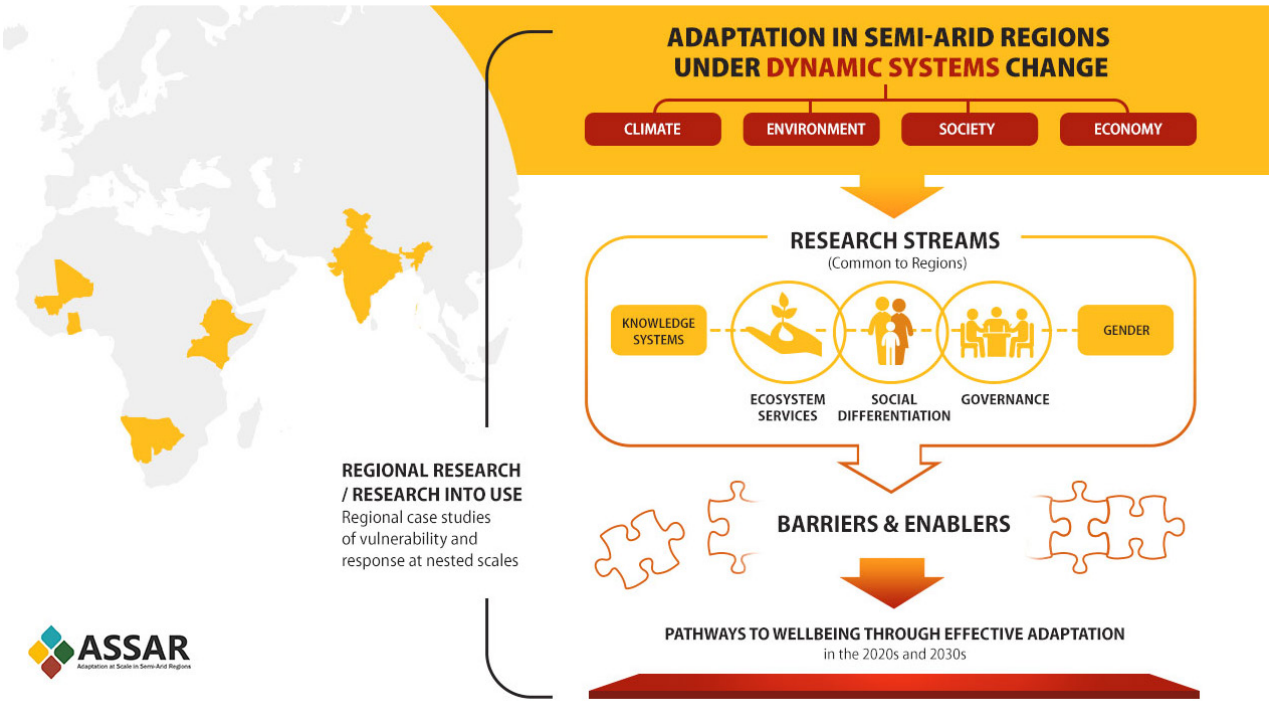
Each of ASSAR's research teams focused their case-study based investigations on regionally-relevant, socio-ecological risks and dynamics that related centrally to livelihood transitions, and access, use, and management of land and water resources. The teams worked in a coordinated manner to enable ASSAR to develop a systemic understanding of the processes and factors that impede adaptation and cause vulnerability to persist.

Creating relevant, usable research

To ensure better linkages between adaptation research, policy and practice, ASSAR employed a Research-into-Use (RiU) approach. Our research was stakeholder-guided, and responded to the adaptation challenges faced by people living and working in semi-arid regions. ASSAR's work was underpinned by early and continued stakeholder engagement based on interactive stakeholder mapping and power analyses. We targeted different levels of adaptation practice and policy, from local communities and organisations, to sub-national and national governments and institutions.

We used multi-stakeholder, participatory processes – such as Vulnerability and Risk Assessments (VRA), Transformative Scenario Planning (TSP), and Participatory Scenario Analysis (PSA) – to bring together key stakeholders. The aim was to build common understandings of current adaptation needs and past adaptation failings, while co-producing adaptation responses that can yield appropriate, tangible, and lasting benefits.

We also worked to develop audience-appropriate communication products to ensure that important research findings reached the right people, at the right times, and in the right ways.



Strengthening capacities within and outside ASSAR

To ensure that ASSAR's impact would live on after the project was completed, we prioritised building the capacity of project team members, and a variety of external stakeholders in our regional study sites.

ENHANCING RESEARCHER SKILLS AND ABILITIES

Financial support: We provided financial support for graduate students (for fieldwork and full study programs), postdoctoral researchers, and research associates. In total, we offered academic and research-focused capacity building grants to support approximately 100 early- and mid-career researchers.

Training and workshops: Through specialised training opportunities and workshops, we built researcher capacities in specific areas. These included gender, RiU, VRA, TSP, experiential learning, land use and land cover change, and climate science.

Upskilling early-career researchers: Project members also benefited from Small Opportunities Grants. These gave early-career researchers the chance to tap into a broad range of strengths, skills, perspectives, and ideas across different semi-arid hotspots. These opportunities contributed toward joint outputs across the ASSAR regions. Through these grants we bolstered the influencing and communications capacity of ASSAR researchers, built stronger ties with stakeholders in the regions, trained early-career researchers to work with stakeholders on improving local adaptation efforts, and boosted the RiU work done by regional teams.

BUILDING CAPACITY AMONG VULNERABLE GROUPS

Our two external capacity building initiatives, the Grants for Local Adaptation Support (ASSAR GLAS) and Scenario Based Capacity Building (SBCB) grants, helped strengthen the relevance and sustainability of ASSAR's research. The ASSAR GLAS were developed in order to use our research findings to help support the most vulnerable groups in each region. They focused on supporting women's groups, strengthening disaster risk management, integrating climate and development projects, and fostering peer-to-peer learning among stakeholders. We used the SBCB grants to build on the momentum and connections made during the regional teams' participatory processes, and to align these with ongoing ASSAR findings to attain actionable results. Specifically, these awards served to build capacities of those stakeholders who played vital roles in overcoming barriers to, or supporting enablers of, adaptation. They focused on topics including irrigation and soil fertility management, accessing climate information, and invasive species management.

"PREVIOUSLY, WE FOUND IT DIFFICULT AS WOMEN TO GO TO SOME OFFICES LIKE THE DISTRICT ASSEMBLIES AND FINANCIAL INSTITUTIONS TO ASK FOR CERTAIN SERVICES, BUT WITH THE HELP OF ASSAR'S PARTICIPATORY METHOD OF ENGAGING WITH US […], WE FEEL MORE CONFIDENT […]. WE WERE NOT UNITED AS WELL […], BUT THROUGH THE GLAS PROJECT WE NOW HAVE WOMEN PLATFORMS THAT HAVE BEEN FORMALLY REGISTERED WITH THE DISTRICT ASSEMBLIES WORKING TOGETHER TO IMPROVE THE WELLBEING OF WOMEN."

An international and interdisciplinary team

The interdisciplinary ASSAR team comprised a mix of research and practitioner organisations from 11 countries. It included groups with global reach as well as those deeply embedded in their communities. The ASSAR consortium was a partnership between five lead managing institutions – the University of Cape Town (South Africa), the University of East Anglia (United Kingdom), START (United States of America), Oxfam GB (United Kingdom) and the Indian Institute for Human Settlements (India) - and 12 partners – the University of Botswana, University of Namibia, the Desert Research Foundation of Namibia, University of Ghana, International Crops Research Institute for the Semi-Arid Tropics, University of Nairobi, Addis Ababa University, Ashoka Trust for Ecology and the Environment, Watershed Organisation Trust, Indian Institute for Tropical Meteorology, Reos Partners, and the Red Cross Red Crescent Climate Centre.

ASSAR was one of four hotspot research projects in the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) programme, funded by Canada's International Development Research Centre (IDRC) and the United Kingdom's Department for International Development (DFID).

ASSAR IN NUMBERS

GENERAL:

7 COUNTRIES

17 INSTITUTIONAL PARTNERS

272 PROJECT STAFF

1990+ PEOPLE ENGAGED

RESEARCH OUTPUTS:

110 JOURNAL ARTICLES*

10 BOOK CHAPTERS

26 WORKING PAPERS*

47 PHD AND MASTER'S THESES

COMMUNICATIONS OUTPUTS:

335 BLOGS

5 BROCHURES AND FLYERS

18 INFOGRAPHICS

52 INFORMATION BRIEFS

9 PHOTO ESSAYS

11 RADIO SHOWS

44 REPORTS

9 SPOTLIGHTS

9 TOOLKITS AND GUIDES

51 VIDEOS

24 WEB ARTICLES

7 WEBINARS

CAPACITY BUILDING:

13 POST-DOCS

14 PHD STUDENTS

35 MASTER'S & HONOURS STUDENTS

75 STAKEHOLDER ENGAGEMENT & TRAINING EVENTS

* As of May 2019, 41 journal articles were published, 30 were under review and 39 in preparation. Of the 26 working papers, 5 were in preparation.

CROSS-REGIONAL INSIGHTS

Key messages from our synthesis work

BARRIERS AND ENABLERS TO ADAPTATION NEED TO BE VIEWED AS DYNAMIC AND INTERSECTING RATHER THAN INDIVIDUAL AND STATIC

In ASSAR we framed our view of barriers and enablers in a normative sense, with a particular focus on what encourages or prevents effective, widespread and sustained adaptation that aligns with the aspirations of local communities. Given ASSAR's people-centred work, we placed high emphasis on understanding the barriers and enablers to adaptation for less well-off and politically-marginalised people facing livelihood and wellbeing stresses in semi-arid regions. We showed the central role that cultural factors can play in shaping the development, uptake and effectiveness of adaptation actions. Secondly, we drew attention not just to the existence of multiple forms of barriers and enablers, but to their interaction in shaping adaptation processes and outcomes. Just as different forms of enablers could combine to increase the chances of progress, so multiple interacting barriers can be mutually reinforcing to severely constrain progress.

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GLOBAL WARMING OF 1.5°C AND HIGHER BRINGS PROFOUND CHALLENGES TO SEMI-ARID REGIONS

In semi-arid regions, a global temperature rise of 1.5°C (and each interval of 0.5°C thereafter) will have progressively severe local impacts. With average local temperatures increasing faster than the global average (and rising more with each interval of global increase), along with intensifying climate extremes and changing rainfall patterns, semi-arid regions will experience declining crop yields, shifts in water availability, compromised health of people and livestock, and additional pressures to livelihoods.

Affected countries have growing evidence available to argue for emissions reductions in line with a 1.5°C warming target, as proposed in the Paris Agreement, and at the same time push for adopting climate-resilient development pathways that acknowledge the threats of increasing temperatures and their associated impacts.

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CHANGING ECOSYSTEM SERVICES ARE INCREASING PEOPLE'S VULNERABILITY IN SEMI-ARID REGIONS

Semi-arid regions are undergoing complex shifts in land-vegetation-atmosphere interactions. These shifts impact on ecosystem services, with major corresponding implications for local communities. Yet, socially-just access to key ecosystem services is an integral part of climate change adaptation, across rural and urban settings.

Enhancing human wellbeing and climate resilience in the face of these changes requires governance at multiple scales to take into account the synergies and trade-offs associated with the ecosystem services that are of value to different social groups. Including affected populations more concretely in management decisions will help to identify the main trade-offs, and support more effective design and implementation of interventions. Decision makers should also capacitate customary, traditional, and community-based natural-resource managers by devolving decision making rights to them, and by facilitating and promoting equitable and adaptive natural-resource management.

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FORWARD LOOKING, INCLUSIVE GOVERNANCE ARRANGEMENTS ACROSS DIFFERENT SCALES ARE A CRITICAL ENABLER FOR ADAPTATION

Marginalised groups in semi-arid regions who live on the frontline of climate impacts will benefit if they are more actively included in climate adaptation governance. However, in these areas, governments struggle to deliver services or engage with local communities due to a range of factors, such as inadequate mainstreaming of climate concerns in development planning, staff capacity deficits at lower levels of governance, and limited technical expertise. We see fragmented decision making across different governance levels.

Climate change adaptation responses could learn from widespread implementation of decentralisation, and how it has enabled, and in some cases undermined, the ability to support participation and flexibility across scales. Strengthening governance, and the capacity to engage in decision making across scales, across actors, and between formal and customary governance structures, should be a priority for enabling effective adaptation. Doing so could enable more equitable participation, promote flexible, hybrid forms of governance, and encourage forward-looking, cross-scalar collaboration and knowledge flows.

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PARTICIPATORY PROCESSES BUILD ADAPTIVE CAPACITY AND AGENCY AND CAN HELP TRANSFORM SYSTEMS

Transformation in climate change adaptation is the opposite of today's business as usual. It requires a reframing of the climate challenge to allow a shift from the existing largely technocratic and Northern knowledge base, to a fairer configuration of power relations that recognises the critical role of non-technocratic knowledge. Indeed, initiatives that can lead to transformation in climate change adaptation need to emphasise the reorientation of social norms and relations, as well as the reorganisation of climate governance structures.

Inclusive, participatory processes that bring together diverse stakeholders – both in positions of power and dispossession – can help to integrate marginal voices into the mainstream, thereby shifting the adaptation narrative and research methods to new spaces of grounded solutions. In so doing, these processes can help build people's agency, and their adaptive and transformative capacities.

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EFFECTIVE ADAPTATION MEANS DIFFERENT THINGS TO DIFFERENT PEOPLE

Different framings of effectiveness will influence the entire adaptation process, from identifying the vulnerabilities that adaptation aims to address, to determining who benefits and who is left behind, which adaptation actions are chosen and funded, and how they are implemented. Justice, governance, community-based adaptation, and sustainability framings are particularly important for ensuring outcomes that benefit vulnerable communities in semi-arid regions. But in any adaptation process, considering multiple framings is critical for facilitating effective, equitable and inclusive adaptation that is actively cognisant of the marginalised and most vulnerable. A clear exploration and articulation of effectiveness, from multiple framings, can guide organisations in setting adaptation priorities and outcomes, in defining criteria for funding adaptation projects, in assessing proposals, and in evaluating implementation.

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A FOCUS ON WELLBEING CAN LINK ADAPTATION TO OUTCOMES THAT MATTER TO PEOPLE

Using a wellbeing approach in climate adaptation efforts helps to humanise adaptation debates, making them less technocratic and scientific. The approach focuses on the links between human needs and aspirations; the different resources and capacities people have; and how these shape livelihood choices, satisfaction with life, and resilience. It recognises that people's capacity to engage in adaptation action, and the types of action they can engage in, varies within communities and households. All these factors coalesce to have implications for equity and inclusion. A wellbeing approach is critical for designing policies that respond to the many ways in which social dynamics lead to different levels of vulnerability.

GENDER IS ONE OF MANY SOCIAL FACTORS INFLUENCING RESPONSES TO CLIMATE CHANGE

People's vulnerabilities and responses to climatic and non-climatic risks, vary according to the way that social norms, market signals, laws and policies intersect with different dimensions of their identity. To avoid further marginalising the already vulnerable, we need to steer away from conventional approaches that focus on binaries of men and women, and move towards considering intersectional variables, that is, how aspects of age, ethnicity, class and marital status, amongst others, interact with gender to shape vulnerability and response strategies.

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MOBILITY IS AN INHERENT DYNAMIC AMONG VULNERABLE POPULATIONS

Mobility is an important strategy to manage risk in semi-arid regions, but it doesn't always lead to improved wellbeing. Whether moving or staying put, risks can increase for those with little agency. Conversely, mobility can provide the means to move out of risky locations and improve livelihoods. In these cases, migration contributes to improved wellbeing and adaptive capacity.

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ENHANCED KNOWLEDGE SYSTEMS ARE CRITICAL FOR CLIMATE CHANGE ADAPTATION

Climate adaptation knowledge is currently predominantly focused on weather and seasonal timescales, is dominated by climate warnings, and rarely extends to adaptation information. As climate change progresses, greater integration across timescales will be needed to prepare for novel climate risks. Integration of knowledge across institutions, knowledge domains, and geographic scales is equally necessary. Though the policy mandate for the generation and dissemination of climate information typically resides with government agencies, their efforts can be supported by intermediaries who are often better placed to bridge the different knowledge domains, and to work with at-risk communities.

Developing the capacity of these intermediaries, and embedding them in the broader knowledge system is key, as they can also help to tailor adaptation information for different social groups to ensure that knowledge reaches those who might otherwise be excluded. The use of mobile technology offers further opportunities for improving people's access to timely, usable and locale-specific climate and adaptation information, particularly in rural areas where access is frequently limited.

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COLLABORATIVE RESEARCH CONSORTIA ARE COMPLEX, BUT HAVE GREAT POTENTIAL

Large-scale collaborative consortia provide multiple opportunities for professional and personal growth of those involved. Interactions across disciplinary, geographical, cultural and sectoral dimensions offer a rich learning environment; and consortia provide multiple opportunities for networking, capacity building, and broadening one's understanding. However, working in consortia can be challenging, involving varied transaction costs given the diversity of partners involved, and their dispersed nature. Bridging the research-practitioner divide, for instance, requires overcoming certain barriers, such as differences in professional language and priorities. Yet continuous and iterative collaboration between researchers and practitioners is critical for research to be impactful and meaningful. Building relationships and trust is one of the most worthwhile investments one can make for the success of large-scale collaborative initiatives.

Read more

COUNTRY INSIGHTS

Key messages from our case studies

KEY INSIGHTS
BOTSWANA

- Botswana is one of the countries in Africa that will experience the most extreme changes in temperature and precipitation under global warming scenarios of 1.5°C-3°C above pre-industrial levels. These changes will have significant negative impacts on agriculture and other water-dependent sectors. There is an urgent need for communities and government to respond to climate change with measures that will build resilience and enhance wellbeing.

- In recent years, there have been adverse changes in the quantity, quality, distribution and timing of certain ecosystem services due to increasing human pressure and climate change impacts. As dependence on and access to ecosystem services varies by gender, men and women are affected differently by these ecosystem changes. Ecosystem services need to be sustainably and equitably managed through improved monitoring and restrictions on harvesting. Access to alternative livelihood options should also be enhanced.

- To increase the use of seasonal climate forecasts by people with different values, customs and belief systems, meteorological and place-based climate information need to be integrated through participatory processes with traditional and religious leaders. Forecasts should also be tailored and communicated in a way that is relevant and understandable to farmers, and should include information on what actions farmers should take.

- Climate change is causing the frequency, severity, duration and spatial extent of droughts to increase. Yet, institutionally, drought and climate change are managed separately. There is a lack of coordination among departments responsible for drought management, and responses are largely reactive and crisis-driven. While emergency drought response does have an important role to play in drought management, a more proactive and integrated approach is needed to build the longer-term resilience of vulnerable people, ecosystems and the economy.

- Grassroots stakeholders have equally valuable contributions to make as those in positions of power in policy, planning and vulnerability assessment processes. Multi-sector and multi-scalar participatory processes that enable collaborative planning and engagement with and between representative and marginalised stakeholders are thus important for ensuring that climate change responses are legitimate, effective, and tailored to the realities of various social groups.

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KEY INSIGHTS
NAMIBIA

- Adaptation policy approaches should consider that factors like gender, ethnicity, age, household composition, marital status, social capital and class are important determinants of people's vulnerabilities, and of their capacities to respond to climate risks and impacts. These intersecting factors need to be considered explicitly to enable the most marginalised to adapt.

- Building on Namibia's decentralised water reform, water and drought governance could be strengthened if there was a better understanding of and support for local challenges. This could be partly achieved by increasing the awareness and willingness of decision makers to be more inclusive of the knowledge that community members and other marginalised groups offer, building the capacity of local actors to proactively engage in governance, and by providing more targeted support for managing water better at the village level.

- Improved collaboration – among government, non-governmental organisations, academia and communities – can lead to the production of climate and adaptation information that is reliable and relevant to local subsistence farmers. It can also ensure that this is disseminated to those who need it in a timely manner.

- By engaging with traditional and religious leaders, and considering their value systems, adaptation policy makers and practitioners can promote adaptation responses that work in conjunction with cultural and social norms. Doing so will assist in helping to reduce group-specific vulnerabilities. This should also be done on a case-by-case basis considering the implications of these social norms on gender equality and human rights more broadly.

- More long-term, targeted responses to climate change are needed. Government needs to support people's livelihoods by building adaptive capacity, providing vocational training and jobs, and creating markets. These efforts must also lead to rural development processes that address water scarcity, food insecurity, and human development needs.

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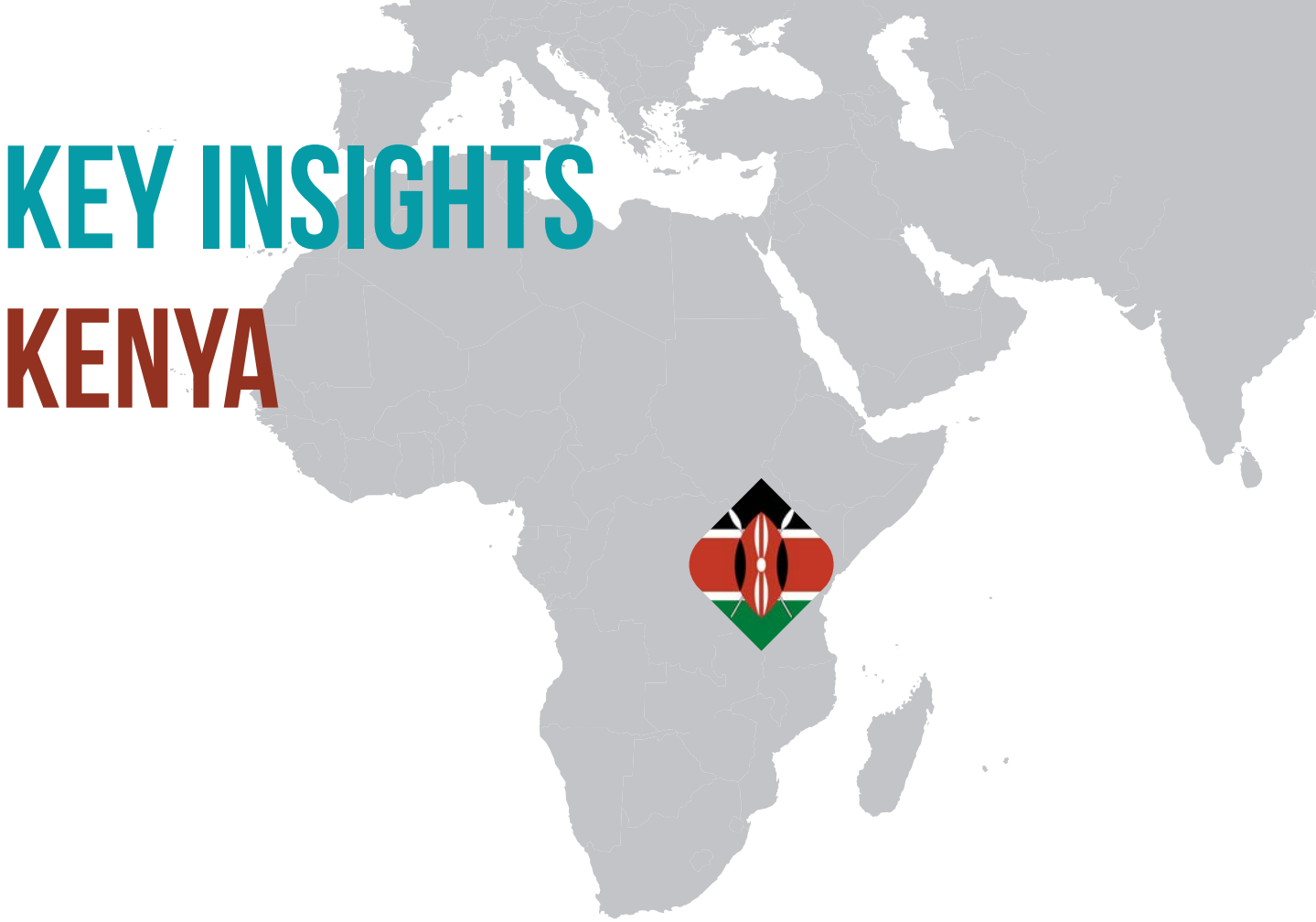
KEY INSIGHTS
KENYA



- Factors like gender, age, location, livelihood and status intersect with social and economic characteristics like household composition, social capital, marital status, income and educational attainment to determine people's capacity to effectively respond to climate risks and impacts. Adaptation policies need to consider these intersecting factors explicitly to enable the most marginalised to adapt.

- Although decentralisation has enabled local officials to respond to local needs flexibly and effectively, greater coordination between levels and sectors of government, as well as more resources, better alignment of planning and development cycles, and better provision of timely and relevant information, would further strengthen action on water governance and disaster risk management.

- Conservancies have benefitted communities with improved governance, more livelihood opportunities, and enhanced social services. To continue to build resilience, further improvements are required to reduce tensions between communities within and outside conservancies, enable more sustainable and equitable approaches to natural resource management and livelihoods, and address ongoing problems associated with human-wildlife conflict.

- Recognising that interventions will result in trade-offs, with some people winning and others losing, is important. Including affected populations more concretely in decisions about interventions will help to identify the main trade-offs, support more effective design and implementation of interventions, avoid unintended consequences – especially for the most vulnerable – and help to ensure that the needs of those typically excluded from decision making are heard and valued.

Read more

KEY INSIGHTS
ETHIOPIA

- Factors like gender, age, location, livelihood and status intersect with social and economic characteristics such as household composition, social capital, marital status, income and education level to determine people's capacity to respond effectively to climate risks and impacts. Adaptation policies need to consider these intersecting factors explicitly to enable the most marginalised to adapt.
- Although decentralisation has strengthened the ability of local officials to respond to local needs flexibly, greater coordination between levels and sectors of government, as well as more resources and better provision of timely and relevant information, would further strengthen action on water governance and disaster risk management.
- Policies and interventions on key issues such as villagisation, irrigation and invasive species management need to balance the competing needs of different stakeholders and population groups to enable more sustainable and equitable approaches to natural resource management and livelihood support in the face of climate change.
- Recognising that interventions will result in trade-offs, with some people winning and others losing, is important. Including affected populations more concretely in decisions about interventions will help to identify the main trade-offs, support more effective design and implementation of interventions, avoid unintended consequences – especially for the most vulnerable, and help to ensure that the needs of those typically excluded from decision making are heard and valued.

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KEY INSIGHTS

GHANA

- Intersecting climatic and non-climatic challenges manifest in varied ways for different groups and individuals. Therefore, researchers, policy makers and practitioners should view these combined stressors holistically, and use this more complete understanding when making decisions that will impact livelihoods and adaptation options of different social groups.
- Measures can be taken now to ameliorate non-climatic challenges and bolster adaptive capacities. These include developing market support services, expansion of veterinary services, enforcement of regulations on bush burning, and better grading and packaging of produce.
- Policy makers, government ministries, and practitioners should tailor water management to the needs of different social groups, prioritise provision of accurate and timely rainfall information, and strengthen technical capacities for maintaining water infrastructure. Further, to increase uptake among farmers, measures need to be taken to integrate traditional irrigation approaches that are culturally accepted with more modern mechanised approaches and financing.
- Migration is often seen, in an overly simplistic manner, as a favourable adaptation response to combined stressors, but this is not necessarily the case. Migration is not always an available or desirable option. A focus should be placed on supporting sustainable adaptation options for those for whom migration is not a viable alternative.
- Traditional patriarchal norms have favoured males and promoted structural inequalities among females in terms of decision making, access to and control over land for agricultural activities, and the ability to engage in more productive livelihoods. Recognising gendered dimensions of land tenure, and improving access and ownership rights for women and marginalised groups, is central to identifying successful adaptation strategies for the future.

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KEY INSIGHTS

MALI

- New ways of conducting climate change research jointly with a wide range of stakeholders are needed. Nuanced information, including that on gender and social difference, should inform understandings on how different people, even within the same household, make decisions, and how policies might affect their ability to adapt in times of stress.
- Building continuous communication and flexible design into policy and governance systems that encompass all involved stakeholders and scales is crucial. This helps to avoid disconnects between national-level policies and local-level needs, and also helps decentralised governance structures become more transparent and effective.
- Alternatives to migration should be explored as adaptation strategies in order to avoid potential risks to the health and wellbeing of migrants and those who stay at home.
- It is essential to recognise the ways in which climatic and non-climatic stressors interplay to create new adaptation challenges and address/include these in policy.
- Participatory processes such as Transformative Scenario Planning are valuable tools for identifying and prioritising issues, building relationships, and fostering learning. These processes should be built into broader stakeholder engagement strategies in order to stimulate meaningful changes.

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KEY INSIGHTS
KARNATAKA, INDIA

- To deal with differential vulnerability across the rural-urban continuum, development policies and climate change adaptation interventions need to respond to the needs and dynamic aspirations of the most vulnerable. Urban development policies require a deeper understanding of informal settlements, including dimensions of differential vulnerability, particularly across the multitude of social categories present, the various actors involved, and the roles of social networks, local associations, and social cohesion. Additionally, viable employment options in rural areas should be developed through the strengthening of rural livelihoods and/or the natural resource base upon which these livelihoods depend.

- Migration drivers, processes and outcomes are complex, differentiated, and span the rural-urban continuum. Migration does not necessarily lead to improved wellbeing, and might have trade-offs for some members of the household. The increasing volumes of migration mean that policy makers need to reimagine adaptation as beyond-local, and develop strategies that can, on one end, make agriculture more viable, and on the other end, provide safer and more inclusive conditions for migrants in urban areas.

- Urban and regional governance in India is fragmented and weak, and there is little engagement with climate policy. Local governments lack personnel and technical capacity, and have not sufficiently leveraged the presence of a range of domestic and international non-state actors. The relationship between state and city government remains top-down, with decision making occurring at the state level, and local agencies responsible for implementation. The largest challenge, however, is to build support for climate action within state and local government officials.

- For decision makers and practitioners in semi-arid regions to make robust and informed decisions it is imperative that they take into account the available, legitimate and reliable knowledge that supports fine-scaled, contextualised, and robust adaptation responses. To facilitate knowledge transfer and local-level adaptation, knowledge brokers should be recognised and formally supported, and the effectiveness of extension services should be improved.

- Preserving functioning ecosystem services within the urban fabric is crucial for climate resilience planning. However in Bengaluru, these ecosystem services are being challenged by unplanned, haphazard urbanisation. Promoting ecosystem-service-based stormwater-management practices, and exploring alternative strategies that can enable stormwater attenuation or retention are necessary.

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KEY INSIGHTS
MAHARASHTRA, INDIA

- Building people's adaptive capacities in Maharashtra requires understanding differential vulnerabilities to climate risks and capacities among the different social (castes) and farmer (based on land ownership) categories. This understanding can be used to inform and develop local-level livelihood adaptation strategies. At the same time, the needs and aspirations of people in these different social and demographic categories need to be taken into account when preparing local adaptation and development plans.

- Heat stress in the peak summer months is increasingly affecting people's health and livelihoods. Many factors influence vulnerability to heat stress, including age, pre-existing health conditions, occupation, and type of housing. There is a need for state- and local-level heat action plans that address the needs of rural and urban populations. Community awareness about heat stress should also be improved so that people can take adequate precautions.

- Agricultural growth in semi-arid regions is largely dependent on groundwater. Depleting groundwater levels put the agrarian economy of the entire semi-arid region at serious risk. Raising farmer awareness about water management through effective communication, especially about groundwater use, is a crucial step towards implementing rules and regulations for groundwater management.

- There are a number of government and private information-communication-technology initiatives in India aimed at supporting farmers. But farmer access to usable information on weather and climate risks, and agro-advisories remains a challenge. There is also ambiguity around whether the available information meets famer requirements. A dynamic and responsive agro-met advisory system is needed to help manage climate risks and support adaptation. This system needs to provide information that is demand-driven, and relevant to the location of farmers and the specific crops that they grow.

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KEY INSIGHTS

TAMIL NADU, INDIA

- Climate change and climate variability have resulted in increased temperatures and unpredictable monsoons. Despite observed declines in rainfall and recurrent drought, some agricultural areas are greening due to a growing dependence on groundwater, and unauthorised lift irrigation from perennial rivers.
- An increase in agricultural water use, driven by government policy (e.g., free electricity), has enabled a shift from dryland agriculture to intensively-irrigated agriculture that may not be sustainable under future climates.
- The agrarian transition driven by changing aspirations has increased household incomes, especially of large and medium farmers. However, this increase has had little impact on women's capacity as they often cannot access these incomes for their own investments. The increased movement of men into non-agricultural livelihoods has opened up space for women in agriculture, but they remain constrained by a lack of asset ownership and consequent inabilities to increase land productivity.
- Although food security has improved in the region through the targeted Public Distribution System, undernourishment persists and may worsen with increasing urbanisation, shifts to high-value commercial farming (despite the risks), and water scarcity.
- Invasive alien species are adversely impacting native biodiversity and communities. Yet a lack of tenure, and the extensive network of protected areas in the region, complicate the use of these species by forest-dependent communities to supplement agricultural incomes.
- Poor access to services, and lack of knowledge and support constrain women, while men continue to maintain hegemony over technology-related, and indeed, more remunerative tasks. Education, however, remains one of the biggest assets to women, which allows them to diversify their livelihoods out of agriculture.

Read more

RESEARCH-INTO-USE HIGHLIGHTS

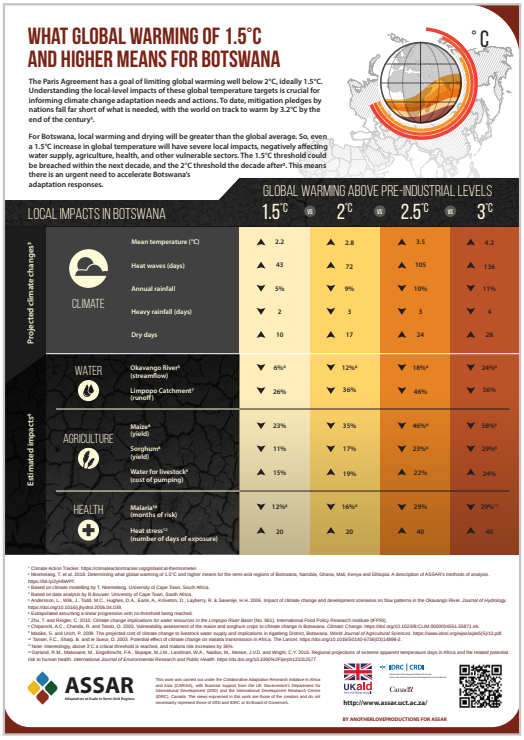
CREATING AWARENESS ABOUT THE LOCAL IMPACTS OF GLOBAL WARMING OF 1.5°C AND HIGHER

What does global warming of 1.5°C and higher mean for the countries ASSAR worked in? We developed a series of country-specific infographics to provide insight into this question by highlighting the impacts of rising global temperatures on local climatic conditions and key vulnerabilities in Botswana, Namibia, Ghana, Mali, Ethiopia and Kenya.

While limiting global warming to 1.5°C above pre-industrial levels is the main goal of the 2015 Paris Agreement, to date, mitigation pledges by nations fall far short of this, with the world being on track for a warming of 3.2°C by the end of the century. Under an increasing emissions trajectory, the 1.5°C threshold could be breached as early as the next decade, and the 2°C mark the decade thereafter.

In ASSAR countries, which are considered climate change "hotspots," even a 1.5°C increase in global temperature will have severe local impacts. Hence, there is an urgent need for these countries to accelerate their adaptation efforts, and to do so as effectively as possible.

These infographics highlight the projected changes in mean temperatures, heat wave days, annual rainfall, heavy rainfall days and dry days at 1.5°C, 2°C, 2.5°C and 3°C global warming scenarios. We positioned these climatic indicators in relation to their potential impacts on vulnerable sectors, including water, agriculture, health and biodiversity.



Understanding the implications of these projected changes is essential for policy makers and practitioners to make more informed decisions about adaptation needs and actions, and to target long-term resilience building in the face of unavoidable climate change.

Some of these infographics were presented at COP24. One immediate impact was with the Minister from Namibia, who had not been aware of the fact that global warming of 2.0 °C would lead to local warming of more than 3.0 °C in his country. Overall, these resources will provide important ammunition for national governments in arguing the case for meeting the Paris Agreement targets, and also in furthering understanding of national adaptation efforts to overcome the impacts of the rapid expected changes.

COMMUNICATING CRUCIAL FINDINGS ON HEAT STRESS IN A MYRIAD WAYS

The semi-arid regions of India are highly exposed to extreme heat events, which are likely to worsen in future. This means that heat-related deaths and illness are set to increase too, and urgent action is needed to protect vulnerable populations. During ASSAR, WOTR produced a body of work that examines heat stress in the semi-arid Maharashtra state of India. This peer-reviewed book chapter, together with this working paper, explore the health implications and coping strategies in vulnerable rural communities, where people are particularly exposed to heat. Many do strenuous outdoor work, tending to fields or working construction jobs through the hottest parts of the day.

Heat stress can lead to a variety of physical symptoms, ranging from mild to severe. If severe heat stress (heat stroke) remains untreated, people can die. In an effort to help government stakeholders understand and respond to these risks, WOTR used information briefs to highlight the key vulnerabilities and health impacts of heat stress.

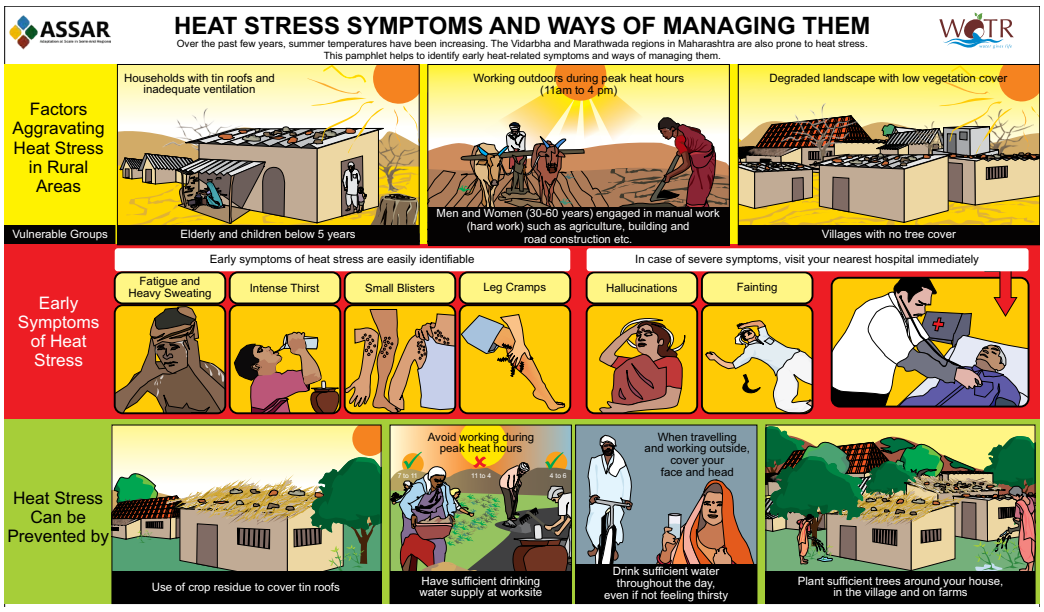
This information was also communicated in a short documentary that delves into the issue of heat stress in India's Yavatmal District. A pamphlet and poster, each of which were translated into several local languages, further explain how communities might recognise and respond to the signs and symptoms of heat stress. This multimedia approach provides an excellent example of how important research findings can be made widely accessible to diverse audiences.

INFLUENCING BOTSWANA'S DROUGHT MANAGEMENT STRATEGY

In recent decades, recurrent drought conditions have had devastating impacts on Botswana's food security, human health, and the national economy. Historically, government has taken a reactive approach to dealing with drought. However, climate change has caused an increase in the frequency and intensity of droughts, and a 'crisis-driven' approach is no longer appropriate. The Government of Botswana recognises the need to implement a more proactive and integrated approach to drought management.

In this light, and on the basis of recurring extreme drought conditions, Botswana's Rural Development Council has set up a 'Technical Team' tasked with developing a National Drought Management Strategy (DMS). This 'strategy ready' Background Paper was co-developed by a team of ASSAR researchers and practitioners from UCT and Oxfam GB with the view of contributing to and influencing the development of the DMS. Input was also provided by independent consultants who are experts in the field of policy development.

The Background Paper builds on and extends the Botswana Technical Team's outline of a draft DMS, the final version of which is required to be comprehensive enough to address all key issues directly and indirectly impacted by drought, covering short-, medium- and long-term time horizons. The outline of this Background Paper follows a proposed revised outline for the next version of the Botswana Government's DMS, in order to provide maximum assistance to the Technical Team as they revise the draft document.



ENCOURAGING PEOPLE TO CHALLENGE THEIR ASSUMPTIONS ABOUT WHO IS MOST VULNERABLE TO CLIMATE CHANGE

Climate change affects different people in different ways. While the harm caused by an impact is partly dependent on the event itself, the risks and vulnerabilities faced by people, households and communities are often socially differentiated by factors like gender, ethnicity, age and wealth. This series of infographics, which were the first of their kind to be developed by ASSAR, highlight the complex challenges faced by different social groups, and explore how effective adaptation can be achieved in highly unequal social contexts. The messages conveyed in these infographics were shared at the United Nations 62nd session on the Commission on the Status of Women in New York (2018), which focused on gender and the empowerment of rural women and girls.

In conjunction, ASSAR researchers and practitioners hosted a webinar on social differentiation across Africa and India, where we challenged assumptions about gender and climate adaptation which, traditionally, have positioned women as victims, whilst overlooking other factors that determine people's vulnerability. Participants were engaged in discussions around the socially-differentiated nature of climate risks and impacts. We provided examples of how, in some contexts, women do have agency, whilst in others food security is a largely gendered challenge. We also emphasised the role of changing household composition, and changes to the relationships within households, as well as the importance of considering people's changing aspirations when developing adaptation strategies. Understanding this complexity is essential for ensuring that adaptation is successful, sustainable and equitable, and that it does not compromise people's wellbeing.

HARNESSING THE POWER OF CITIZEN SCIENTISTS TO IDENTIFY AND MAP INVASIVE ALIEN SPECIES IN INDIA

The extensive spread of invasive species has become a thorny problem in the southern regions of India, where biologically-diverse landscapes provide an abundance of important ecosystem services to local communities. While invasive species such as *Prosopis juliflora* were initially introduced to India to combat desertification, stabilise sand dunes and provide fuel, their uncontrolled spread has negatively impacted indigenous ecosystems and rural livelihoods in a myriad ways.

There is now an urgent need to combat invasives, as climate change renders India hotter and more water stressed. However, ASSAR's findings show that responding to the country's invasive species problem is made difficult by poor access to relevant ecological data, and a lack of political motivation. Also, the dissemination of important information to farmers and other end-users is practically non-existent.

To combat these challenges, ATREE and its partners piloted the use of the ODK Collect application, which makes it easy for researchers, practitioners, Forest Department officials and schoolchildren to identify and map invasives using Android-based smartphones and tablets. They also created a pocket size invasive species identification key, along with a Land Use and Land Cover map of the region, that organisations can use to plan citizen-science mapping walks. Whilst only a first step to addressing the problem of invasives, such innovative approaches are essential for building an open-access database, and for paving the way to longer-term solutions, including the implementation of a co-management strategy whereby communities can benefit from invasive species management.

ENCOURAGING THE USE OF EXPERIENTIAL LEARNING TO STRENGTHEN ADAPTIVE CAPACITIES

Adaptation to climate risks involves decision making under highly complex and uncertain socio-ecological conditions, making anticipatory adaptation very difficult. Recently, experiential learning tools have gained traction among researchers and practitioners for their potential to enable a deeper understanding of stakeholder decision making under conditions of complexity and uncertainty. These learning-centric methods can be effective because they simulate realities in a way that cannot be captured in more traditional research and engagement techniques, such as surveys and presentations.

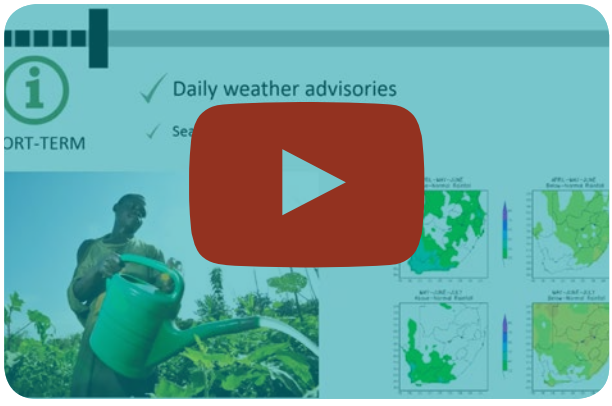
In collaboration with the Red Cross / Red Crescent Climate Centre, ASSAR researchers took part in experiential learning workshops and a webinar in which they learnt how to use creative, fun approaches to drive home key research messages. We then created a series of videos for widespread use to explain how, for example, the dynamic 'Farming Juggle' exercise can be used to explore the compounding effects of multiple stressors; or how the 'Vulnerability Walk' can allow participants to practically explore the socially-differentiated vulnerabilities that exist within their households and communities, and reflect on how adaptation efforts can effectively address these. Learning from these and other activities, such as the seasonal forecast and paying for predictions exercises, some ASSAR researchers were inspired to come up with their own games that would more accurately address their specific country challenges. For example, Maitreyi Koduganti developed the 'Peri-Urban Maze' to help people gain better insight into the complexities of living in peri-urban Bangalore; Udita Sanga developed a role-playing board game called 'Food and Farm' that explores the dynamics of decision making under a changing climate in Mali; and the WOTR team adapted games to help communities recognise the challenges associated with unsustainable groundwater use.

BRIDGING THE GAPS BETWEEN SCIENCE, POLICY AND PRACTICE

A major barrier to managing the risks of climate change in developing countries is the limited availability of accessible, reliable, and relevant weather and climate information. Equally challenging is the accessibility of scientific publications to non-academic audiences, including communities, and policy and decision makers to whom such information is often most relevant. ASSAR's work on the utility of weather and climate information for adaptation decision making in Africa and Asia has contributed to addressing both of these interlinked challenges.

This was achieved, firstly, through the publication of a journal article that explores why, despite an increasing volume of global and regional climate model simulations, there are very few clear examples of long-term climate information being used to inform decisions at sub-national scales. The article suggests that this is largely because the information being produced and disseminated is often ill-suited to inform decision making at the local scale. Drawing on lessons learnt from recent successes and failures in the study site countries, the article proposes a framework to help increase the utility and uptake of climate and weather information.

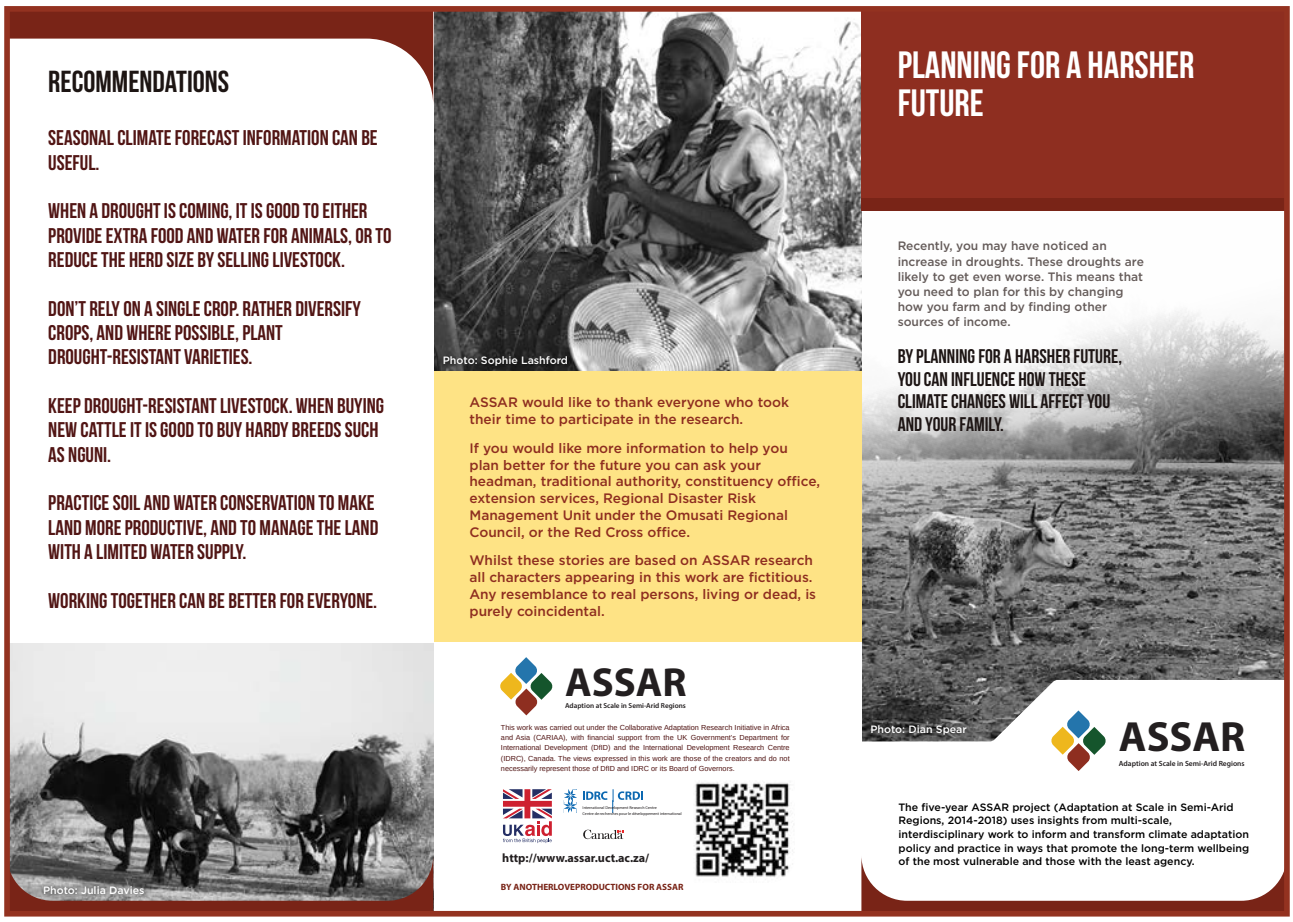
In response to the second challenge, in which non-academic stakeholders often miss out on the important messages conveyed in scientific publications, we worked in two ways to make the journal article more accessible to a wider range of audiences, namely: by highlighting the key findings and recommendations of the published article in a short, illustrative video; and by doing the same in information brief format. This integrated approach to publishing and sharing research findings is one example of how ASSAR contributed to bridging the gap between science, policy and practice.



ASSAR'S MASSIVE OPEN ONLINE COURSE TO TEACH DIVERSE AUDIENCES ABOUT RESEARCH-FOR-IMPACT

The Research for Impact Massive Open Online Course (MOOC) is a six week, free online course focused on what ASSAR initially called Research-into-Use, but what was later renamed to 'Research-for-Impact' (R4I). This MOOC continues ASSAR's mission to respond to the ever-increasing imperative of development research programmes contributing to impact beyond the academic sphere.

Hosted by ASSAR's institutional lead, UCT, and co-branded with Oxfam, the course covers the five key areas of the R4I approach in dedicated modules as well as an introductory module. These are: (1) Theory of change and monitoring, evaluation and learning; (2) Strategic partnerships and stakeholder engagement; (3) Strategic communications; (4) Capacity development; and (5) Influencing. The course also features case studies telling stories of impact and transformation from across ASSAR and the wider CARIAA programme. It is aimed at: academics, postgraduates and consultants working on development-related research; development practitioners (e.g., where a development agency wishes to mainstream climate change into their operations); and professionals from different sectors (e.g., engineering, water) working in developing countries.



A MULTIMEDIA APPROACH TO REACH LOCAL AND NATIONAL AUDIENCES IN NAMIBIA

Communities in the semi-arid Omusati Region of Namibia are highly vulnerable to climate variability and change, and it is increasingly urgent that Namibia implements effective adaptation measures. ASSAR's work in Namibia focused not only on understanding key vulnerabilities and identifying adaptation options for addressing them, but sought to share these important messages in innovative ways with a range of different audiences, using diverse forms of media.

One way that this was achieved was through the broadcasting of ASSAR's work on radio, a medium that reaches over 90% of the regional population. The radio show, which was conducted in the local Oshiwambo language, stimulated public dialogue on climate change, and focused on key topics related to adaptation. These broadcasts were complemented by a series of news articles that covered some of ASSAR's main research findings, for example those relating to water governance, culture as a barrier to the sale of livestock, the role of tradition and religion in farming decisions, and the need for support for smallholder farmers in Namibia. Developed by science writer Leonie Joubert, these articles were published in print and online in several newspapers including The Namibian, The Mail and Guardian, New Era, and The Patriot.

Academic and policy audiences were targeted through the publication and sharing of various journal articles, information briefs, working papers and a book chapter. We reached communities (in both English and Oshiwambo) using an information manual that explains what climate change is, as well as a brochure that describes what communities might do to adapt. We also produced a video documentary that explores how droughts and floods impact local farmers in Omusati, and how they are adapting to these ongoing challenges.

USING THEATRE TO REVEAL OUR BIASES AND SEEK NEW SOLUTIONS

The use of the theatre of the oppressed (TO) as a transformative social learning tool has proven to be a highly effective, yet underappreciated, mechanism for knowledge co-production and empowerment. Opposite to top-down approaches, TO creates supportive environments where people from diverse backgrounds can come together to experience, understand, analyse, and challenge unjust realities. The TO methodology was conceptualised by Augusto Boal in the 1970s, and gives audiences the opportunity to participate in the play and become actors, effectively rewriting the narrative and changing the outcome. Doing so encourages people to recognise their own biases and seek solutions from new perspectives. Effectively, this helps people to move from a situation where only the obvious, traditional, and socially/politically-tolerated solutions are pursued, to one where thinking about more just, liberatory, and hopeful futures is possible and encouraged.

ASSAR's experimentation with TO proved to be a successful way to engage people in thinking differently about problems and relating to them as human beings, and not just from the perspective of the roles they are playing professionally. We played ASSAR TO sessions:

1. At the Adaptation Futures conference in June 2018 in Cape Town, South Africa, where we worked with semi-professional performers from the Drama School of the local university (theme: Achieving research impact);
2. At the Transformations 2017 conference in Scotland;
3. For practitioners and students at Wageningen University and Reading University;
4. At UNFCCC COP 24's side event 'Development and Climate Days' in collaboration with IDRC (theme: Gender justice in the context of climate change);
5. For a generalist audience in two theatres in Cape Town, South Africa (one of which was within one of the city's informal settlements) on the topic of gender and climate justice; and
6. At one of ASSAR's annual meetings.

STRENGTHENING THE ABILITIES OF GHANAIAN FARMERS TO ACCESS CLIMATE INFORMATION

In the Upper West Region of Ghana, increasing climate variability, lengthy dry spells and water stress create pressing challenges for agricultural production and food security. With inadequate access to extension services, and a low base of knowledge about adaptation options, many vulnerable farmers have to make the hard choice of migrating to southern Ghana, or else to engage in relatively low-yielding, unprofitable dry season farming. As climate change exacerbates these challenges, there is an increasingly urgent need to capacitate farmers to implement effective adaptation measures that will enable year-round farming.

In this light, ASSAR's Ghana team resolved, with the support of a START Scenario Based Capacity Building grant, to establish Climate Advisory Resources Centres (CARCs) in the Nandom and Lawra districts. These CARCs are digital information centres aimed at training farmers and extension officers in practical adaptation, water management, and agronomic practices that will build resilience to climate change, whilst enabling higher crop productivity, including through the use of dry season farming advisories.

To complement this, and given the rapid increase in the use of smartphones in Ghana, the ASSAR team used funding from a Small Opportunities Grant to develop 'The Adaptation Hub' mobile application. This platform is aimed at extension officers, community development workers, researchers and students, and supports information transfer and knowledge sharing about climate change adaptation. This initiative inspired other ASSAR teams, such as Namibia, to consider developing their own mobile application to create sustainable links between extension workers, farmers and the private sector, and to support their research dissemination and stakeholder engagement efforts.

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ASSAR ACRONYMS

AAU	Addis Ababa University
ACDI	African Climate and Development Initiative
ASSAR	Adaptation at Scale in Semi-arid Regions
ATREE	Ashoka Trust for Ecology and the Environment
CARIAA	Collaborative Adaptation Research Initiative in Africa and Asia
CCAFS	Climate Change, Agriculture and Food Security
DES	Dynamics of ecosystem services
DFID	Department for International Development
DRFN	Desert Research Foundation of Namibia
FGD	Focus group discussions
ES	Ecosystem services
GLAS	Grants for local adaptation support
IAS	Invasive alien species
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
IIHS	Indian Institute for Human Settlements
IITM	Indian Institute of Tropical Meteorology
KII	Key informant interviews
LULC	Land use/land cover
PSA	Participatory scenario analysis
R4I	Research for impact
RCCC	Red Cross Red Crescent Climate Centre
RDS	Regional diagnostic study
RiU	Research-into-Use
SBCB	Scenario based capacity building
SCF	Seasonal climate forecasts
SOG	Small opportunities grant
TSP	Transformative scenario planning
UB	University of Botswana
UCT	University of Cape Town
UEA	University of East Anglia
UG	University of Ghana
UNAM	University of Namibia
UoN	University of Nairobi
VRA	Vulnerability and risk assessment
WOTR	Watershed Organisation Trust

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CROSS-REGIONAL INSIGHTS

Photograph: Institute for Environment and Sanitation Studies (University of Ghana)

BARRIERS AND ENABLERS TO ADAPTATION NEED TO BE VIEWED AS DYNAMIC AND INTERSECTING RATHER THAN INDIVIDUAL AND STATIC

ASSAR's overall concern was to generate knowledge that can support adaptation for the poorer and often politically-marginalised people facing livelihood and wellbeing stresses in semi-arid regions. To this end, ASSAR's primary research question and research framework placed high emphasis on understanding the barriers and enablers to adaptation in this context.

We were by no means the first project to try to understand how different factors constrain or promote the chances of achieving success in adaptation initiatives and actions. However, one thing we did do distinctively is explicitly frame our view of barriers and enablers in a normative sense – that is, in relation to explicit goals of how adaptation should proceed. We were not just interested in what makes *any* form of adaptation work; we were interested in what encourages or prevents effective, widespread and sustained adaptation that aligns with the aspirations of local communities.

The attention to barriers and enablers in this sense was imbued in all of the strands of our work (governance, social differentiation, ecosystem services, gender and knowledge systems). This helped to define not just what we studied and how, but how we approached the challenges of working with stakeholders, encouraging more participatory and transformative modes of engagement. Research on barriers and enablers was therefore an overarching rather than specific theme in ASSAR. Nevertheless, by comparing the insights drawn from our empirical cases with the existing body of literature on barriers and enablers, we think it is important to highlight two key points:

First, many discussions of barriers and enablers in adaptation focus on matters relating to finance, technology, skills, institutional capacity, and governance. But from our people-centred work in ASSAR we emphasise a strong, and in some case central role, that *cultural factors* may play in shaping development, uptake, and effectiveness of adaptation actions. By culture we refer to shared traits such as worldviews, values, norms, taboos, behaviours, and tastes that are often institutionalised within cultural structures related, for example, to social status, caste and gender. The importance of recognising cultural dynamics in this context is key, especially in semi-arid regions where deep-rooted traditions tend now to be confronted by rapid environmental and social change.

Second, we draw attention not just to the existence of multiple forms of barriers and enablers, but to their interaction in shaping adaptation outcomes. Just as different forms of enablers could combine to increase the chances of progress, so multiple interacting barriers can be mutually reinforcing to severely constrain progress. Equally, different factors can, in effect, counteract one another, with some acting to strengthen while others act to undermine the uptake and success of adaptation actions. Furthermore, barriers can be dynamic and change over time, with barriers in one adaptation context morphing into enablers at certain times or in certain situations. These interactions can often be highly complex and context-specific; but attempts to understand how a web of interacting factors is likely to play out in terms of shaping the conditions for successful development, uptake and effectiveness of adaptation actions is a key consideration for all those promoting effective adaptation.

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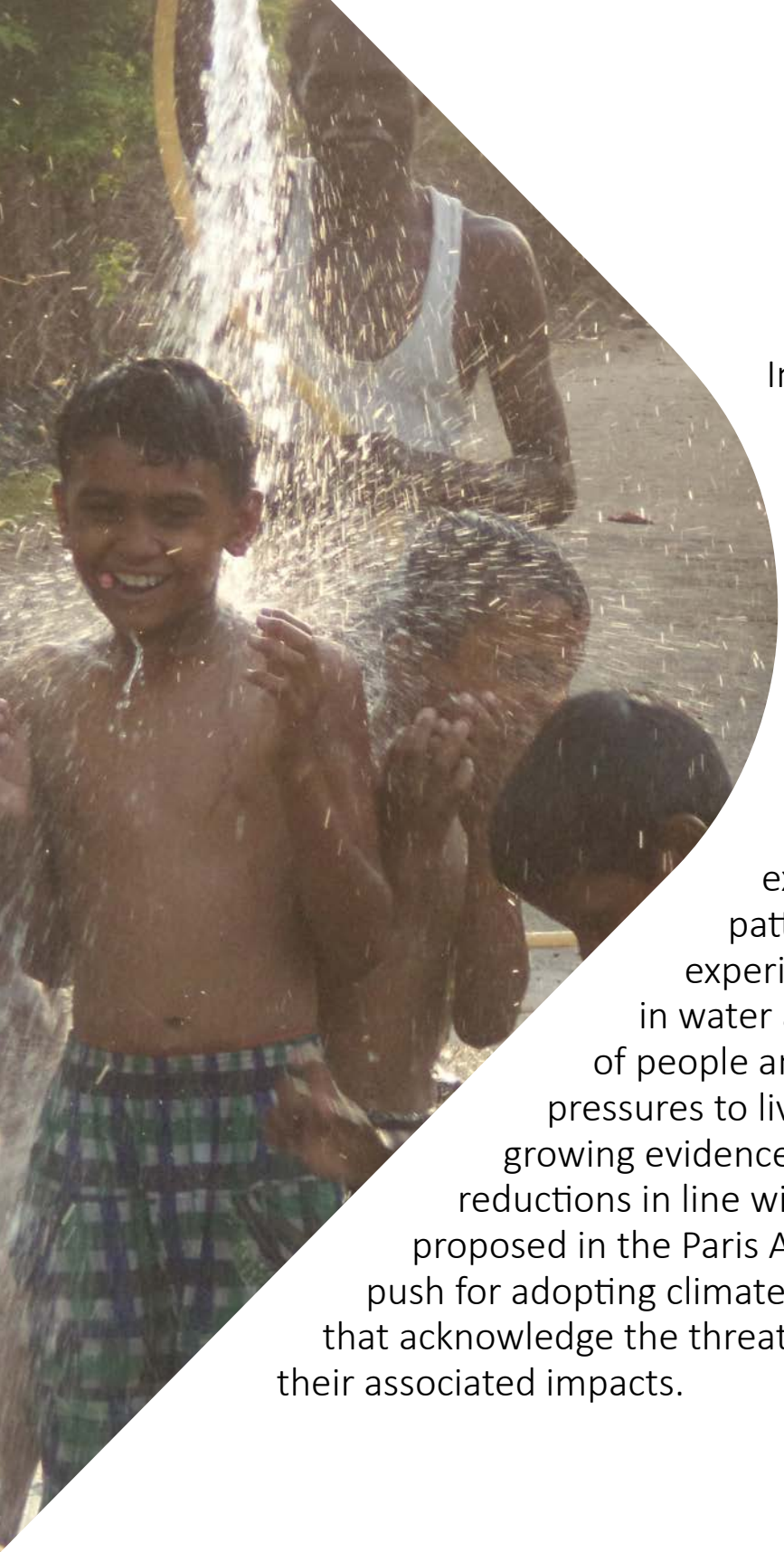
GLOBAL WARMING OF 1.5°C AND HIGHER BRINGS PROFOUND CHALLENGES TO SEMI-ARID REGIONS



In semi-arid regions, a global temperature rise of 1.5°C (and each interval of 0.5°C thereafter) will have progressively severe local impacts. With average local temperatures increasing faster than the global average (and rising more with each interval of global increase), along with intensifying climate extremes and changing rainfall patterns, semi-arid regions will experience declining crop yields, shifts in water availability, compromised health of people and livestock, and additional pressures to livelihoods. Affected countries have growing evidence available to argue for emissions reductions in line with a 1.5°C warming target, as proposed in the Paris Agreement, and at the same time push for adopting climate-resilient development pathways that acknowledge the threats of increasing temperatures and their associated impacts.

ASSAR's focus on global warming of 1.5°C+ and local impacts in semi-arid regions

The Paris Agreement set international targets for keeping global warming to well below 2°C compared to pre-industrial levels, with an ambition of limiting warming to 1.5°C. However, with the current emissions trajectory suggesting the world will exceed the 1.5°C target sometime in the 2020s there is an urgent need for countries to implement and raise the ambition of their mitigation commitments, as well as prepare for the local impacts of global warming.

To support the development and implementation of informed adaptation policy in the countries ASSAR worked in, we sought to better understand how global temperature rise will play out at the local level in the semi-arid zones of each country. We prepared a set of country-specific briefs and infographics, which examine in our focus countries (Botswana, Namibia, Kenya, Ethiopia, Mali, Ghana): (i) the changes in local temperature, rainfall, and climate extremes at intervals of global temperature increase; and (ii) the expected impacts on vulnerable socio-economic sectors, such as agriculture, water, health and fisheries – based on an extensive literature review and subsequent analyses. We timed our work on 1.5°C to coincide with the October 2018 release of the Intergovernmental Panel on Climate Change's (IPCC) special report on global warming of 1.5°C (IPCC, 2018), and put a local lens on the implications of this global report.

The countries we worked in are particularly vulnerable to the impacts of 1.5°C and higher levels of global warming. The semi-arid zones within these countries are at even more risk, due to the heat and drought sensitivity of many livelihood activities, and the isolation of semi-arid communities from alternative livelihood options and other support mechanisms. Our 1.5°C work helps quantify the impacts of each increment of global temperature, and illustrates the growing risks to the livelihoods and wellbeing of people in these areas. Our findings stress the urgency of implementing adaptation measures that anticipate the impacts of crossing the 1.5°C threshold, and serve to support the urgency of adaptation for the most vulnerable communities and sectors.

KEY CLIMATIC CHANGES

LOCAL WARMING IN SEMI-ARID REGIONS WILL BE GREATER THAN GLOBAL AVERAGE WARMING

Global temperature could exceed the 1.5°C threshold as early as the 2020s. Mean annual temperatures in semi-arid regions are expected to increase more than the global average (and progressively so with each interval of global increase). This means that already-hot semi-arid regions will be exposed to additional burdens of heat stress. As a priority, affected countries need to press for global commitments to limit global warming to 1.5°C, while planning pre-emptively for the threats associated with increasing temperatures.

The semi-arid zones of Botswana, Namibia and Mali are expected to experience considerably higher levels of warming than the global average (Table 1). Temperatures in the semi-arid zones of Kenya, Ethiopia, Ghana and India will also rise above the global mean, but will not warm as quickly as those in southern Africa and Mali. Rising global temperatures will become increasingly threatening to semi-arid regions if the global temperature threshold of 1.5°C is exceeded and further warming is not curbed.

Table 1: Multi-model mean temperature change (relative to pre-industrial levels) representing how different levels of global warming will affect mean local temperature changes for the semi-arid zones of each ASSAR country.

Level of global warming	Semi-arid Botswana	Semi-arid Namibia	Semi-arid Kenya	Semi-arid Ethiopia	Semi-arid Ghana	Semi-arid Mali	Semi-arid India
1.5°C	+2.2°C	+2.1°C	+1.7°C	+1.8°C	+1.9°C	+2.0°C	+1.7°C
2.0°C	+2.8°C	+2.8°C	+2.2°C	+2.4°C	+2.5°C	+2.7°C	+2.3°C
3.0°C	+4.2°C	+4.1°C	+3.4°C	+3.6°C	+3.8°C	+4.0°C	+3.4°C

GLOBAL WARMING BRINGS LONGER HEAT WAVES AND HOTTER DAYS TO SEMI-ARID REGIONS

Across all of the semi-arid regions ASSAR focused on, rising mean temperatures will result in much longer heat waves, many more extremely-hot days and nights, and fewer cool days and nights. This means that semi-arid regions will face increasing heat stress, which will threaten people's livelihoods and wellbeing. Semi-arid regions are thus locations of heightened sensitivity where action will need to be taken soon to improve the adaptive capacity of vulnerable populations.

As mean annual temperatures in semi-arid regions increase, temperature extremes are expected to increase in frequency and severity. The number of extremely-cold days and nights are expected to decrease across all regions, while extremely-hot days and nights are expected to increase across all regions. The largest changes to these temperature extremes are expected in the semi-arid zones of the countries that will experience relatively small increases in mean annual temperature (Kenya, Ethiopia and India). This suggests that although these zones may not be warming as fast as other semi-arid zones, the already-high temperatures they experience will cause even small increments of global temperature to have significant effects on heat stress exposure, and harmful effects on vulnerable sectors.

Heat waves are expected to become an increasing risk with rising global temperatures, increasing in duration at each interval of global temperature increase (Table 2). At the 3°C threshold, heat waves will dominate the climates of semi-arid zones for the length of summer, and in some zones for much longer periods (e.g., in Kenya heat waves may last up to 7.5 months at 3°C).

Table 2: Multi-model median change (relative to pre-industrial levels) in warm spell duration index representing how different levels of global warming (i.e., 1.5, 2 and 3°C) will affect maximum duration of heat waves for the semi-arid zones of each ASSAR country.

Level of global warming	Semi-arid Botswana	Semi-arid Namibia	Semi-arid Kenya	Semi-arid Ethiopia	Semi-arid Ghana	Semi-arid Mali	Semi-arid India
1.5°C	+44 days	+59 days	+89 days	+84 days	+48 days	+63 days	+43 days
2.0°C	+73 days	+94 days	+147 days	+136 days	+90 days	+105 days	+74 days
3.0°C	+138 days	+177 days	+225 days	+210 days	+181 days	+200 days	+113 days

SEMI-ARID REGIONS ARE EXPECTED TO EXPERIENCE SIGNIFICANT CHANGES TO ANNUAL RAINFALL, AS WELL AS MORE INTENSE RAINFALL EVENTS

Global temperature increases of 1.5°C and above will have significant effects on rainfall, reducing annual rainfall in the semi-arid zones of some countries (Botswana, Mali, Namibia), and increasing annual rainfall in others (Ghana, India, Ethiopia, Kenya). Equally important will be changes in the number of dry and wet days, with fewer days with rainfall, and more intense rainfall on days when rain does fall. For many semi-arid zones, drought will continue to be a persistent and increasing risk to the communities depending on rainfall for their livelihoods. At the same time, the intensification of rainfall events in all zones will increase the frequency and severity of floods that cause extensive damage to crops, livestock and infrastructure, and threaten human lives.

Statistically significant changes in total annual rainfall are expected in the semi-arid zones of most ASSAR countries (Botswana, Namibia, Kenya, Ethiopia), although some will become dryer (Botswana, Namibia, Mali), while others become wetter (Kenya, Ethiopia, Ghana, India; Table 3).

These rainfall changes will be accompanied by changes to the number of dry days and wet days, albeit in different ways in different places. The southern African semi-arid zones are expected to have considerably more dry days, while dry day numbers in the semi-arid zones of Ethiopia, Ghana, Mali and India will be less affected. The increasing number of dry days in semi-arid regions are likely to be associated with an increase in late onset rainfall and an erratic rainy season, increasing the chances of crop failure, and placing strain on already-stressed water resources. Despite increased rainfall in some zones, the number of wet days will not increase. Instead all semi-arid zones are expected to experience either no change to wet day numbers, or fewer wet days. These rainfall changes suggest that drought will continue to be a persistent and increasing challenge for many semi-arid regions.

While changes to total rainfall vary place-by-place, the intensity of rainfall will increase across all semi-arid zones at global warming of 1.5°C and above with more rain falling in heavy events (including on single rainfall days and during 5-consecutive rainfall days). While this is particularly true in places that are also expected to have increased annual rainfall (Kenya, Ethiopia, Ghana, India), for all zones, increasing rainfall intensity is likely to contribute to flooding and crop damage rather than alleviate drought and water stress. Therefore, to avoid extensive damages, communities and all those responsible for flood-risk management and reduction, need to factor in the changing nature of rainfall so as to develop locally-relevant approaches to managing flood risks.

Table 3: Multi-model median total annual precipitation representing how different levels of global warming relative to pre-industrial levels (i.e., 1.5, 2 and 3°C) will affect local rainfall patterns for the semi-arid zones of each ASSAR country. Data were not available for India.

Level of global warming	Semi-arid Botswana	Semi-arid Namibia	Semi-arid Kenya	Semi-arid Ethiopia	Semi-arid Ghana	Semi-arid Mali
1.5°C	-5%	-3%	+6%	+3%	+1%	-4%
2.0°C	-9%	-7%	+10%	+4%	+1%	-4%
3.0°C	-11%	-12%	+14%	+10%	+3%	-5%

KEY IMPLICATIONS OF DIFFERENT WARMING LEVELS

WATER SCARCITY AND WATER STRESS IN SEMI-ARID REGIONS WILL INCREASE PROGRESSIVELY AT EACH INTERVAL OF GLOBAL WARMING

Global warming of 1.5°C and above will have significant impacts on water resources in semi-arid regions. In most regions, inland deltas, rivers, dams and groundwater resources are expected to be adversely impacted by rising temperatures and changing rainfall patterns. These changes are likely to result in water scarcity and water stress that will get progressively worse at each level of global warming, exacerbating the vulnerabilities of semi-arid communities.

Semi-arid regions are classified as areas where evapotranspiration exceeds rainfall and are therefore inherently prone to water scarcity and water stress. Often, water resources in these areas, such as rivers, originate in places with wetter climates. At 1.5°C of global warming and above the streamflows of rivers will be affected by changing rainfall, with the streamflow of some rivers expected to decline (e.g., the Okavango river in Botswana is expected to lose 6-24% of streamflow between 1.5 and 3°C), while others are expected to increase due to heightening rainfall intensity (e.g., streamflow of the Awash river in Ethiopia is expected to rise by 3-10% between 1.5 and 3°C).

Inland deltas are vital water sources in Botswana (Okavango Delta) and Mali (Inner Niger Delta). The catchments for both of these deltas are expected to receive progressively less rainfall at 1.5°C and above. Higher temperatures will mean there will be a greater loss in water in these deltas because of increased evapotranspiration. This, along with decreased rainfall, will make droughts more severe, and water more scarce.

Groundwater is also a particularly important water resource for semi-arid regions. Groundwater stocks are expected to progressively decline at 1.5°C and above as these resources become increasingly exploited and recharge declines. For example, in the Klela Basin in Mali, groundwater recharge will decline significantly, dropping by 38% at 1.5°C of warming, and reaching zero net recharge by 3°C. Declining groundwater stocks will pose significant challenges to semi-arid communities who often lack access to alternative water services.

INCREASING GLOBAL TEMPERATURES THREATEN LIVELIHOODS, HEALTH AND WELLBEING OF SEMI-ARID COMMUNITIES

The local impacts of global warming of 1.5°C and above will have profound impacts on the dominant livelihood activities in semi-arid regions, such as rainfed agriculture and pastoralism. Agricultural and livestock productivity is expected to decline due to the direct and indirect effects of local climate change, and health and disease burdens of semi-arid communities are expected to increase.

Rainfed agriculture is extremely vulnerable to the changes associated with global warming of 1.5°C and above. Cereal crops in semi-arid regions are expected to suffer increasing losses at each interval of global warming, posing significant challenges to livelihoods and food security. For example, Botswana is expected to experience a 23% loss in maize yields at 1.5°C, with losses increasing to 35% and 58% at 2°C and 3°C, respectively. Communal and pastoral livestock rearing is also a vital, yet climatically-sensitive, livelihood activity in semi-arid regions. Changing rainfall patterns will affect rangelands for grazing, resulting in changes to the composition and amount of feed available for livestock. For example, the forage available for livestock grazing in the semi-arid regions of Mali is expected to decrease by 17% at 1.5°C, and by 26% and 43% at 2°C and 3°C, respectively. Water scarcity and heat stress associated with 1.5°C warming will also reduce livestock productivity, and likely increase livestock deaths, and reduce fertility. These losses in agricultural and livestock productivity will pose significant challenges to the livelihoods of semi-arid communities.

In addition to increasingly challenging livelihoods, the wellbeing and health of semi-arid communities will also be adversely affected. Changes in temperature and rainfall will affect the areas prone to malaria; the areas that become drier (e.g., semi-arid Namibia) will become less suitable for mosquito breeding at each interval of global warming, while those that become wetter (e.g., semi-arid Kenya) will become increasingly prone to outbreaks. Additional heat stress will also increase health risks, particularly for children, the elderly, women (on account of their outdoor workloads), and people with pre-existing diseases. By the 3°C global average temperature mark, the semi-arid zones of ASSAR countries will be exposed to temperatures where people will become vulnerable to heat stress and heat exhaustion almost year-round.

HIGH SENSITIVITIES AND LOW ADAPTIVE CAPACITIES MAKE SEMI-ARID REGIONS HOTSPOTS FOR CLIMATE CHANGE

While semi-arid regions are particularly vulnerable to the effects of global temperature increases of 1.5°C and above, they are not necessarily expected to receive more drastic changes than some of the other climatic regions in Africa and Asia. However, since semi-arid regions are more marginal for livelihood activities, the effects of climate change may have a relatively larger impact on these communities.

The IPCC's special report on 1.5°C identified southern Africa as a hotspot for climate change, with predictions suggesting hotter and drier futures that have numerous impacts on water, agriculture and human health. Indeed we found that, of all ASSAR countries, the semi-arid zones in Botswana and Namibia are likely to have the biggest relative local changes.

However, not all semi-arid zones will be disproportionately affected by global warming. Besides those in southern Africa, we found that the projected changes in average climates and climate extremes will not be significantly larger for semi-arid zones than for other climatic zones. In fact, for most countries we found that relatively bigger changes will occur in humid zones (Kenya, Ghana, Mali) and arid zones (Ethiopia).

The hotspot nature of semi-arid regions is thus more strongly determined by the sensitivity of semi-arid livelihoods to climate changes, and the low adaptive capacity of semi-arid communities. Semi-arid regions are often transitional zones between wetter and drier climates, and offer marginal landscapes for livelihood activities, such as rainfed agriculture and livestock. The reliance of semi-arid communities on sensitive natural resources, as well as their isolation and limited adaptive capacity, means that the impacts of climate change are expected to be more hard felt here than in other areas.

RECOMMENDATIONS

- Early and decisive international action to reduce the risks of overshooting the Paris temperature targets, and slow down the rates of change, is critical to reducing climate change impacts in semi-arid regions, and reducing an already considerable adaptation challenge. Parties to the UNFCCC should take immediate action to honour commitments made in the Paris Agreement, by lowering their greenhouse gas emissions and transitioning to low-carbon development pathways.
- Given the higher sensitivity of semi-arid regions to the impacts of global warming of 1.5°C and above, affected countries need to accelerate their adaptation planning, and prioritise early adaptation implementation.
- Vulnerability and Risk Assessments should be carried out across semi-arid regions to identify the communities, sectors and social groups that are most vulnerable to the local impacts of global warming of 1.5°C and above. These assessments should identify adaptation options which are sensitive to the varying vulnerability between social groups (e.g., gender, age, social class), and should integrate local knowledge and experiences of risk.
- Participatory planning should be promoted in order to build a shared understanding of vulnerabilities and risks between vulnerable communities, government and practitioners. Local communities need to be included in decision-making and adaptation planning for locally-relevant adaptation strategies that support their livelihoods and wellbeing.

- Semi-arid regions need to prepare for the increasing risks associated with droughts. Robust drought management strategies should be built on the three pillars of: monitoring and early warning systems, vulnerability and risk assessment, and preparedness, mitigation and response.
- Coordinated water governance with inclusive decision-making will be vital for dealing with droughts and vulnerability in rural communities.
- Economic development planning should account for water scarcity by focusing on development and implementation of low-water-footprint activities, or by assigning high economic values to water use.
- In anticipation of increased flood risks, semi-arid regions need to proactively devise, or improve upon, existing strategies for flood-risk management and reduction.
- The increasing pressure that each 0.5°C global temperature increment will place on communities in semi-arid regions may have significant impacts for the sustainability of their livelihoods and wellbeing. Policymakers need to plan for the transformation of livelihoods and migration of people out of these areas.

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ADDITIONAL RESOURCES

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Photographs in this section: Salma Hegga, Watershed Organisation Trust, Indian Institute for Human Settlements

CHANGING ECOSYSTEM SERVICES ARE INCREASING PEOPLE'S VULNERABILITY IN SEMI-ARID REGIONS

Semi-arid regions are undergoing complex shifts in land-vegetation-atmosphere interactions. These shifts impact on ecosystem services, with major corresponding implications for local communities. Yet, socially-just access to key ecosystem services is an integral part of climate change adaptation, across rural and urban settings. Enhancing human wellbeing and climate resilience in the face of these changes requires governance at multiple scales to take into account the synergies and trade-offs associated with the ecosystem services that are of value to different social groups. Including affected populations more concretely in management decisions will help to identify the main trade-offs, and support more effective design and implementation of interventions. Decision makers should also capacitate customary, traditional, and community-based natural-resource managers by devolving decision-making rights to them, and by facilitating and promoting equitable and adaptive natural-resource management.

ASSAR's focus on the dynamics of ecosystem services in semi-arid regions

Across the world, ecosystem services – which can be product-based (e.g., food, water), process-related (e.g., climate regulation, hydrology), cultural (e.g., spiritual enrichment, cognitive development) and ecosystem-supporting (e.g., soil formation, nutrient cycling) – offer direct and indirect contributions to human wellbeing. In the semi-arid regions of Africa and Asia, people are particularly dependent on ecosystem services given that communities here are characteristically poor with limited access to public services and livelihood opportunities. By harnessing ecosystem services, such communities have evolved lifestyles and traditions that enable their survival even when conditions are harsh.

Recently, however, the integrity of ecosystems in these areas has been compromised by rapid growth in the human population, inadequate or unsustainable governance of resources, and the increasing intensity and severity of climate extremes. These threats have led to reduced crop yields, diminished availability of fodder and non-timber forest produce, reduced surface flows in rivers, and depleted groundwater. As changes in regional climates are expected to increase the frequency and severity of extreme weather (rain, droughts and heatwaves), these impacts are expected to intensify.

ASSAR's primary aim was to understand the factors that enhance or degrade ecosystem services, and the ways in which these services can be equitably managed and governed to improve wellbeing under climate change. In a novel south-south approach, our research saw a non-hierarchical collaboration of 16 researchers from seven countries across East, southern and West Africa, and three Indian states (Tamil Nadu, Karnataka and Maharashtra), and we worked to understand the complex changes and patterns in semi-arid vegetation and socio-ecological systems through space and time.

We mapped ecosystem changes using a cross-regional coarse-scale study that relied on AVHRR GIMMS NDVI3g and CRU climate data to capture global and regional trends, and dynamics in vegetation response to climate and non-climatic divers – including evidence for the CO_2 fertilisation effects. We used finer-scale MODIS data (250 m) to capture recent changes that could be interpreted effectively by combining with household and village-level data. At the finest spatial scale we relied on Landsat (30 m) to map changes in land use and land cover. We also achieved a common understanding that greening and browning trends have a complex linkage with changes in key ecosystem services. We supplemented our work with insights from local communities drawn from participatory processes and focus group discussions.

We specifically sought answers to the following questions:

1. What are the key ecosystem services, how are they distributed and who benefits from them?

2. How is the use of ecosystem services governed and what are the consequences of this governance for different social groups and the ecosystem services themselves?

3. What changes in quantity, quality and distribution of ecosystem services have been seen in the last few decades and are expected in the medium- and long-term, and what drives these changes at the study sites?

4. What strategies and governance systems could enable the equitable and sustainable use of ecosystem services and enhance human wellbeing under climate change?

We found that global, regional and local drivers have changed vegetation in semi-arid ecosystems with implications for the spatial and temporal distribution of ecosystem services. In the next section, we detail some of these changes, and their impacts, from across our wide study area.

OBSERVED CHANGES AND DRIVERS OF CHANGE IN THE SEMI-ARID REGIONS OF EACH ASSAR COUNTRY

NAMIBIA

Changes	Drivers
Reduced access to water sources	Increasing frequency and intensity of droughts, government-regulated water restrictions
Decline in Mopane caterpillars	High temperatures, floods
Decrease in fuelwood, pasture lands and thatching	Increasing population and land clearing, drought-induced habitat degradation, unsustainable harvests, expansion of agricultural lands

BOTSWANA

Changes	Drivers
Decline in pasture land, Mopane caterpillars and fuelwood	Drought-induced habitat degradation, expansion of agricultural lands, over-harvesting linked to over-permitting
Increased human-wildlife conflict, decline in plant resources	Changes in rainfall

ETHIOPIA

Changes	Drivers
Reduced access to pasture and water, degrading pasture lands	Agro-industrialisation and land privatisation, invasive species

KENYA

Changes	Drivers
Increase in conservancies and pastures	Community income-generating schemes (e.g., tourism), wildlife protection, planned grazing management
Decline in pastures and water availability	Increase in livestock, human population, perceived climate changes

ETHIOPIA AND KENYA

Changes	Drivers
Expected increases in crop production	Irrigation, good water governance
Changes in water availability and access	Large infrastructure, agricultural intensification, competing uses for water (agricultural/industrial, household/livestock)
Increased pressure on natural resources	Population pressures

GHANA

Changes	Drivers
Decline in availability of timber and non-timber forest products	Increasing demand (domestic and commercial use of timber as fuelwood and building materials)
Loss of Forest Reserve lands	Charcoal production
Expected changes in water availability	

WEST AFRICA

Changes	Drivers
Decline in provisioning ecosystem services	Climate variability, deforestation, increased bush-burning

INDIA

Changes	Drivers
Shifting boundaries of semi-arid regions	Changes in precipitation regimes combined with warming and CO_2 fertilization effects

INDIA, BENGALURU

Changes	Drivers
Changes to grazing lands (peri-urban Bengaluru), and to the lake system, with impacts on hydro-services (Bengaluru)	Urbanisation and unplanned development, declines in rainfall (but low-cost interventions are leading to restoration)

INDIA, MAHARASHTRA

Changes	Drivers
Reduced groundwater availability	Government farm-pond scheme (maladaptation), rainfall variability
Increased vulnerability to agricultural yields	Increases in area under cultivation, agricultural intensification, horticulture

KEY INSIGHTS

SEMI-ARID REGIONS IN INDIA AND AFRICA ARE HOTSPOTS OF CLIMATE CHANGE

Semi-arid regions, typically located on the boundary of arid and subhumid climate zones, are considered one of the more vulnerable hotspots for global change, especially climate change. These transitional climatic regions are relatively highly populated, with livelihoods strongly dependent on climate-controlled, often degraded, natural (ecosystem) resources. We assessed spatially-averaged and spatially-explicit trends in climate over 1901-2013 in four semi-arid regions in India, East Africa, southern Africa and West Africa, and compared the rates of change with those from surrounding non-semi-arid areas.

Since 1960, all semi-arid regions have showed temperature increases ranging from 0.15°C to 0.24°C per decade, similar to global averages, with semi-arid regions in West and southern Africa warming faster than surrounding areas, and vice versa for India and East Africa. There are, however, locations of much faster warming – "hotspots within hotspots" – in all semi-arid regions. Rainfall shows decreasing trends in the African semi-arid regions, similar in direction and magnitude to surrounding areas, but the trends are not spatially statistically significant. Over India, semi-arid regional rainfall exhibits an increasing trend, in contrast to drying in the surrounding areas. There is a decoupling between the ways that temperature and precipitation covary between semi-arid regions and surrounding regions in recent decades in all four regions, especially in India, East Africa and southern Africa. This suggests that the four semi-arid regions may be critical areas of change for precipitation-evaporation-temperature interactions.

PROTECTED AREAS IN INDIA RESPOND DIFFERENTLY TO GLOBAL CLIMATE DRIVERS COMPARED TO SIMILAR AREAS IN AFRICA AND INDIA

Natural and human-dominated semi-arid ecosystems show clear signals of CO_2 fertilisation effects across protected areas and their buffers in India and Africa. Although the amplitude of the annual seasonal cycle is increasing over time in all regions, there are clear differences in the response of protected areas and their agro-pastoral buffers in India and the three African regions. In India, the protected areas have a smaller amplitude of annual seasonal change compared to the buffer, which we attribute to their relatively greater moisture-storage regimes; these trends are reversed in the African semi-arid regions where protected areas and buffer zones respond similarly.

The amplitude of annual seasonal phenology is increasing over time; some of this is due to decreases in dry-season vegetation, and some to greater greening at the peak of the growing season. A comparison of protected areas with agro-pastoral buffers (20 km) around them, indicated that semi-arid protected areas in India have a relatively lower amplitude of annual seasonal change, which we attribute to the higher elevations, and the protected watersheds in which these protected areas tend to be located.

Greening and browning had very different impacts on key ecosystem services in the regions. In some cases greening was associated with increased productivity and improved ecosystem services, while in other cases it was driven by a proliferation of detrimental invasive species. These vegetation changes impact communities, households and individuals through changes in the availability of ecosystem services such as biomass, water and food, which are mediated by social differentiation and governance regimes. We found clear evidence for CO_2-fertilisation causing higher greening trends, particularly across sites in the 350-800 mm rainfall gradient, supporting the hypothesis that this effect would find its highest expression in moisture-stressed sites.

Recommendations

- Better communication of global and local drivers of ecosystem change and emerging trends amongst policy makers and communities may result in more robust adaptation practices. For example, a better understanding of the effects of CO_2 fertilisation and sequestration can help understand a few of the positive impacts that IAS have on global change.

- The connectivity in ecological and hydrological processes between protected areas and their buffer areas should be reflected in land-use policies in the buffer zones. Specifically, recharge areas for groundwater inside protected areas should be recognised for their role in sustaining agriculture outside.

- The capacity of multi-disciplinary teams of practitioners, land managers, and scientists needs to be built to: improve their understanding of the ongoing changes in socio-ecological systems, including the dominant local, regional and global drivers of ecosystem change (and their feedback mechanisms); and enhance their abilities to generate future scenarios of change.

- The overall implications of greening linked to bushy encroachment of invasive tree species should be considered when designing adaptation options under near-future and multi-decadal time-scales.

MANAGING NATURAL RESOURCES AND INVASIVE SPECIES REQUIRES APPROACHES THAT ACTIVELY ENGAGE WITH, RECOGNISE, AND RESPOND TO THE DIFFERENTIATED NEEDS OF AFFECTED COMMUNITIES, INCLUDING TRADITIONALLY-MARGINALISED STAKEHOLDERS

Including affected populations more concretely in decisions about interventions for natural-resource challenges will help to identify the main trade-offs, support more effective design and implementation of interventions, avoid unintended consequences – especially for the most vulnerable – and help to ensure that the needs of those typically excluded from decision making are heard and met.

Pasture scarcity is a major issue for pastoral and agro-pastoral populations in the semi-arid regions of Kenya, impacting on livestock and the wellbeing of populations, contributing to increased levels of population mobility, creating conditions for conflict, and leading to other negative impacts. In Ethiopia, one of the biggest problems facing the Middle Awash Valley is the spread of the invasive thorny shrub Prosopis (*Prosopis juliflora*), which is increasing rapidly in the region, reducing the availability of pasture, closing off access to water resources, and posing health threats to livestock and people. To date, management interventions have seldom been effective. In both countries we focused on understanding both of these problems and their potential solutions, including understanding how different ways of managing the problems are viewed by different people, and what helps or hinders different approaches.

We conducted Participatory Scenario Analysis (PSA) with three communities in each study area to explore the positive and negative trade-offs associated with different scenarios or visions for future *Prosopis* management (Ethiopia), and future resource management (Kenya), and assess the relative preferences for these. In both sites, we augmented our PSA work using key informant and semi-structured group interviews on how the respective problems were perceived, and which solutions were most preferred. We also analysed remotely-sensed data to understand the distribution (and change) of *Prosopis* in the study area.

In Kenya we found urgent and effective approaches are required to address the issue of pasture scarcity. As the climate becomes more unpredictable and interacts with other causes of vulnerability, maintaining access to adequate pasture is likely to become even more pressing. However, attempts to manage the availability of pasture fairly have only been partially effective because such initiatives have commonly suffered from design and operational issues. For example, attempts to stimulate sustainable land management have been hampered by the competing stakeholder interests and power imbalances that prioritise the interests of certain groups over others, increasing the likelihood that interventions will fail, with potentially negative consequences for populations already experiencing pasture scarcity.

In Ethiopia, attempts to control or contain *Prosopis* have struggled not only because of the rapidity and tenacity of its spread but also because such initiatives have commonly suffered from design and operational issues. For example, attempts to stimulate sustainable use have been hampered by the use of inappropriate technologies that have failed to operate effectively, and economic barriers that deny widespread access to livelihood opportunities associated with the harvesting of *Prosopis* wood and seed pods. Moreover, many interventions have been designed with generally little voice given to grassroots perspectives, increasing the likelihood that interventions will fail, with potentially negative consequences for populations already experiencing the impacts of the invasive plant.

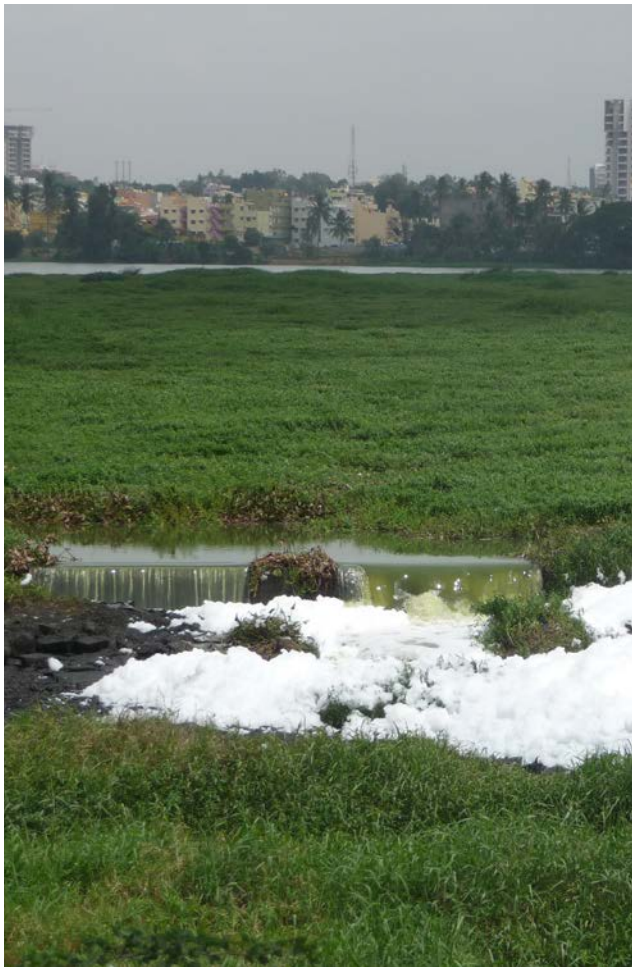
We learned that making *a priori* assumptions about how people in a particular setting are likely to perceive and prioritise a specific form of intervention is a risky endeavour. In both Kenya and Ethiopia, the divergent viewpoints exhibited between participants within the same workshops highlighted the importance of consulting in a way that is sensitive to the socially-differentiated nature of communities. Any intervention will result in winners and losers; recognising this should form an important element of design and implementation.

Recommendations

- Affected populations experience the impacts of management decisions in socially-differentiated ways and, crucially, have a plurality of views and opinions on the most appropriate responses to the issue in hand. Any intervention will result in winners and losers. Recognising the potential for unintended social consequences should form an important element of the design and implementation of any intervention, with efforts taken to minimise negative impacts on the most vulnerable groups.
- The views and perspectives of affected communities must be included within decisions on the most appropriate ways and means to manage environmental change. To achieve this, meaningful and effective consultation that carefully considers power imbalances is required to allow a plurality of opinions and voices to be heard. One way to achieve this is to consult with socially-differentiated groups of people separately.
- In the context of *Prosopis*, this widespread consultation is particularly important because the invasive plant is likely to result in ecosystem 'bads' and disservices as well as ecosystem 'goods' and services, which will be distributed unevenly across affected populations. Policy and action cannot rely on de-contextualised narratives and aggregated notions of wellbeing that pre-define and structure how institutional actors see, understand and, by implication, frame solutions.
- Any intervention will produce trade-offs. Exposing and making these trade-offs explicit, particularly those that affect marginalised populations, can aid institutional actors in identifying not only which interventions are preferred, but by whom and at what cost or benefit.
- Present available technology makes it difficult to completely remove *Prosopis* from the landscape. This may never be a viable goal. It is advisable instead to propose a mosaic of management methods suited to specific geographical settings: strategies that are likely to comprise both its use in some less productive areas, and removal from some of the most productive areas used for irrigation cropping and rangelands.

FUNCTIONING ECOSYSTEM SERVICES CAN ENHANCE CLIMATE RESILIENCE IN CITIES

Preserving functioning ecosystem services within the urban fabric is crucial for climate resilience planning. However in Bengaluru, these ecosystem services are being challenged by unplanned, haphazard urbanisation. Promoting ecosystem-service-based stormwater management practices, and exploring alternative strategies that can enable stormwater attenuation or retention are necessary.



Urbanisation, especially in developing countries, is often accompanied by degradation of the surrounding environment and overall loss of biodiversity. When urbanisation is rapid (due to increased economic activity), institutional capacities are often found lacking, and unplanned development occurs. The result is the degradation and loss of crucial ecosystem services such as water provision, disaster protection, water treatment and healthy environments. A changing climate will exacerbate and compound these urbanisation issues while the decline in ecosystem services is likely to make cities less resilient in the future.

Bengaluru is the fastest growing city in India. This growth is fueled by a sharp rise in economic activity, which inadvertently has had a major impact on ecosystems and biodiversity. While historically, the city attracted people for its pleasant climate provided by the large expanses of green cover and water bodies, the subsequent influx of growth has led to a reduction in green cover due to the disproportionate increase in impervious surfaces, along with the encroachment and degradation of water bodies. Furthermore, due to weak governance and haphazard planning, the city has grown in an inequitable fashion where the peripheries have seen rapid urbanisation along with a high degree of fragmentation of processes and services.

Peri-urban growth in Bengaluru has had implications on the integrity of the watersheds that define the northern edge of the city. The management of water in a city, both for anthropocentric uses, and for those that cater to the health of the environment, should be critical components of planning practices. It is with this lens that we conducted geospatial analyses on a sub-watershed which is a part of the larger Yale Mallappa Shetty Kere (YMSK) watershed.

We found that changing rainfall regimes are increasing water extraction patterns. In addition, changes in land use and land cover, and reduced infiltration caused by rapid urbanisation, have led to a decline in groundwater levels. Encroachment of previously green and open spaces coincides with regions that have reported floods in the last few monsoon seasons. Land-use changes – typically in the form of an increase in impervious area, reduction in local water retention in lakes, a decrease in vegetation cover, and alteration in drainage patterns – have led to enhanced threats of flooding and water shortages in the city. Stormwater often mixed with sewage flowing through the urban landscape has also led to widespread contamination of water bodies, causing degradation of ecosystem services attached to these water bodies.

Recommendations

- Ecosystem-service-based stormwater management practices should be promoted to better conserve stormwater as a resource, while in the process providing additional ecosystem service benefits including hydrological services, climate regulation, and flood mitigation.

- There is a need for exploring alternative strategies that enable stormwater attenuation or retention within urban environments. Low Impact Development (LID) is one such suggested approach. Green Infrastructure-based development (such as LID) is intended to mimic the pre-urbanisation hydrology of the location or city, thereby providing a valuable ecological service. It is possible to identify potentially viable spaces within urban catchments and to map them at a high resolution with the intention of rejuvenating hydrological flows in cities. This is technically feasible for Bengaluru, but the social implications of doing so need to be extensively studied first.

CLIMATE CHANGE, LAND USE/LAND COVER CHANGES, AND OVEREXPLOITATION OF GROUNDWATER EXACERBATE VULNERABILITIES

In Maharashtra, increased access to groundwater has caused the area of land used for agriculture and horticulture to mushroom over the past 25 years. A major part of the Sangamner transect is now classified as groundwater 'overexploited.' Global warming of 1.5°C and higher is expected to add further challenges to existing groundwater vulnerability here, and exacerbate the impacts of recurrent droughts and heat stress.

Between 1991 and 2016, the Mula-Pravara river basin, located in the semi-arid region of Maharashtra state, has seen the area of land used for agriculture and horticulture increase by about 98% and 1601%, respectively. At the same time, unculturable and culturable wasteland (UCW) declined by 34.6%, and fallow lands declined by 60.5%. These changes can be majorly attributed to increased access to groundwater, irrigation projects, and watershed development programmes.

In the Sangamner sub-region, an assessment of precipitation trends indicated a modest increase in annual average rainfall since the early 1990s. It also recorded high variability in the contribution of sparse rain and moderate rain events. Due to increased groundwater dependence in the Sangamner transect, the major part of the block is now groundwater 'overexploited'.

We found that almost 87% of the area in the study villages is classified as having 'high' to 'extreme' groundwater vulnerability. These zones have very low hydraulic yields, with low capacities for groundwater storage in the hard rock basaltic aquifers. This makes it all the more important to use the groundwater resource judiciously. Vastly different vulnerabilities and current trends of groundwater use exist in the region that can shift areas of 'low' vulnerability to 'high' and 'extreme' vulnerability in the coming years. Current practices of groundwater exploration and use (pumping excessively; storing groundwater in farm ponds; drilling new and deeper wells) can impact base water flows, and dramatically reduce water availability.

Amongst various schemes, farm ponds are being encouraged at a large scale by the government in order to drought-proof the region. In principle, farm ponds are traditional rainwater harvesting structures that are supposed to have an inlet to allow runoff to ingress in the pond, and an outlet to let out excess water. Their purpose is to help farmers adapt to the vagaries of the monsoon by harvesting rainwater. But these farm ponds have changed from their intended design and are now widely used as storage tanks to hold groundwater, which is extracted indiscriminately from the multi-layered aquifer system.

We found that the benefit-cost ratios were higher in the case of smaller farm ponds as compared to large farm ponds. When considering externalities of pumping out groundwater and storing it in surface water structures (e.g., value of evaporation losses, and opportunity costs of land lost to farm pond structure) as costs, then the Net Present Values (NPV) decreased for all sizes of farm ponds. Only the smaller farm ponds were found to be viable with a positive NPV and benefit-cost ratio.

Global warming of 1.5°C and higher is expected to result in local temperatures in much of India rising more than the global average. This will likely usher in further climate challenges that exacerbate current community vulnerabilities to land use/land cover change, and groundwater overexploitation.

Recommendations

- It is essential for India's current national and state action plans on climate change and adaptation to consider the local implications of global warming of 1.5°C and 2°C in India and make informed policy decisions around these.
- Overdependence on groundwater could have serious implications for regional agricultural sustainability. State government needs to prioritise groundwater management by formulating strategies to operationalise the recently-enacted Maharashtra Groundwater (Development and Management) Act, 2009 to regulate groundwater. This is a first step towards addressing groundwater governance issues, and will require tackling the conflicting development programmes and subsidies that sometimes inadvertently lead to groundwater overexploitation.
- In zones identified as being 'highly' or 'extremely' vulnerable to groundwater scarcity, the use of inefficient and unsustainable irrigation practices, like flood irrigation, should be reduced. Farming of water-intensive crops, such as sugarcane and sweet lime, should be avoided.

- A better, more fine-scale/local level understanding of underground common-pool, multi-layered aquifers, and groundwater flow patterns, can guide the regulation of borehole drilling, determine the best placement of water-saving measures, and assist communities with their water-management efforts in lieu of changing rainfall regimes.

- Farm ponds converted to groundwater storage structures should be closely managed to minimise and prevent misuse. For this to happen, the gram panchayat (village governing body) needs to proactively engage in monitoring and regulating the extraction of groundwater for storage in farm ponds, as well as farm pond size.

- It is important to generate knowledge and evidence about groundwater status at the local level, create awareness among different stakeholders (farmers, concerned government authorities, researchers), and create a platform for dialogue for local solutions at the community level. Such a platform could help to bridge knowledge gaps pertaining to hydrogeological information at the community level, and contribute to making more robust groundwater management plans at the village and aquifer levels.

EFFECTIVE ADAPTATION TO, AND MANAGEMENT OF, INVASIVE ALIEN SPECIES REQUIRES BOTH TOP-DOWN AND LOCAL PARTICIPATORY APPROACHES

In the Moyar Bhavani, Invasive Alien Species (IAS) are negatively impacting native biodiversity and ecosystem services. The ability of local forest-dependent communities to develop management practices and adaptation strategies to the emerging novel ecosystems is constrained by lack of land tenure due to the delayed implementation of the Forest Rights Act (2006) in Tamil Nadu, and confounded by the protected area status of a large part of the landscape. Meanwhile, the capacity of the Forest Department, NGOs and local communities in understanding the temporal and spatial dynamics, and magnitude of the problem, is constrained. Potential short- and long-term management strategies remain reactive, and are uninformed by scientific studies.

Forests in the semi-arid tropics play a key role through provisioning services to tribal communities, which are strategically used to buffer risks. *Prosopis* (*Prosopis juliflora*) was introduced to the landscape in the 1960s and was expected to contribute to provisioning services through fuel and animal feed, thus increasing the productivity of grasslands. The expansion of *Prosopis* is driving a significant greening of vegetation along the Moyar valley. *Prosopis* in the region is now impacting biodiversity (blackbuck in the region prefer native species, and avoid *Prosopis*-dominated landscapes) and community livelihoods (crop raiding on farm lands from herbivores is linked to increases in *Prosopis* growth). The impacts of *Prosopis* may also worsen in the near future as the consumption of pods by wild herbivores is augmenting the dispersal of this species by blackbuck and elephants.

At higher elevations, the expansion of *Lantana* (*Lantana camara*), another IAS, has impacted local livelihoods significantly. Livestock pasturing areas have reduced, and NTFP productivity in the region has been impacted by the spread of IAS. Resistance from state agencies (especially the Forest Department) to implement the Forest Rights Act, and the pertinacious focus on physical solutions for IAS spread in the region has neglected the potential of community-led solutions.

Furthermore, the spatial and temporal dimensions of the spread of IAS, and their impacts on NTFP, livestock grazing, and wild herbivores, is not adequately acknowledged and more research is needed on the factors that drive their occupancy and persistence.

Recommendations

- The Forest Department invests significant effort in control of IAS in protected areas, albeit sporadically. An ecological monitoring effort is needed to assess the effectiveness of current strategies.
- Information on IAS is patchy and restricted to protected areas, and the potential of technological advances (e.g., smartphones and tablets) to map and monitor the spread of IAS frugally and efficiently remains underused.
- The management of IAS needs to move from the rhetoric of state-funded extraction alone to community-led solutions that take into consideration the potential for livelihood generation through the removal of IAS by communities. A novel ecosystem framework is needed to assess the potential of IAS for livelihoods, biodiversity and ecosystem services.

CLIMATE CHANGE AND VARIABILITY ARE DISCORDANT WITH OBSERVED CHANGES IN LAND USE AND LAND COVER

Large parts of Tamil Nadu receive the bulk of their annual rainfall during the northeast monsoon (Oct-Dec), but our analysis reveals a shift in the monsoon, with less rain falling during the winter months. The winter rains are crucial for agriculture, and this reduction in moisture, combined with warming, is likely to pose a challenge to the resilience of these socio-ecological systems. These shifts in rainfall regimes are, however, being currently buffered by increasing dependence on groundwater, which is driving greening in cultivated areas. Farmers are reducing risks by opting for non-agrarian livelihoods, and increasing – and likely unsustainable – dependence on groundwater. Future climate is likely to reduce moisture availability and elevate temperature, but SWAT (Soil and Water Assessment Tool) hydrological models are not adequate to capture changes in evapotranspiration under different land-cover change scenarios.

We noted a significant decline in the southwest (Jun-Sep) monsoon in the semi-arid regions of north-west and central India from 1951-2007. Although these declines are not observed in Tamil Nadu, large parts of the state are witnessing declining contributions from the northeast (NE) monsoon in areas historically adapted to receiving the bulk of their annual rainfall in these (Oct-Dec) months. This shift in monsoonal regime is also accompanied by delays in the onset and amount of rainfall received through the NE monsoon, driving changes in cropping patterns. Our analysis also revealed significant increases in mean annual temperature, and summers are now reported to be hotter and starting earlier.

Despite the declines in precipitation we observed, we noted significant greening in the Moyar-Bhavani semi-arid region (from 2001-2015), with rapid change occurring from 2006-2015. In the agrarian socio-ecological systems (SES) along the Bhavani River, this reflects an increasing dependence on lift irrigation from the river, and groundwater extraction for crop irrigation. The current risk-management strategies of farmers, which include non-agrarian livelihood diversification, groundwater dependence, and shifting of cropping patterns, have adverse implications for household wellbeing and gender relations within the household, which may not be sustainable.

We also conducted an assessment of the impacts of future climate and potential land-use change on hydrology in the Moyar-Bhavani by combining statistically-downscaled climate variables with a

SWAT hydrological model. Our assessments reveal a projected decline in precipitation, and an increase in minimum temperatures by 2100 under the conservative RCP2.6 (Representative Concentration Pathway 2.6) with respect to the baseline (1970-2000). Currently, evapotranspiration is observed to be more than half of the incident precipitation, followed by soil moisture, runoff and deep recharge. This is expected to change dramatically under future climate scenarios with nearly 90% being consumed by evapotranspiration at the cost of contributions to soil moisture and runoff. Changes in landuse and landcover were explored using a scenario-based approach that incorporated (10%, 25%, and 50%) changes in the extent of forest cover, agriculture, plantations and barren land, but these results were inconclusive. Evapotranspiration under future climate is likely to be a key driver of water stress.`

Recommendations

- More effort needs to be invested in studying the NE monsoon, as monsoon research tends to be focused on studying the southwest monsoon. This will help in the development of appropriate adaptation options for communities that depend on these rains.
- Shifts in monsoonal regimes need to be investigated under ongoing and future climate change as these are expected to impact regional ecology, agriculture and adaptation options.
- Further work is needed to assess the hydrological response of changing land cover (e.g., by using different hydrological models) under future climates, by choosing physical hydrologic models or combinations of models that are able to mimic the key hydrologic fluxes in a particular basin (e.g., evapotranspiration in semi-arid regions).
- Adaptive management of groundwater under a changing climate is a key ingredient of adaptation.

ECOSYSTEM SERVICES NEED TO BE MANAGED MORE SUSTAINABLY AND EQUITABLY, AND ALTERNATIVE LIVELIHOODS MAY BE NEEDED

Provisioning ecosystem services are fundamental to the livelihoods and wellbeing of communities in the Bobirwa sub-district of Botswana. The enforcement of restrictions on harvesting, monitoring of government programmes to improve agricultural productivity, and the enhancement of alternative livelihood options could all help to reduce the pressure and overreliance on vulnerable ecosystem services.

With few alternative livelihood options, communities in the Bobirwa sub-district are heavily reliant on ecosystem services, whether directly or indirectly. Crop and livestock production, and the exploitation of timber and non-timber forest products are particularly important for maintaining food security and wellbeing. However, in recent years, there have been adverse changes in the quantity, quality, distribution and timing of certain ecosystem services. Contributing factors include less predictable rainfall, more pervasive droughts, an increased demand for agricultural land, and an expansion of villages. Phane caterpillars, which local people have harvested for centuries, are one important ecosystem service that has seen a significant decline in the last decade. An overexploitation of woodlands has also been observed, while the clearing of shrubs for crop cultivation has resulted in trade-offs with other provisioning ecosystem services, such as communal grazing land.

Dependence on and access to ecosystem services varies by gender. Women are most affected by changes in the availability of water for the household, firewood, wild vegetables and palm leaves for basket-making. On the other hand, men are disproportionately affected by changes in the availability of timber, pasture and water for livestock. Both men and women are affected by the fluctuating availability of phane caterpillars, firewood, and fertile soils for crop production. Part of the challenge around declining natural resources is that there is a mismatch between how national authorities and local communities view ecosystem services. While the latter feel that in Bobirwa these belong to them, at the national level ecosystem services are considered a common resource. Competition from people residing beyond the sub-district therefore means that local communities have little incentive to sustainably manage ecosystem services.

Recommendations

- Ecosystem services need to be sustainably managed through regulatory measures, including permitting and restricting the timing of harvesting activities, as well as the volume of resources collected. Given their dwindling numbers, it may be necessary to place a ban on the harvesting of phane caterpillars for two or three consecutive breeding seasons to allow the population to recover, and to avoid losing this important source of protein and income entirely.

- All decisions around ecosystem services should be made through inclusive and participatory processes that emphasise the integration of community knowledge and values into plans for the management and use of ecosystem services under a changing climate. This is important for ensuring buy-in among traditional leaders, local authorities, and importantly, the grassroots people dependent on ecosystem services.

- Shifts in the availability of ecosystem services in Bobirwa impact people differently. For example, women and children are particularly vulnerable to declines in the availability of phane caterpillars as they are sometimes forced to camp far away from their homesteads in unhealthy conditions in order to access this dwindling resource. Such socially-differentiated vulnerabilities should be a key focus of policy and planning around ecosystem services.

- To ensure more sustainable management of ecosystem services, possible ways of engaging communities and resource users in enforcing regulatory measures, and monitoring the state and trends in ecosystem services should be explored.

- Key to supporting the communities that depend on declining ecosystem services is to ensure that they have other ways to make a living or survive off the land. Access to alternative livelihood options is required, although enhanced diversification (especially for women) needs to be accompanied by support systems that ensure they are not overburdened. The monitoring of government programmes aimed at increasing agricultural productivity should also be improved. This is also important for reducing the increasing pressure being placed on towns and cities from the in-migration of rural youth in search of work.

STRENGTHENED MANAGEMENT OF SCARCE WATER RESOURCES IS CRITICAL FOR REDUCING CONFLICT AND ENABLING ADAPTATION

Rising temperatures, unpredictable rainfall, and increased pressures from growing populations are shaping a complex landscape around water resources, especially groundwater and water from the Black Volta River which forms the border between Ghana and Burkina Faso. Supporting greater technical capacities and more integrated management of these resources will be essential for lessening negative impacts of climate change in the future, and for reducing conflicts among users.

Droughts, floods, and increasingly variable rainfall are impacting the quantity and quality of water sources in Upper West Ghana. Nitrate levels are elevated across many water sources due to the proximity of farming activities, and microbial levels from the Black Volta exceed the guidelines for domestic use. These issues can be harmful to human health and can impact negatively on adaptive capacities. Likewise, seasonal drying of rivers and streams, and of some boreholes during more extreme conditions, is contributing to increased conflict between water users at boreholes, as well as between livestock and irrigation farmers along rivers. For example, recent decreases in the water level of the Black Volta have resulted in a struggle between dry season farmers and semi-nomadic Fulani herdsmen. Factors such as age, ethnicity and gender can greatly shape how and to what degree these challenges impact different people. For example, it is women and girls who are primarily in charge of fetching water for households, while young men are often in charge of moving livestock.

Concerning governance and management, decisions are spread across different decision makers at multiple scales. For example, regulations designed at the district level are enforced by local-level Water and Sanitation Committees (WATSAN). Then, there are traditional authorities who pass and enforce bylaws. These multiple layers of governance all aim for increased protection of water in the region. However, there are disconnects between community-level capacities and district-level management goals, and between traditional and formal government strategies. Lack of sufficient funding and technical expertise to maintain water harvesting infrastructure is perceived as contributing to a greater risk of increasing conflict around water in the future.

Recommendations

- To reduce vulnerability of smallholder farmers in the Upper West region to increasing water scarcity and other interrelated challenges, policies and programmes should target smallholder farmers at the level of disaggregated social groups, instead of considering them as a homogeneous group.

- The Ministry of Food and Agriculture and other development organisations should focus on reducing vulnerability to drought and flooding through: 1) the provision of accurate and timely rainfall information, 2) strengthening of technical capacities for maintaining water infrastructure, and 3) more transparent communication and inclusion of different water user groups in the development and updating of regulations.

- Education of community members by government and non-governmental organisations on water quality issues and related health hazards should be prioritised where possible.

- Government institutions, including district assemblies and departments of agriculture, along with the Ghana Irrigation Development Authority (GIDA), should take measures to integrate traditional irrigation approaches that are socially and culturally accepted with more modern mechanised approaches, climate smart agriculture, and well-targeted financing in order to increase uptake among farmers.

ADAPTATION TO CLIMATIC STRESSORS IS IMPORTANT, BUT IT IS EQUALLY IMPORTANT NOT TO OVERLOOK NON-CLIMATIC FACTORS THAT AFFECT PEOPLE'S LIVES AND ABILITY TO ADAPT

Climatic changes are not the only stressors that factor into adaptation needs in Koutiala, Mali. Urbanisation, changing social structures, and governance of resources are also impacting the abilities of different people to adapt. Moreover, sometimes adaptation strategies can bring about unanticipated non-climatic changes that can create new challenges that people must also cope with.

In the village of Zangasso, climatic changes (e.g., declining rainfall) are negatively affecting fishing resources. However, a number of combined non-climatic changes are also having a large impact on the fishery, and the ability of people to build their livelihoods around it. Changes in who is using the fishery are complicating its management. For example, beyond the traditional ethnic groups known to be fishers by profession and through generations, fishing is now practiced by all ethnic groups in the village including Bambara and Minianka, who are traditionally known to be farmers. With this shift, the division of labour along ethnic lines is becoming blurred. At the same time, climatic changes are combining with other factors that are degrading the fishery, including the obstruction of water sources resulting from erosion and the construction of new urban infrastructure (e.g., roads and bridges). This is also contributing to traditional fishers, the Bozo and Somono, converting to farming.

The entry of new groups of fishers, who are introducing prohibited fishing tools and techniques, is contributing to overfishing. These changes are also making it challenging to enforce the traditional governance of water resources that involve the prohibition of fishing during the reproductive periods of fish. Combined, these factors are affecting the viability of fishing as an alternative income-generating activity, and form of adaptation, for local people.

In another area of Koutiala, farmers have been engaging in low-land farming where small-scale irrigation can be used as a way to adapt to climatic changes impacting their farms. Along with this adaptation strategy, though, have come new and unforeseen challenges. For example, an invasive weed species has emerged in areas where new irrigation facilities are built for repetitive rice production. This has created a situation where an adaptation strategy aimed at coping with climatic changes has produced a non-climatic stressor that now also needs to be dealt with.

Additional insights on agricultural intensification and ecosystem services were gained through documenting the contribution and importance of agro-biodiversity to climate change adaptation in Koutiala. This work assessed (including through farmers' perceptions) the impact of climate change and variability on agro-biodiversity and its services in rural Mali, and modelled the impact of harnessing agro-biodiversity on household vulnerability in its semi-arid areas. This work found that thinking of agrobiodiversity-based (or ecosystem-based) versus other adaptation practices/strategies as mutually exclusive might be misleading and not tell the full story on the ground. Agrobiodiversity-based adaptation practices always occur in combination with other practices. Further, both climatic and non-climatic risks drive adoption of agrobiodiversity-based practices.

Recommendations

- Policy makers and other decision makers need to take a systems view when thinking of adaptation, as pursuing adaptation in one area may create unforeseen challenges in another. Continuous learning and adjustment of adaptation planning is required.

- Climatic changes are combining with changing social traditions and urbanisation in unpredictable ways. This should be recognised when designing new policies or programmes aimed at natural resource governance or adaptation.

- While introducing new and more climate-resilient crop varieties is an important step toward sustained adaptation, the importance of traditional varieties for maintaining biodiversity and providing broader adaptation options should not be ignored.

- A holistic approach is crucial for taking stock of the synergies created through integrating multiple practices/strategies (agrobiodiversity/ ecosystem-based) across scales. The effectiveness of these synergies in reducing vulnerability to risks or improving adaptive capacity needs further investigation.

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FORWARD-LOOKING, INCLUSIVE GOVERNANCE ARRANGEMENTS ARE A CRITICAL ENABLER FOR ADAPTATION

Marginalised groups in semi-arid regions who live on the frontline of climate impacts will benefit if they are more actively included in climate adaptation governance. However, in these areas, governments struggle to deliver services or engage with local communities due to a range of factors, such as inadequate mainstreaming of climate concerns in development planning, staff capacity deficits at lower levels of governance, and limited technical expertise. We see fragmented decision making across different governance levels. Climate change adaptation responses could learn from widespread implementation of decentralisation, and how it has enabled, and in some cases undermined, the ability to support participation and flexibility across scales. Strengthening governance, and the capacity to engage in decision making across scales, across actors, and between formal and customary governance structures, should be a priority for enabling effective adaptation. Doing so could enable more equitable participation, promote flexible, hybrid forms of governance, and encourage forward-looking, cross-scalar collaboration and knowledge flows.

ASSAR's focus on adaptation governance

ASSAR concentrated on issues of governance in semi-arid regions, with a focus on what forms of governance will enable effective adaptation. The primary question we addressed was: How do existing governance structures help those most vulnerable to adapt to existing climatic and non-climatic dimensions of risk? Our research focused on the impacts of decentralisation in: the water sector in Namibia, Kenya, and Ethiopia; land tenure and customary law in Mali; and climate risk, vulnerability, and adaptation planning in India.

KEY INSIGHTS

IN SEMI-ARID REGIONS THERE IS INSUFFICIENT UNDERSTANDING OF WHAT THE MOST APPROPRIATE GOVERNANCE APPROACHES ARE FOR ADAPTING TO CLIMATE RISK

Adaptation governance is often fragmented; there are disconnects across different levels of governance, and between ecological and administrative scales. Different institutions and actors often have overlapping, competing or antagonistic relationships with regard to adaptation-related responsibilities. Within different institutions there is often a lack of capacity and infrastructure for adaptation across scales, as well as limited planning that is flexible and forward looking, and which accounts for future climatic risks and impacts. As a consequence, marginalised groups often have to manage climate risks without the support they need.

In many cases in semi-arid regions, governance for adaptation is not clearly defined and structured. Adaptation is typically not prioritised, and although it might be called 'climate adaptation', it is more often 'business as usual' development that happens to be impacted by climate variability. Often, the adaptation space is cluttered with institutions working in disjointed and incoherent ways. Seldom do different sectors plan together for how they might manage climate risk. Rather, they each develop and implement their own responses, missing out on opportunities for synergies and collaboration.

Policy and legal frameworks for adaptation planning and implementation are also lacking in some places. For example, in Botswana, there is no guiding policy document for adaptation, although the country has plans to develop one. Other countries where ASSAR worked have adaptation policies in place, or under development. Ethiopia has prepared a National Adaptation Programme of Action (NAPA). Here, adaptation policies and strategies are driven by a number of factors, such as: the country's green economy agenda and international obligations; government's efforts to synchronise regional agendas with the national initiative; and improvement of development indicators, land possession, and settlement of pastoralist populations through the 'villagisation' programme. In Kenya, key adaptation policies and interventions are driven by international obligations and demands, often supported through projects from donor funding, and access to the Global Environmental Facility. At lower governance levels, there are also County Integrated Development Plans, and ward- and county-level adaptation planning committees which are working on identifying key issues and possible adaptation responses. In India, the National Action Plan on Climate Change is the key policy directing action on climate change adaptation and mitigation.

Even when national and local plans exist, there is often a lack of synergy between these plans. For example, in the cities of Bengaluru and Chennai in India, state-level climate plans are often too broad and lack frameworks for implementation of climate action at the city level. Communication and translation of adaptation policies at the local level is often not sufficient. There is also fragmentation of responsibilities for policy implementation, and knowledge mismatch between policy makers and implementation agencies.

Our work in Mali shows how regulations cannot be effective when designed at one scale while ignoring conditions at other scales. For example, Mali's Cooperative Law as well as its Seed Law, both designed at national level to enable farmers' access to agriculture services and improved seeds, have yielded mixed results. Farmers believe the Cooperative Law degrades social cohesion and the mutual support on which they rely when facing climatic and non-climatic risks. Farmers also find the new seed system onerous and unaffordable.

Instead of having a long-term, forward-looking approach, adaptation governance is often understood and characterised as short-term, ad-hoc decision making, aligned to disaster risk reduction and emergency management. Contributing to the challenge, past development pathways and policy decisions can result in irreversible lock-ins and inherent trade-offs which entrench inequities and lead to maladaptation.

Overall, we see a lack of cohesion in the adaptation space which leads to confusion over who is and who might be responsible for climate change adaptation. The result is that climate adaptation is not strategically framed across sectors and scales. This has implications for sectors and livelihoods, that will be negatively affected when climate impacts are not adequately addressed in a holistic manner.

Recommendations

- Adaptation governance requires planning tools that enable a shift from short-term, crisis-driven approaches to longer-term, forward-looking approaches.

- A holistic understanding of adaptation, and of the sectors vulnerable to climate change, requires an enhanced awareness of social, ecological and technical dimensions, and strategic linkages across these sectors (horizontal governance). For example, reduced rainfall in an area has an impact on agriculture, water availability, jobs, health and education.

- Strategic linkages between national and sub-national levels (vertical governance) are necessary for the planning, implementing and monitoring of climate adaptation efforts. These linkages need to be underpinned by requisite technical and financial support that enables multiple actors to engage. In addition, attention should be paid to the processes that support linkages, recognising that these processes take time.

- Expanding existing governance arrangements to be more inclusive of local communities will ensure that their concerns, desires, and expertise can inform and influence adaptation planning and implementation. This may require new ways of engaging with local communities that address power dynamics and cultural norms, and involve innovative means of participation.

HYBRID GOVERNANCE ARRANGEMENTS ARE EMERGING TO SUPPORT ADAPTATION

Disconnections between national, regional and local governments in semi-arid regions mean that intermediary entities often need to negotiate between local actors and government. With some of these intermediaries linking across different scales and across traditional and bureaucratic practices, hybrid governance arrangements are emerging to support adaptation. However, intermediaries often lack capacity in adaptation-related knowledge and decision making, and need requisite support to perform these roles.

Adaptation governance in semi-arid regions remains largely fragmented. However, some changes brought about by decentralisation have created new spaces and opportunities for intermediaries to become more responsive to the needs of local populations. These intermediaries can take the form of non-governmental organisations (NGOs), community-led groups, research groups, government-initiated groups, and private sector partnerships; and they are starting to bridge the gaps between local populations and government at both local and national levels. These intermediaries are actively driving vertical integration, that supports cross-scalar arrangements and integrated implementation.

In some cases, governments have established these intermediary structures. In Kenya, the National Drought Management Authority established Ward and County Adaptation Planning Committees and a County Steering Committee chaired by the County Governor to better coordinate actions at county level. Elsewhere, the private sector has become involved, helping to conserve water resources. In India, public-private networks are emerging such as the Karnataka State Water Network, which convenes stakeholders to coordinate around water management. In Ghana, irrigation farmer associations and landlords located near the Black Volta River collaborate with the Water Resources Commission to ensure safe farming practices. In other areas, formal government entities, like the Constituency Development Committee (CDC) in rural north-central Namibia, link directly down to village chiefs at the community level and up to the regional government, in order to identify local priorities. However, the CDC has limited resources for implementation since these resources are allocated at regional level; it also lacks capacity in adaptation-related knowledge and decision making.

While intermediary structures can help bridge the divide between local needs and government, they are typically nascent and need support in terms of finances and technical skills to function properly. There is also the significant risk that other actors can appropriate these new spaces and opportunities to further their own aims in ways that may not be conducive to effective adaptation governance. Such is the case with the drive to villagise pastoral communities and encourage more agriculture in Ethiopia.

Recommendations

- Administrative decentralisation can support adaptation governance by bringing decision-making and implementation structures closer to local communities; but for this to be effective, finances, knowledge, and human capital must be made available to support decentralised governance structures. Furthermore, the decentralisation process should focus not only on operational aspects (e.g., administrative and technical inputs), but on socio-cultural and ecological aspects (e.g., local perceptions of risk, resource degradation).
- National support for adaptation is critical but needs to be complemented by cross-sector coordination and bottom-up input, and further development of intermediaries to bridge scales.
- Issues of coordination, responsibility, capacity, and accountability need to be better understood to strengthen decision making across scales, and to understand how each level of governance enables or constrains climate adaptation.
- Approaches to support vertical integration should recognise that substantial resources will be needed to actively ensure that multiple stakeholders at multiple levels of state and society are part of conceptualising and implementing adaptation responses. This requires a richer understanding of the relationships between state and community actors, and alignment with the growing focus on collaborative governance and co-production for climate change adaptation.
- Formal government structures need to embrace rather than resist intermediary bodies, so that effective hybrid governance systems can emerge.

WORKING WITH CUSTOMARY INSTITUTIONS CAN HELP FOSTER COLLABORATIVE ADAPTATION RESPONSES THAT ARE COGNISANT OF LOCAL CONTEXTS

In semi-arid regions, traditional and customary institutions can play an important role in natural resource management and adaptation responses. In some cases, formalising or supporting these institutions has led to improved management of water, pasture land and forests. It has also led to the emergence of hybrid structures where traditional institutions collaborate with formal government agencies on land stewardship and resource management. However, conflicts between customary and formalised government arrangements remain, especially when the definition of mandates, authority, and roles and responsibilities is unclear. Ways of integrating traditional and customary institutions with government institutions need more attention. Integration holds opportunities for adaptation that recognises local needs and structures while acknowledging the role of government.

Customary and traditional institutions play an important role in many of the ASSAR study sites. They help to manage grazing land, water and other natural resources according to traditional methods. In Kenya and Ethiopia, *Dedha* committees manage pasture land according to customary land management principles. They use a zoning system that partitions grazing land into wet season, dry season, and drought areas. Kenya has recognised *Dedha* committees at the local level in policies, such as the Customary Natural Resources Bill of Isiolo, which is currently in development. Recognising and strengthening the roles of these committees has enabled them to work together with formalised water committees and Water Resource Users Associations for water management. Doing so, the *Dedha* committees help to support the government's decentralised water governance approach.

In Kenya too, the conservancy model of resource management and adaptation, previously promoted by NGOs and now also by Isiolo county government, uses traditional institutions, like the council of elders, to run some activities. Some institutions are engaged in conserving natural resources while others perform administrative roles, such as facilitating pasture sharing.

The recognition and, in some cases, formalisation of traditional institutions – along with policies that enable customary management of natural resources – has helped support local and sub-national level governance of adaptation, empowering these institutions. For example, in Mali's villages, such as N'Goutjina, a local convention based on traditional natural-resource-management principles enables community-led management of timber. A local committee levies fines on people caught harvesting wood outside of set times, which deters overcutting. However, there remains conflict over enforcement. The district officer working for the forest service in that area considers the fines for violators to be illegal. "Only the state has the power to impose fines on a contravener to the rules," he said. Similarly, in Mali's Cinsina ward, the devolution of decision making over natural resources to local authorities, as part of the decentralisation policy, has made locally-agreed bylaws the major tools for management of pastoral resources. But the enforcement of these bylaws does not always sit well with individual interests.

One provision mandates that the stay of transhumant pastoralists in local pastoral areas cannot exceed five days. But some local people hosting these transhumant pastoralists want them to stay longer to benefit from the organic manure the animals leave behind in the fields. They also take advantage of the milk production and the business opportunities during the pastoralists' stay, such us buying or selling oxen at a good price for the next rainy season.

Although these bottom-up approaches are important, they are designed from within a particular local context and so are unlikely to achieve management goals for a much larger scale without broader organisational structure, and support from higher levels of government.

While the recognition, and in some cases formalisation, of traditional structures assists in adaptation governance, challenges remain. In some cases, these groups report being inadequately supported. In Namibia, for example, traditional authorities are formally recognised by government but feel the budget they receive is insufficient to carry out their duties effectively. Representation of diverse voices in traditional structures is also challenging. In some cases, women and other minority groups remain under-represented. Sometimes, traditional authorities and other local level institutions are dominated by specific groups. In India's Maharashtra state, even though there are women *sarpanches* (village heads), in many cases the decision-making power still rests with men.

Recommendations

- Appreciating hybrid modes of governance is important and has not received enough attention. Northern approaches tend to focus on government, but southern realities show the importance of traditional governance. Adaptation needs to appreciate this reality and find ways to leverage it.

- Effort is needed to ensure that there is better representation of marginalised groups within hybrid modes of governance that incorporate traditional and customary institutions.

BUILDING CAPACITY OF LOCAL ACTORS TO ENGAGE IN LOCAL AND CROSS-SCALAR ADAPTATION GOVERNANCE IS CRITICAL, BUT MUST START FROM APPRECIATING EXISTING CAPACITY AND ASPIRATIONS

People living in semi-arid regions hold a lot of local knowledge about adaptation challenges, and in many cases are responding to change. Future shifts in temperature and rainfall patterns as a result of climate change will put extra pressure on these communities, increasing their need for support. Although work is happening around climate change policy and the establishment of national priorities, this work is not yet feeding into or sufficiently supporting on-the-ground needs. At the local level, there is a lack of financial and technical support for communities to innovate for adaptation. Local capacity needs to be strengthened to adapt to long-term change and support engagement in multi-level governance processes and flexible planning. This capacity strengthening needs to build on existing skills and local knowledge while recognising that new skills are needed. Maximum benefit will be derived if the capacity support links to wellbeing and aspirations, and is context specific.

Key to the success of community-based adaptation responses is the ability to innovate in the face of local climate change challenges. However, evidence points to a number of socio-technical lock-ins that hinder communities' ability to innovate. For example, in India, the focus on subsidies for borewell digging has led to an individualisation of resources, and undermined efforts to incentivise restoration of Kolar's old system of community water tanks which doubled up as water-harvesting structures. In Ghana, there are projects that provide technologies to help farmers scale up operations that communities consider ineffective or inadequate, and yet these projects persist. For example, the Ghana Social Opportunities Project (GSOP) provided small surface dams (or 'dugouts') that do not adequately store enough water to last through the dry season, as well as boreholes that require expensive or uncommon spare parts for maintenance that communities are unable to afford. Land tenure rights can also act as obstacles to adaptation. In Ghana's semi-arid north, the lack of land tenure rights has negatively impacted on farmers' socio-economic characteristics, which limits their adaptive capacity, particularly for female crop farmers.

Without the necessary technical, social, financial and legal support, communities struggle to properly manage resources. In Namibia's Onesi Constituency, Water Point Committees run and maintain water points in villages voluntarily. They do not, however, have sufficient technical and managerial skills to do this well, and also lack funds for maintenance. This has created a situation where many community water points (standpipes) have closed down, and poor people cannot afford to get water from private taps. When taps shut down poorer households rely on hand-dug wells to draw free water during the dry season, which can have negative health impacts.

Recommendations

- Cross-scalar approaches to governance for adaptation need to improve ways of integrating the concerns and realities of communities on the ground.

- Increasingly, national decentralisation has expected local communities to be more responsible for the governance of resources, such as water. In many cases these communities do not have the requisite financial, technical and capacity skills. This needs to be urgently addressed so that communities are better equipped to perform their expected responsibilities.

- Capacity support should be context-specific and should value local knowledge.

- More attention needs to be paid to monitoring and evaluating the current and potential capacity needed for communities to best manage natural resources and the climate risks they face.

- Adaptation governance requires a shift that fosters innovation and learning at the community level and across scales.

ADAPTATION NEEDS TO PRIORITISE VULNERABLE GROUPS AND CONTESTED VIEWS, WHICH REQUIRES MORE ATTENTION TO HOW DIVERSE NEEDS AND VOICES GET HEARD

In the adaptation space, certain views dominate decision-making processes and the identification of adaptation priorities. For most potential adaptation responses, trade-offs exist. Frequently, these are insufficiently explored from the perspective of diverse groups, and dominant groups tend to have the final say. More attention needs to be paid to how to shift away from dominant views, to support processes and implementation that can include the priorities of the most vulnerable, who are often least able to support their own adaptation sufficiently. This is likely to require additional support from NGOs and intermediaries that can liaise between vulnerable groups, government actors and, at times, the private sector.

With increased decentralisation of governance in semi-arid regions, there have been moves to incorporate community concerns by institutionalising bottom-up processes. However, in the absence of feedback mechanisms and two-way flows of information, communities are unsure of how their priorities have been addressed.

In some places, there is little space for communities to input on governance decisions that affect their ability to adapt, as is the case in Namibia's Onesi Constituency. Instead, the priorities of local leaders often determine the extent of inclusion of the poor and marginalised people, such as ethnic minorities, who are seldom explicitly considered and integrated into water management and village decision-making processes. Elsewhere, these needs are being better considered. For example in India's rural semi-arid Maharashtra state, local level village plans were found to reflect priority needs of communities even though the satisfaction levels of the community members differed across the villages based on the quality of execution on the ground.

There are several mechanisms in place to try to address issues of inclusion of marginalised groups, such as women. Generally, though women are represented, they are not represented well enough. In some cases, illiteracy, and lack of knowledge about roles and responsibilities, hinders their active participation in governance. Additionally, the representation of other marginalised groups, such as youth, remains tokenistic. We also see the development of formal institutional arrangements to support participation that are not adequately used, such as in Namibia, where villages are supposed to have Village Development Committees that feed into Constituency Development Committees (CDC). But these are often not able to feed into the CDC sufficiently. Where they do work well, there is an enabling and engaged village chief.

To make space for the views of marginalised groups, which may conflict with dominant views, it is important to build, or maintain, platforms that actively encourage vulnerable groups to input their views on adaptation issues that affect their lives. These spaces need to feel safe, and illustrate how these views are taken up in practice. ASSAR has experimented with various tools for increasing participation, including Participatory Scenario Analysis (PSA), Vulnerability and Risk Assessments (VRA), and Transformative Scenario Planning (TSP). These processes have brought together actors from across scales, which has allowed different perspectives to surface, and potential ways forward to be explored. For example, in 2015, ASSAR undertook a VRA in Botswana's Bobirwa sub-district, a climate-change hotspot in the Limpopo River Basin. The process brought together representatives of central and local government, farmer groups, women traders, and representatives from youth and NGOs, among others. Participants assessed the vulnerability of different social groups, like small-scale livestock keepers, and women vegetable sellers, to different risks. The VRA paid close attention to issues affecting the elderly, and the gendered dimensions of vulnerability. In 2018, ASSAR subsequently trained district-level officers in the VRA approach to assist government with informing district-level planning processes.

Recommendations

- Adaptation efforts need to support underrepresented groups to allow them to participate in ways that have impact. More recognition is needed of contested views that acknowledge different perspectives. A more integrated approach to adaptation cannot succeed without actively incorporating traditionally-marginalised constituents, like women and youth, in decision-making processes.

- Formal platforms for the inclusion of different voices in adaptation decisions that have been developed but are not functioning adequately, should be revisited and strengthened.

- Local development initiatives that build leaders within communities are an important way to develop agency and increase engagement across scales. Processes that are aimed at strengthening local capacities and engaging local actors through scenario planning or seeking responses to reduce vulnerability in a participatory way - while being cognisant of power dynamics - are a good step in this direction.

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Photographs in this section: Mark Tebboth, Birgit Otterman, Indian Institute for Human Settlements, Watershed Organisation Trust, Lucia Scodanibbio, Institute for Environment and Sanitation Studies (University of Ghana)

PARTICIPATORY PROCESSES BUILD ADAPTIVE CAPACITY AND AGENCY, AND CAN HELP TRANSFORM SYSTEMS

Transformation in climate change adaptation is the opposite of today's business as usual. It requires a reframing of the climate challenge to allow a shift from the existing largely technocratic and Northern knowledge base, to a fairer configuration of power relations that recognises the critical role of non-technocratic knowledge. Indeed, initiatives that can lead to transformation in climate change adaptation need to emphasise the reorientation of social norms and relations, as well as the reorganisation of climate governance structures. Inclusive, participatory processes that bring together diverse stakeholders – both in positions of power and dispossession – can help to integrate marginal voices into the mainstream, thereby shifting the adaptation narrative and research methods to new spaces of grounded solutions. In so doing, these processes can help build people's agency and their adaptive and transformative capacities.

ASSAR'S FOCUS ON PARTICIPATORY PROCESSES

An overarching theme throughout ASSAR was the contested nature of what it means to be inclusive, participatory and transformative in advocating for climate change adaptation. As there are conflicting views on transformation and its normative nature, our research was mostly exploratory. We started by assessing the different uses and interpretations of transformation in climate change and development circles. We then implemented and researched different types of participatory processes that aimed to understand the potential for adaptation pathways and for transformation as a result of stakeholder engagement. In response to the shortcomings of techno-rational logic which ignores socio-political contexts at different scales, we particularly worked to understand the benefits of challenging unequal power relations through representative stakeholder participation, and its contribution to transformation. Trying to stay true to the spirit of transformation, we aimed to challenge our own values and be open to shifting the way we understood the climate change challenge, as opposed to imposing our own world view on others.

As ASSAR ended, it became increasingly apparent that any work on climate change needs to be framed with the need for transformation at its core. The scale and speed of change needed to avoid an irreversible climatic overshoot (going beyond 2°C of global warming) requires systemic and behavioural changes that could only reasonably be described as major departures from today's mindsets and visions of a desirable future, namely, transformations. Universal principles of social and environmental justice, human rights and the Sustainable Development Goals (SDGs) could serve as pillars of reference against which to consider the implication of possible transformations.

KEY INSIGHTS

SOCIAL AND ENVIRONMENTAL JUSTICE IN CLIMATE CHANGE ADAPTATION REQUIRES DEEP SHIFTS IN POWER STRUCTURES AND SOCIAL NORMS

The existing power imbalances in climate governance structures at local to global levels demonstrate that transforming power relations is an important element of attaining just and effective adaptation. Working with stakeholders – those in positions of power and in states of dispossession – can help rebalance these social inequalities.

When participatory assessments recognise the social roots of vulnerability, they become critical in helping individuals and institutions rethink their understanding of climate change impacts and how to respond to these. As such, these tools can help shift narratives and power dynamics, allow marginal voices to be heard, and enable the co-creation of solutions. They can contribute to moving the adaptation conversation beyond incremental and instrumentalist approaches, towards one that inspires transformational thinking and action.

Furthermore, the process of deciding who contributes to setting the climate change agenda, and who doesn't, is loaded with political interests. In the present climate governance arrangement, Northern academic and political institutions exert disproportionate influence over the sector, and a vast wealth of knowledge is excluded from high-level climate-change related decision-making processes. Transformation in climate governance should be founded on the amalgamation of various sources of knowledge that support otherwise-marginalised groups to become increasingly influential in defining their own development pathways.

Using a typological framework for categorising forms of change (Table 1) can help researchers and practitioners relate different interpretations of transformation to practice. These categorisations link to the broader conceptions and critiques of transformation, and can enable those seeking to assess or plan adaptation actions/theories to better analyse what types of action are potentially constitutive of transformation. So-called transformative adaptation initiatives, namely those that aim to bring about change beyond the initiative itself (e.g., by reducing climate risk while empowering marginalised women), can be particularly helpful in shifting the sector's paradigms.

Recommendations

- Effectiveness in adaptation efforts can be increased by demonstrating to governments how genuine participation in decision-making processes can generate constructive learning environments. These participatory processes also enable governments, and others with mandates to address climate change challenges, to benefit from advice generated by a combination of robust and grounded researcher and practitioner knowledge, alongside the voices of marginalised groups.

- Despite what the term might suggest, transformations will rarely happen overnight. Rather, they are lengthy processes with kinks in their trajectories. Enhancing the idea of justice in climate change adaptation initiatives (e.g., through inclusion, and by recognising wellbeing as an element of effective adaptation) will often require radical departures from predominant social norms and power arrangements. However, this concerted effort can help to build a new vision of social, environmental and climate justice.

- Working with decision makers and other stakeholders from local and sub-national levels in the Global South can change our understanding of climate change impacts and required responses. It can also provide key evidence to influence multilateral processes that in turn could inform the global rules on finance that would make funding for local-level work more readily available.

- Influential institutions around the world should lead by example in changing their own practices to address the root causes of climate change and to minimise inequalities by, for example, increasing the number of women in decision-making positions, or shifting toward more participatory and representative research.

NEW PARTNERSHIPS BETWEEN RESEARCH INSTITUTIONS AND PRACTITIONERS CAN POSITIVELY IMPACT POLICIES AND PRACTICE

Despite increasing recognition in the last decades of the root causes of climate change, the limited progress that has been achieved on the problem calls for new partnerships and new ways of acting. Collaborations between research and practitioner institutions that are based on equality and trust can deliver impactful results in climate action, and capture much interest from governments.

A key example of the benefits delivered by a partnership between researchers and practitioners in ASSAR was the Government of Botswana's commissioning the University of Cape Town and Oxfam to develop a framework for the design of the national drought management strategy. In this framework we made a series of recommendations, and shared lessons about what we believe should be the plan's principles, and development and implementation goals.

Table 1: Typological distinctions and their implications: interrogating transformation (from Few et al. 2017).

What type of change process is occurring or envisioned?	Mechanisms of change	**Innovation** (completely novel activity or application of an activity in a new location) **Expansion** (application of an existing activity at a much greater scale or much greater intensity) **Reorganisation** (major change in the governance structures that frame adaptation) **Reorientation** (reconfiguration of social values and social relations in adaptation)
How does it relate to the drivers of risk?	Target outcomes in relation to climate risk	**Instrumental** change (focus on addressing climate risk as an environmental problem) **Progressive** change (targets reduction of differential social vulnerability to climate risks) **Radical** change (tackles underlying causes of vulnerability to climate risks)
Is the change limited to climate change adaptation?	The object of transformation	**Transformational** adaptation (transformation of adaptation practice) **Transformative** adaptation (transformation of broader aspects of development *through* adaptation activity)

We argued that a process of inclusivity and participation is needed to shift from a disaster-response mode to a risk-management one, and the importance of understanding and addressing the role of gender, and gender dynamics, in dealing with drought.

Another important collaboration in ASSAR was the one between ICRISAT and Wetlands International in Mali, used to build the capacity of local stakeholders on soil and water management. This partnership allowed a research project like ASSAR to directly result in the implementation of pilot projects through collaboration with an on-the-ground institution.

ASSAR's work makes a convincing argument about the need for academic institutions, particularly those working on climate and development, to design their research processes with meaningful involvement of the people affected. Jointly framing research questions, and identifying problems and responses to them will ensure that research is grounded and relevant. It also increases the possibility that decision makers will be interested in, and make use of, the findings.

By the same token, the ASSAR experience has demonstrated to practitioner institutions that robust processes in designing programmes and interventions are beneficial in that they base action on informed choices.

Recommendations

- Collaborations between practitioners and researchers can result in improvements in climate-related work, especially when it comes to efforts to reduce the negative impacts of climate change on populations at risk.
- Being propositional to governmental decision makers, the private sector, and donors regarding the value added by partnerships can help them to identify the benefits of working with researchers and practitioners.
- Regardless of the form of partnership, the importance of building trust through hard work, and long-term commitment, should not be underestimated.
- We all need to stretch our boundaries by pushing ourselves and our institutions to be increasingly solutions-oriented. Showing that climate change is a problem is no longer enough. Research institutions need to enter the solutions space head on, which will include having to take normative positions.
- Let's show our humanity in our work on climate change. Our 'house' – our planet – is in real, urgent, trouble. Engaging with the problem as people who care, who are worried, and who have a direct stake in the question, is a strength, not a weakness.

INCLUSIVE, PARTICIPATORY PROCESSES GENERATE VALUABLE NEW KNOWLEDGE THAT IS CRITICAL FOR ADAPTATION

Rather than state of the art innovation, more often than not what is needed in adaptation efforts is good, honest collaboration among a wide group of stakeholders. These collaborations flourish when the opportunity to co-create ideas and challenge our assumptions are genuinely offered. These processes can help shift the adaptation narrative and research methods to new spaces of grounded solutions.

In ASSAR we experimented with inclusive, participatory processes to ensure that our research was representative and relevant to the most at-risk groups in climate hotspots. These included Participatory Scenario Analysis (PSA), Vulnerability and Risk Assessments (VRA), and the Theatre of the Oppressed. Our PSA work helped us push stakeholders to reimagine their roles in the challenge at hand, and explore how they themselves, and their institutions, could contribute to addressing the problem. The importance of strong relationships and of building trust among stakeholders emerged as crucial. A similar journey took place with the VRA, which also contributed to building agency of the most marginalised members of society, and increased accountability of decision makers.

These processes contributed to ASSAR's aim to generate impact on practice and policy by doing research *with* stakeholders, as opposed to research *for*, or *on*, them. This approach can be seen as novel or even transformational, particularly because it seeks to steer the climate change research agenda from a strongly climate-science-heavy perspective to one where the challenge is centred on human impact and wellbeing.

Meanwhile, our efforts through participatory theatre in several conferences of global relevance helped us demonstrate to wide audiences of researchers and decision makers the importance of placing humanity (ours and others') at the centre of climate change understanding and action.

Recommendations

- Inclusive, participatory processes with stakeholders can deliver valuable new insights (including to research questions). These consultations should recognise and welcome the difficulty of working with actors who hold very different levels of power, and who may have complicated relationships among themselves. Conversations facilitated in the local language by teams who have an existing relationship with the people affected by climate change are likely to yield more successful outcomes.

- Working with 'unusual suspects' within key stakeholder groups could help go beyond the political headlines that formal members are likely to share. For example, when working with members of a community, it is important for the sake of diversity and representation to talk not just with the chief and the more outspoken people, but also with those less used to interacting with researchers and NGOs.

- Encouraging all stakeholders to participate in the *analysis* of the problems and not just in their identification, is both beneficial to the research, and an important way to recognise the value of different sources of knowledge and lived experiences.

- Art and experiential learning activities offer a great way to push people to engage beyond their specific roles and paradigms (e.g., indigenous person, climate scientist), thus opening new opportunities for knowledge generation, and for seeing new perspectives on the question at hand.

A PROCESS THAT AIMS TO BE TRANSFORMATIVE REQUIRES A HIGH LEVEL OF COMMITMENT

It can be challenging to secure the commitment of influential and diverse stakeholders to participatory processes that aim to be transformative. However, making compromises at this stage can limit the potential of collaborations to challenge the status quo. A word of caution, though: the repercussions of transformations need to be carefully considered, as they are likely to produce winners and losers.

We experimented with adapting a process for ASSAR called Transformative Scenario Planning (TSP). Developed by Reos Partners, TSP processes carefully bring together stakeholders with diverse and conflicting perspectives. Our TSP workshops resulted in new opportunities to network, question convention, and incorporate disruptive and surprising elements in long-term planning on particular issues that are affected by climate change. Beyond our workshops, any continued participation by stakeholders in adaptation-related activities was largely coordinated by ASSAR, which resulted in practical changes for some.

The momentum created by our TSP workshops varied greatly from one ASSAR region to another according to the timing of workshops and the participation of key stakeholders. Teams who held workshops early on in ASSAR had more follow-up initiatives compared to processes undertaken in the final year of the project, and were consequently able to capitalise on relationships built. Although issues were urgent, uneven representation of stakeholders from across the social system limited the transformative capacity of the process. Overall, the use of TSP in ASSAR was a valuable first step towards building relationships in the field of climate change adaptation. However, the process was less about rigorous scenarios and more about the process of building stories as a way to make discussions meaningful across social divides.

Recommendations

1. TSP is recommended for tackling climate change adaptation but only if specific conditions are met: project teams need to be committed to the long-term (over several years) process of change beyond the scenario building workshops; project teams need to be convinced that the TSP process is an appropriate option, before persuading stakeholders of its utility; and teams need to have the time, energy, and convening power to get the right stakeholders in the room.

2. The TSP process needs to be set in motion at the outset of a project. Allow plenty of time to decide who should be in the room, and meet with stakeholders in person several times before holding workshops. Anticipate 'workshop fatigue' and use it as an opportunity to talk about power relations prior to workshops.

3. The scenarios in the TSP process are recommended as a way to get people talking about long-term collective futures rather than short-term individual interests. In contexts where the scenarios need to be more than a tool for thinking, consider other forms of scenario processes.

4. Do not limit yourself to one type of participatory process. Tailor processes to the context in which you are working and the types of people you want to target. TSP should not be confused with community engagement, and may be less easy to adapt to contexts where the language of TSP does not translate well. Think about how a targeted approach to selecting stakeholders may entrench existing power relations before proceeding with the process. Multi-pronged capacity-building activities, site visits, conferences and radio may all be equally viable options towards the co-creation of adaptation pathways.

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EFFECTIVE ADAPTATION MEANS DIFFERENT THINGS TO DIFFERENT PEOPLE

Different framings of effectiveness will influence the entire adaptation process, from identifying the vulnerabilities that adaptation aims to address, to determining who benefits and who is left behind, which adaptation actions are chosen and funded, and how they are implemented. Justice, governance, community-based adaptation, and sustainability framings are particularly important for ensuring outcomes that benefit vulnerable communities in semi-arid regions. But in any adaptation process, considering multiple framings is critical for facilitating effective, equitable and inclusive adaptation that is actively cognisant of the marginalised and most vulnerable. A clear exploration and articulation of effectiveness, from multiple framings, can guide organisations in setting adaptation priorities and outcomes, in defining criteria for funding adaptation projects, in assessing proposals, and in evaluating implementation.

ASSAR's focus on effective adaptation

Current and future climate change necessitates urgent adaptation action, especially in semi-arid regions across Africa and India which are home to millions of people, many of whom are acutely vulnerable to climatic and non-climatic risks. While researchers, practitioners and funders converge to accept the urgency for adaptation, there is less agreement on what this adaptation should entail. What outcomes should adaptation deliver? Which options should be implemented? Who should benefit? Where should adaptation be prioritised? What rules and institutional arrangements should apply? In ASSAR, we examined what 'effective adaptation' can mean for different disciplines, perspectives and actors, and explored the implications of these different meanings for adaptation in practice. Our findings are based on a review of the theoretical advances in adaptation and related research, as well as primary case studies across semi-arid Africa and India.

KEY INSIGHTS

ASSESSING "EFFECTIVENESS" FROM MULTIPLE FRAMINGS CAN ENHANCE THE SUCCESS OF ADAPTATION, AND RESULT IN A BETTER SET OF EXPECTED OUTCOMES

Defining and measuring effectiveness in adaptation is complex and challenging. It is difficult because climate change is a fast-moving target, delineating climate adaptation from development interventions is difficult, and there is low agreement on the indicators to measure adaptation. Critically, what is effective today may not be effective tomorrow, and present adaptation interventions may have trade-offs either in other places, for other people, or in the future. However, it is of utmost importance to plan for 'adequate' and 'effective' adaptation in a post-Paris-Agreement world. We argue that assessing effectiveness from different framings will enhance the success of adaptation, by taking a multidimensional approach, avoiding unintended consequences, and through a greater awareness of the assumptions that come into play when defining effectiveness.

Different ways to think about effectiveness

We have identified **eleven conceptual framings** that can influence how adaptation effectiveness is defined and measured. These framings often overlap, but at their core have distinct primary principles. For each framing, we reviewed the underlying thinking and epistemological origins, and show examples of how the framing has been used in adaptation theory and in practice. We then distilled each framing into a "principle for effective adaptation". These principles combine to provide a proposed list of issues that anyone engaged in adaptation should reflect on when designing, funding, implementing and evaluating an adaptation action.

Adaptation should minimise costs, and maximise benefit

Drawing on a utilitarian cost-benefit farming, adaptation is deemed effective if it is efficient. Usually framed in terms of financial cost, and the number of people who benefit, it has also been applied to look at minimising other costs, such as implementation complexity, and delivering multidimensional social and environmental benefits, as well as co-benefits with mitigation.

Adaptation should reduce risk and vulnerability

Drawing from a long history of disaster, food security and development studies, adaptation to climate change is successful if exposure and sensitivity to climate risks is reduced, or adaptive capacity is enhanced, with a particular focus on the most vulnerable. Adaptive capacity can be enhanced by focusing on five capitals (natural, physical, social, financial and human) which will result in effective adaptation to climate change.

Adaptation should be oriented toward socially-just, inclusive, and equitable processes and outcomes

This approach to effective adaptation focuses on three main aspects of justice, drawing from the environmental justice literature. The quest for distributional justice is to essentially understand who benefits and who loses in society, while procedural justice focuses on the fairness in the processes by which decisions are made. The idea of recognition justice tries to understand whose needs count and which concerns matter, when it comes to climate change adaptation.

Adaptation actions should take into account unintended outcomes, and explicitly look at potentially maladaptive consequences

A maladaptation lens forefronts the idea of acknowledging how adaptation actions may have cross-scalar, long-term impacts where an intervention could inadvertently increase GHG emissions, disproportionately burden the most vulnerable or increase vulnerability, have high opportunity costs, reduce future incentives to adapt, or create path dependency.

Adaptation actions should be economically, ecologically and socially sustainable

Drawing on ideas from sustainability science, this framing considers adaptation to be effective when it meets economic, ecological and equity goals (the three pillars of sustainability) with an explicit focus on understanding longer-term, cross-generational viability of adaptation actions. This thinking has led to the term 'sustainable adaptation' which attempts to bring the goals of sustainable development and effective adaptation together.

Adaptation should be oriented towards achieving good governance across scales

Governance arrangements that support greater participation, decentralisation, and inclusion within and across scales will support better definition of adaptation needs and options, as well as more effective implementation. The complexity of governance has been measured using indicators for transparency, accountability, participation, inclusion, knowledge sharing, flexibility, political leadership, technology, funding, and stakeholder engagement.

Adaptation should support achievement of material and subjective wellbeing goals

Drawing from the capabilities approach, a wellbeing framing focuses not only on material aspects of wellbeing, but also on subjective wellbeing. In doing so, it goes beyond structural and distributional aspects of assets and capitals that are possessed by individuals, to aspirations of what people really want to do or be. This allows for adaptation that not only reduces vulnerabilities, but also works towards supporting achievement of people's aspirations for "a good life" in the face of climate change.

Communities are central to adaptation processes, and co-creation/co-production of approaches ensures more effective and sustainable adaptation

Drawing from bottom-up, participatory development approaches, community-based adaptation (CBA) encapsulates the critical role of communities in formulating, implementing and maintaining local adaptation. A CBA lens can help forefront communities in defining adaptation priorities, articulating expected outcomes that deliver on aspirations and needs of the marginalised. It can also build the agency of vulnerable communities, highlighting the importance of capacity building, co-production of solutions, empowerment, and institutional and financial devolution.

Adaptation should increase resilience so that systems have the ability to bounce back from climatic shocks and adapt to climatic changes

Resilience thinking has its roots in the ecological sciences in that it acknowledges ecological limits to adaptation. While parallels and contrasts have been drawn to the concept of vulnerability, the ability to bounce back from shocks and stressors is really what makes systems resilient, and enhanced adaptive capacity can both decrease vulnerability as well as increase resilience. Factors that confer resilience to systems are diversity, functional persistence, and self organisation. Spatial and temporal trade-offs, and trade-offs between objectives, become relevant when thinking of resilience in human-environmental systems.

Adaptation should invest in ecosystem management and restoration to reduce climate change impacts on ecosystem services, and hence on society

An ecosystem-based approach to adaptation (EbA) highlights the critical role ecosystem services play in supporting local adaptation. For example, conserving water resources, maintaining soil fertility, and protecting forest cover can build natural capital and contribute to well-functioning socio-ecological systems. Given that a large proportion of vulnerable populations are dependent on natural resource-based livelihoods, an EbA lens focuses on ecosystem functionality and how it can be enhanced to support these livelihoods.

Adaptation as a process that fundamentally alters how systems operate

A transformational adaptation framing highlights the need to fundamentally reorient human practices in the face of climate change, and overtly challenges the social, political and economic structures that generate vulnerability to its impacts.

IMPLICATIONS FOR ADAPTATION IN PRACTICE

- **Different framings privilege certain aspects of effectiveness**. For example, a justice and equity framing tends to forefront thinking about who benefits from adaptation, and who is involved in adaptation processes. Contrastingly, an efficiency framing that tends to use cost-benefit analyses to define what is effective hinges on utilitarian ideas of the greatest good for the greatest number, reducing costs and maximising benefits, while ignoring differential aspects of vulnerability.

- The eleven **framings can be used as guiding principles** for adaptation, ideally in a pervasive manner, but at least in any relevant part of a process. For example, to define adaptation objectives and outcomes, to address equity, to design and implement governance arrangements, to preempt unintended negative outcomes, and to understand and address deeper political-economic drivers. Keeping these principles as a checklist during project conceptualisation can help forefront intangible but critical aspects of adaptation such as a focus on building flexible, robust and inclusive institutions (good governance framing), or prioritising bottom-up, people-oriented solutions (drawing on the CBA framing). Adaptation financing facilities can use these principles to inform their guidelines for funding, and in the evaluation of the projects they fund.

ASSAR CASE STUDIES

We provide a list of illustrative cases from the semi-arid regions to showcase that meeting multiple aspects of effectiveness is possible.

CASE STUDY 1:

GROUNDWATER AND RURAL LIVELIHOODS IN INDIA

In India, where 34% of the land area is semi-arid, and 50.2% of the population is engaged in agriculture for at least six months of the year, groundwater exploitation has played a central role in expanding irrigation to reduce sensitivity to seasonal drought, leading to higher agricultural productivity and household wellbeing. We studied the role that groundwater played in intra-household relations, particularly gender dimensions such as the division of labour within the household, and vulnerabilities and risks across identities.

In our study of two villages in Tamil Nadu we found that the expansion of groundwater irrigation has led to dramatic shifts in cropping, with cash crops replacing rainfed grain such as millet. This adaptation had benefits and disbenefits. Working on cash crops placed more physical burden on women, but also improved wages for poorer women labourers as demand for labour increased. While groundwater improved some wellbeing outcomes in the short run, in the long run it also increased vulnerability: borewell failures were exacerbated by poor awareness of government support, excessive bureaucracy, and an inefficient delivery system that led to a greater reliance on private contractors, and informal sources of credit. The socially-differentiated implications of groundwater exploitation also emerged: while men competed with each other to dig deeper wells, and felt an enhanced sense of masculinity, women's assets were often used to finance borewell digging, resulting in financial insecurity and marital conflict. This case brings to light temporal and spatial trade-offs at different scales of the household, community, village and ecosystem. Groundwater dependence can lead to maladaptive outcomes that undermine the resilience of systems, and increase vulnerability of some members of the village, while successful borewells lead to bumper crops, resulting in unequal and unjust outcomes.

A better governance framework would help to strengthen the resilience of Tamil Nadu's stressed groundwater system. Although the Groundwater Regulation Bill was passed in 2003, the act was repealed in 2013, and no further progress has been made on governing groundwater. Understanding how groundwater differentially affects different social groups can help avoid inequitable outcomes.

CASE STUDY 2:

NAMIBIA'S NATIONAL DROUGHT POLICY

We analysed Namibia's multi-level governance arrangements through which the National Drought Policy was developed and implemented, and the extent to which the policy targeted and supported the wellbeing aspirations of vulnerable households in the Omusati region.

By looking at the governance structures we highlighted how the policy was driven by a few key voices in government ministries, and stakeholders from the agriculture and environment sectors. While rural communities were the primary beneficiaries of the policy, they were seldom consulted.

The policy focused on addressing the sensitivity of agriculture and water supply to drought, and aimed to support rural communities in reducing their vulnerability to drought through income diversification, sustainable land management, and integrated water resource management.

The policy also clearly distinguished between alleviating food insecurity due to chronic poverty and due to drought, noting that poverty should be addressed through separate mechanisms.

The implementation of the policy is fragmented across government departments, meaning that different components of work on risk reduction are not well coordinated, and there is little flexibility when interventions are implemented. While the aim of the policy was to enhance adaptive capacity and reduce vulnerability of communities, appropriate mechanisms were not put in place; on the contrary, government continues to provide food relief to communities despite this strategy not being cost effective in the long term. Also, participation by communities in decisions and strategies at the local level is patchy. There are local-level platforms, such as the Constituency Disaster Risk Management Committee, where community needs can be discussed, but these committees do not have autonomy to make decisions about drought actions.

We also surveyed the social- and material-wellbeing statuses and aspirations of households in several villages in Omusati. We found both alignment and mismatch of some people's wellbeing aspirations with the drought policy and the way it was implemented, indicating that the policy is only partly meeting the needs of communities. Further we find instances of unintended consequences, where social grants and drought relief build a dependency on the state and undermine individual adaptive capacities.

Our analysis demonstrates how it is important to use several lenses when designing and implementing adaptation actions, namely: wellbeing, maladaptation, CbA, governance, justice and equity, and the consideration of longer- and shorter-term financial costs and benefits.

CASE STUDY 3:

MIGRATION AS ADAPTATION

Migration from rural to urban areas is often identified as an adaptation strategy that helps people diversify away from agrarian livelihoods. Across Africa and India, ASSAR examined the drivers and outcomes of migration to understand the role of climatic risks in driving movement, and whether migration builds adaptive capacity.

In India, we found that rural to urban migration helps people move out of certain climate-sensitive sectors such as farming, but can expose them to new risks, such as precarious and unsafe working and living conditions. Using a rural-urban continuum approach highlighted how risks and responses are connected and shift spatially, and can lead to unintended consequences, or even maladaptation.

Overall, across four cases - in India, Kenya, Ghana and Namibia - we found that household risk and response portfolios vary seasonally and over longer timescales, leading to equally varying household and intra-household wellbeing and adaptive capacities. We found that migration outcomes also flow across geographies, thus remittances in the urban landscape often financed borewell digging in the rural landscape, with critical sustainability implications. Crucially, we found that migrating to cities might increase material wellbeing but it can reduce subjective wellbeing (perceived quality of life).

Our analysis demonstrates that a lens that forefronts dynamics across spatial and temporal scales helps to highlight the tensions and trade-offs inherent in livelihood choices and outcomes. Further, a wellbeing lens teases out what effectiveness can mean for men and women from within the same household, and how it can differ materially and subjectively.

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Photographs in this section: Lucia Scodanibbio, Sophie Lashford

GENDER IS ONE OF MANY SOCIAL FACTORS INFLUENCING RESPONSES TO CLIMATE CHANGE

People's vulnerabilities and responses to climatic and non-climatic risks, vary according to the way that social norms, market signals, laws and policies intersect with different dimensions of their identity. To avoid further marginalising the already vulnerable, we need to steer away from conventional approaches that focus on binaries of men and women, and move towards considering intersectional variables, that is, how aspects of age, ethnicity, class and marital status, amongst others, interact with gender to shape vulnerability and response strategies.

ASSAR's focus on social differentiation and gender

One of ASSAR`s central questions was to understand how and why vulnerability is differentiated between communities and households (as well as within households), and to explore what this differentiation meant for coping and adaptation responses. We used mixed-methods research in rural, urban and peri-urban drylands to examine the socially-differentiated and gendered nature of vulnerability and adaptation. While focussing on household and intra-household vulnerability and adaptation, our research also made connections with broader environmental and socio-institutional dynamics to develop an understanding of vulnerability that is relational, dynamic, and embedded in wider political economy factors. Changes in rules, norms and practices in one institutional site could influence changes in other sites; however, the direction of change is unpredictable, and depends on power relations between individuals and groups. Our research highlights the structural constraints that depress women's agency in semi-arid regions, be they unequal education and labour market opportunities, or the lack of child-care, health, drinking water, and sanitation services.

At the community level, our research approach included surveys and qualitative methods such as focus group discussions and life history interviews. We also brought different people together through participatory scenario analysis and vulnerability risk assessment processes (in southern Africa and India) in order to draw out which households were more vulnerable and why. Within households, we assessed the role of household structure and relationships between members in shaping power relations, agency, voice and aspirations, all of which determine whether people can or cannot respond to pressures. At an individual level, we demonstrated how women and men are not homogenous categories – their levels of vulnerability and abilities to respond to climate change impacts are differentiated by a combination of cultural, institutional, and demographic characteristics. Ultimately, the focus on intersecting identities allowed us to identify ways to support vulnerable women and men in local communities in addressing climate change impacts and the range of risks they are exposed to without compromising their wellbeing or exacerbating inequities.

KEY INSIGHTS

MEN AND WOMEN ARE NOT HOMOGENOUS CATEGORIES

Factors such as gender, age, marital status, and ethnicity or caste interact to shape how households manage risks. We see these multiple identities playing out differently in each context, affecting adaptive capacity to respond to climate-related risks.

How people experience and respond to risks varies, depending on factors like age, ethnicity, gender and class. Gender interacts with multiple identities as well as other factors such as education, income, and access to information to shape access to material, financial and social resources. This 'bundle of resources' affects a person's agency, and influences how they are impacted by, and can respond to, climate change. For example, young men in South India with marginal to no landholding, often migrate to cities where they enter insecure livelihoods with poor living conditions. Their lack of resources and contingent livelihood choices exacerbate their vulnerability. On the other hand, women seldom migrate alone, in keeping with local socio-cultural norms, and thus avoid these precarious spaces. Yet with sole responsibility for maintaining their rural household, women face other vulnerabilities in terms of over-work and indebtedness.

Marital status and dynamics appear to play a key role in risk management, sometimes more so than assets and education levels. For example, in Namibia, we found instances where educated women who participate in village decisions are unable to invest in new farm technologies because they have little decision-making power within their own homes. At other times, with growing male unemployment, men may be unable to provide their wives capital to set up small enterprises, a conjugal expectation in East and West Africa, constraining women from meeting their obligations. Women then are increasingly resentful of their dependence on such men, often initiating separation. Therefore, we cannot assume to know who is most vulnerable: it may be young women struggling to establish their small enterprises, young men in search of employment, or wives in polygamous households, with little say in household decision making.

Recommendations

- Sex-disaggregated data in analyses, policies and plans is not enough. To identify the most vulnerable, and promote more effective adaptation, we need to consider the interaction of factors, such as ethnicity/caste, age and class; the social norms to which they are subject; and the experiences they entail.
- Vulnerable women and men need context-specific support, in the form of both resources and services, to deal with the multiple challenges they face. These could vary from capital and credit for some, to child-care and health support for others.
- In order to set up effective mechanisms for more equitable access to and distribution of resources, it is important to create platforms and spaces where the needs and priorities of different groups of women and men can be discussed, and strategies to address these developed.

UNDERSTANDING INTRA-HOUSEHOLD DYNAMICS IS CRITICAL TO ADAPTATION

In semi-arid regions of Africa and Asia, severe pressure from climate change and other non-climatic stressors affects households – and the members within them – differently. Agricultural-based livelihoods and forms of diversification are associated with particular gender roles. Climate change in drylands is shifting the nature of responsibility sharing and cooperation in the household across gender and generations.

Household dynamics are changing in response to both climatic (e.g., experiencing drought or good rains) and non-climatic factors (e.g., migration and other socio-economic changes). Age and gender, and the social expectations and norms they are embedded in, influence, for instance, who migrates and who stays behind. In Ethiopia and Namibia young men and women migrate to urban areas, diversifying their livelihoods into off-farming activities, for improved incomes. Their remittances serve as useful buffers to risks. In some cases, women who lack appropriate skills remain in farming, looking after household members and resources while men migrate, and are therefore unable to explore strategies to strengthen their adaptive capacities.

Driven by shifts in roles, responsibilities, and indeed aspirations often not aligned with farming, local gender contracts are being renegotiated, and new forms of cooperation and conflict emerging. With women taking on provisioning roles traditionally held by men, they also seek a greater share in household resources and decision making. If this is not forthcoming, tensions and violence may increase.

Recommendations

- In contexts of persistent drought and scarcity, livelihoods are diversifying, and new household forms, often multi-local and multi-generational, are emerging as a response. Adaptation planning needs to recognise the changes in gendered roles and contributions, in order to respond to changing needs and aspirations.

- Complementarity and sharing of resources and responsibilities within households is key to improving adaptive capacity. For this, targeting women alone is not enough; rather it is important to engage both men and women to challenge unequal social norms and patriarchal traditions, and contribute to forming more equitable conjugal and gender partnerships. Efforts are also needed to strengthen intergenerational cooperation between household members.

WOMEN ARE NOT NECESSARILY VICTIMS OR POWERLESS

Women in semi-arid regions of Africa and Asia are not lacking in their sense of agency, but in the context of stress and few livelihood options, their agency is directed towards short-term survival and coping. Supporting safe and remunerative livelihood diversification, and a renegotiation of power relationships to minimise unintended risks, are essential for making women critical agents of longer-term adaptation in a more equitable and inclusive manner.

Our research challenges the assumption that women are victims of climate change and powerless in its wake. They often have no option but to diversify their livelihoods and exercise agency to negotiate social norms and laws that may inhibit this process. Women in Ghana and Maharashtra (India), while working on family farms, have little decision-making control over the income earned from their farms, from cash crops, or from informal businesses. They seek however to expand the spaces for negotiation and welfare available to them. On the other hand, in Namibia and Kenya, widows and female heads of households are exercising their new-found agency to control the income earned from diversifying their livelihoods. Yet in both cases, women felt that their workload had increased, as despite taking on new tasks in the sphere of production, household chores and responsibilities remain unchanged.

Further concerns related to the often-risky livelihoods that women, but also young men, engage in out of desperation – which impact negatively on their long-term health and safety. In the case of women, while this could involve repeated pregnancies and exposure to infection, for men, apart from issues of mental health, it could, in the extreme, lead to involvement in violent conflict and to a threat to life itself.

Recommendations

- Adaptation efforts need to recognise that individuals are embedded in relations of power and hierarchies of authority, and without explicitly acknowledging these, it may be hard to progress towards equitable and sustainable outcomes. For this, apart from working with women, it is also important to challenge social norms by working with men, and across institutional levels, from community bodies to the government.

- To strengthen women's agency and adaptive capacity, barriers across institutions need to be addressed. So while improving access to jobs, productive assets, and information on livelihood options, one needs to concurrently address domestic and reproductive constraints, through provisioning of appropriate infrastructure (drinking water, sanitation) and services (child care, health care).

- In order to counter risky or illegal livelihoods, vulnerable men and women need to be provided with better access to social support, education and technical skills, along with alternative sustainable livelihood opportunities.

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Photographs in this section: Lucia Scodanibbio, Irene Kunamwene, Musa Jillo, Jennifer Leavy

MOBILITY IS AN INHERENT DYNAMIC AMONG VULNERABLE POPULATIONS

Mobility is an important strategy to manage risk in semi-arid regions, but it doesn't always lead to improved wellbeing. Whether moving or staying put, risks can increase for those with little agency. Conversely, mobility can provide the means to move out of risky locations and improve livelihoods. In these cases, migration contributes to improved wellbeing and adaptive capacity.

ASSAR's focus on mobility

Semi-arid regions are crucibles of change in which different stressors coalesce, increasing the pressure on populations who are in many cases already vulnerable. Within these environments, mobility is an essential feature in many people's lives, and represents a key risk-management strategy, enabling populations to respond to livelihood shocks and stresses. Over time, risks change and evolve as do risk management behaviours, including mobility. Unpacking the multiple, intersecting vulnerabilities that are manifest in semi-arid regions is critical to generate greater insights into the 'how and why' of risk management, and to enable more equitable and effective adaptive responses.

ASSAR investigated the role of mobility as an adaptive response to change within populations in semi-arid regions. The dynamic and intersectional nature of risks and responses is not well articulated in global environmental change literature. Using empirically-rich data, our research highlights how people's approaches to managing risks are individualised but set within other social institutions, such as households and communities. It also points to the importance of mobility within risk-management strategies. Mobility can facilitate changes to risk portfolios in a number of ways, including accentuating or attenuating risks, eradicating risks entirely, or exposing populations to completely new risks. Conversely, sometimes mobility doesn't lead to any changes in the underlying risks people are exposed to. Changes are shaped by a person's agency, which is set within a web of broader social structures.

Over time, we see how the risks that people experience, and their responses to them, alter their wellbeing trajectories. Through a novel theoretical concept – the 'adaptation option space' – our evidence suggests that it can sometimes become increasingly difficult to shift downward wellbeing trajectories. Using the life history methodology helps to reveal these wellbeing trajectories, capturing the temporality of risks, livelihood choices, adaptation outcomes, and their interrelationships. This approach shows how current responses are influenced by past events, and enables us to infer how current behaviours may influence future, as yet unknown, events.

KEY INSIGHTS

EVERYDAY MOBILITY ENABLES PEOPLE IN SEMI-ARID REGIONS TO MAINTAIN THEIR LIVELIHOODS, AND MANAGE RISK

The use of mobility in semi-arid regions is the norm rather than the exception, supporting a variety of livelihoods reliant on natural resources (such as firewood collection or pastoralism), in addition to trading and more regularised commuting from rural areas to large urban settlements. Mobility is a key resource that people draw upon to manage highly dynamic conditions.

Mobility plays a key role in enabling livelihoods in semi-arid regions in Africa and India. It is often a necessary foundation on which lives are built, and plays a central role in people's risk management and adaptation behaviour. Despite this importance, commonplace mobility is a neglected area of research within the field of migration and environmental change research, especially within developing countries. The type of everyday or very regular mobility that is used for livelihoods includes commuting, pastoralism, trading *miraa* (the term used in Kenya for the stimulant Khat), and firewood collection. In India there are people who commute long distances daily (e.g., from Kolar district to Bengaluru – a distance of 80-100 km one way) to enter low-paying jobs in the informal sector (e.g., painters, cooks, gardeners, construction workers). In Kenya, *miraa* traders move between rural and urban environments, transporting *miraa* to market, while pastoralists need to move their herds to different areas for days or weeks at a time, and some women make a living collecting firewood.

RISKS AND RESPONSES ARE DYNAMIC AND INTERACT WITH ONE ANOTHER TO SHAPE THE OPTIONS AVAILABLE TO PEOPLE OVER TIME

Mobility occurs within a dynamic context of intersecting risks and responses that change over time. These interactions shape the 'adaptation option space' – the space available to people to adapt given the risks they face, responses they undertake, and adaptive capacities they hold. Different individuals and households respond differently, and the outcomes of mobility also vary. The life history approach shows how risks and adaptation options change over time, and their implications on wellbeing. Knowing where people have come from helps to understand not only their current situation but also their ability to respond to future, as yet unknown, livelihood stresses.

The link between risks and responses for individuals and households is dynamic and varies between socially-differentiated groups of people. It is essential to understand the unique perspectives that households have on key events, significant change, and what this means for their productive lives, wellbeing, and aspirations for their families. The use of the life history methodology helps to reveal people's personal experiences and perceptions of their wellbeing trajectory, thus capturing the temporality of risks, livelihood choices and adaptation outcomes, and their interrelationships.

Mobility can increase or reduce the risks faced by an individual or household. The experience of risks by different people and households is also strongly linked to their level of agency within a broader set of structural limitations. Over time, the risks that people experience and the responses they undertake, lead to changes in their wellbeing and specific trajectories of risk management. In some instances, it becomes increasingly difficult to shift negative trajectories, which leads to dramatic decreases in wellbeing over time with increasingly unlikely chances of recovery.

It is important to understand people's use of mobility within a web of dynamic and related processes. Individuals are active agents in the face of change but are often limited by the broader political, economic, social, environmental, and cultural structures around them. These broader issues affect the choices that people make when responding to risks, and the effectiveness of those choices. For example, we found some households were able to respond to risks in ways that maintained a stable or positive wellbeing trajectory. For other households, despite changing behaviours, their wellbeing trajectory was negative and strongly influenced by compounding livelihood shocks, suggesting the presence of social tipping points. A social tipping point is the instance at which a threshold is crossed, making recovery very difficult or impossible (a similar idea to a poverty trap). If we accept that social tipping points exist then we can shift our focus to thinking through what sort of interventions are required to bring about positive change.

People and places are different. There is clearly a need for approaches that place greater value on understanding intersectionality, social differentiation, and place when generating knowledge about vulnerability. Such knowledge is critical to support the design and implementation of more effective and equitable interventions and policy responses in resource-scarce and highly dynamic climate hotspots such as semi-arid regions.

MIGRATION IS NOT ALWAYS BENEFICIAL SO ALTERNATIVES SHOULD BE EXPLORED TO AVOID RISKS TO MIGRANTS AND THOSE LEFT AT HOME

There are trade-offs associated with moving. At an intra-household level, migration and commuting can alleviate vulnerability for some family members while exacerbating the vulnerability of those left behind. At a larger scale, migration that is adaptive at a household scale can be maladaptive at a system scale if cities are unable to provide for or absorb migrants who often live in highly vulnerable conditions. On a temporal scale, migration and commuting affect livelihood trajectories and choices of those beyond the migrants alone. We found evidence of migration decisions shaping opportunities across generations.

Migration is often portrayed as either 'a failure to adapt' (i.e., only the most vulnerable do not move out of highly vulnerable areas) or a 'successful adaptation strategy' (where those with adequate social networks and financial means are seen to take proactive decisions to move and expand their livelihoods). However, this binary does not accurately capture the mixed outcomes of migration for those who migrate and those who stay behind, or capture the various impacts on rural and urban areas as a whole. We find that migration outcomes are highly differentiated across and within households with causal patterns of vulnerability in rural areas often replicated in urban areas.

In some poor rural villages migration is perceived as a beneficial response strategy because some migrants bring success stories home and support their families with inputs and equipment during the planting season. However, some of the jobs and settlements that migrants move to expose them to harsh working and living conditions (e.g., mines in Mali, and informal settlements in India). This can lead to migrants catching diseases (e.g., from mining settlements) which family members need to spend money to try to treat. In the Mali case, an alternative to working in mines is vegetable production. Having an alternative livelihood and being able to stay at home is beneficial because housing, some food, and a more healthy environment is available at home.

In the case of India, migrants are doing better economically (our survey showed that migrant household incomes were almost double those of non-migrant households) but reported poorer wellbeing, especially satisfaction related to health and community networks. While remittances in India supplement household income and help repay existing loans they do not necessarily build adaptive capacities. This is also the case in other countries, such as Namibia, where households with more remittances didn't adopt adaptation options. In addition, structural constraints were not necessarily lost in moving (e.g., in some cases in India informal settlements were segregated based on religion or caste).

RECOMMENDATIONS

- The importance of everyday mobility to support a range of livelihoods and enhance wellbeing in semi-arid regions needs to be acknowledged.
- There is a need for more refined and sensitive approaches that reveal heterogeneity, intersectionality and situatedness, especially in resource-scarce and highly dynamic climate hotspots such as semi-arid regions.
- More support is needed for livelihoods in both rural and urban environments. People are in need of education and skills; resources and training to increase adaptive capacity; economic opportunities; and decent and safe work and housing in urban areas.
- Understanding how risks and responses interrelate over time can increase our understanding of how best to intervene and what forms these interventions should take.
- Mobility is not the only adaptation strategy people employ. Supporting other forms of adaptation is equally important.
- Mobility can be a valuable adaptation option, but it should not be seen, *a priori*, by policy makers or those working on adaptation as a solution, since it can come with many risks and reproduce vulnerabilities.

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Photographs in this section: Lucia Scodanibbio

ENHANCED KNOWLEDGE SYSTEMS ARE CRITICAL FOR CLIMATE CHANGE ADAPTATION

Climate adaptation knowledge is currently predominantly focused on weather and seasonal timescales, is dominated by climate warnings, and rarely extends to adaptation information. As climate change progresses, greater integration across timescales will be needed to prepare for novel climate risks. Integration of knowledge across institutions, knowledge domains, and geographic scales is equally necessary. Though the policy mandate for the generation and dissemination of climate information typically resides with government agencies, their efforts can be supported by intermediaries who are often better placed to bridge the different knowledge domains, and to work with at-risk communities. Developing the capacity of these intermediaries, and embedding them in the broader knowledge system is key, as they can also help to tailor adaptation information for different sectors (e.g., agriculture, forestry) and social groups to ensure that knowledge reaches those who might otherwise be excluded. The use of mobile technology offers further opportunities for improving people's access to timely, usable and locale-specific climate and adaptation information, particularly in rural areas where access is frequently limited.

ASSAR's focus on knowledge systems

ASSAR hypothesised that "knowledge", and the "knowledge system" within which knowledge is generated, exchanged, used, tested and updated (see Box 1) is a key enabler for adaptation. Our research aimed: (i) to document the knowledge resources relating to climate change adaptation that were available to communities in semi-arid areas, and how their access and use was socially differentiated; and (ii) to understand governance arrangements that act as barriers or enablers for the generation and transfer of climate adaptation knowledge.

A climate adaptation knowledge system is an organised structure and dynamic process that (a) generates and represents content, components, classes, or types of knowledge that are (b) relevant, reliable and useful to those vulnerable, and needing to adapt to, climate risks. These knowledge systems are (c) reinforced by a set of logical relationships that connect the content of knowledge to its value (utility), and are (d) enhanced by a set of iterative processes that enable evolution, revision, adaptation, and advance (modified from the Global System for Sustainable Development, accessed 2018).

We worked across scales, from our local case study sites to regional and national climate service systems, to assess the state of climate adaptation knowledge systems for semi-arid communities. While many previous assessments of climate knowledge have focused on weather and seasonal climate information, we also evaluated the state of knowledge on longer timescales relevant to climate change, and the knowledge that is available for adaptation.

KEY INSIGHTS

CLIMATE INFORMATION NEEDS A LONGER-TERM FOCUS, AND TO INCLUDE ADAPTATION SOLUTIONS

At national levels, most of the effort to produce climate information is placed on weather and seasonal climate forecasting and advisories. Far less effort is placed on generating and using longer-term climate information that can inform strategic planning. This means that local planning is undertaken without consideration for how climate change may impact on different development options and priorities. Knowledge on adaptation – how to respond to forecasted risks – is even less mature and accessible than climate risk information. This can hamper the ability to respond to weather and climate forecasts and projections.

Across several ASSAR sites we looked at the types of climate adaptation knowledge that are being generated, disseminated and/or exchanged at different system spatial scales – national, district and local levels – in five different countries. We assessed the strength of the system on different climate-risk timescales, including daily (weather), seasonal, decadal, and multi-decadal timescales. We also assessed how well the system incorporates different knowledge types or addresses different knowledge needs, including climate and weather information, climate impacts, and adaptation response options.

We found that knowledge systems are typically stronger on shorter timescales, especially weather forecast scales, and weakest on longer timescales (see Figure 1). The knowledge systems also tend to be strongest at national scales, where many of the resources, and much of the capacity for scientific knowledge generation and use, lies. Local knowledge on weather and climate on shorter timescales is often quite strong, and increasingly hybridising with the traditional knowledge and weather information provided by national or district services. Many local communities are only vaguely aware of climate change, and have asked for more information so that they can better understand how they might be affected.

In most places there is local knowledge on the possible responses to weather and seasonal climate risks, but many people say that their actions are becoming less useful as the timing and intensity of impactful weather events change. As the risk horizon moves to multi-year and multi-decadal timescales, very little knowledge is generated and even less is exchanged between different actors in the knowledge system. There simply seems to be very little sharing of existing knowledge between projects about intervention attempts, and so diffusion of potentially-useful adaptation solutions from trial to wider scales is slow or non-existent.

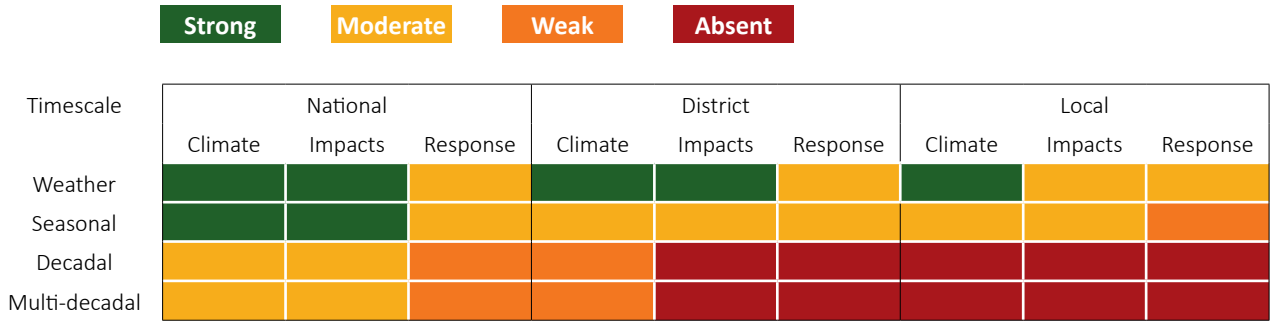

Figure 1: The relative strength of knowledge systems at different spatial scales, timescales, and across different aspects of climate adaptation: climate information, impacts information, and adaptation (response) information.

GENERATING RELEVANT, USABLE AND RELIABLE KNOWLEDGE REQUIRES COLLABORATION ACROSS INSTITUTIONS, KNOWLEDGE DOMAINS, AND GEOGRAPHIC SCALES

The multi-faceted and multi-scale nature of climate adaptation knowledge systems means that inter-organisational collaboration, and the enabling of governance arrangements, are critical in determining what information is generated, how it is communicated and used, and how its relevance, usability and reliability are perceived by vulnerable communities.

The governance arrangements for climate services, and the strength of collaborations among different knowledge generators and communicators, strongly influence the quality – relevance, reliability and usability – of information that is available to vulnerable groups such as pastoralists and small farmers. In some countries, such as Ghana and Namibia, climate adaptation knowledge is centralised nationally and dominated by government organisations. This tends to result in less relevant weather and climate forecasts at sub-national and local scales, with local institutions having poor knowledge of climate risks. Where responsibilities are less centralised, such as in Kenya, the generation and translation of weather and climate forecasts by government organisations at sub-national and local scales is stronger.

Strong collaboration between different actors in climate adaptation knowledge systems enables the iterative processes needed for evolution, revision, adaptation, and advances in knowledge generation and use. These collaborations work best when they occur across scales and bring together the relative strengths of government departments, research institutions, international bodies, as well as community-based and non-governmental organisations. In cases where the feedback processes in the networks are strong (particularly the feedback from local to national organisations), communities and households tend to be more adept with climate change issues.

A pervasive challenge for all actors in these knowledge systems is human and financial capacity. Knowledge systems that operate across scales need both strong capacity in institutions, and capacity for interactions across the network. In many instances we found a lack of capacity to mean that knowledge networks were unable to maximise their potential. This was especially so for local organisations, who sit at the end of the global and national "resource chain".

ACCESS AND USE OF CLIMATE ADAPTATION KNOWLEDGE IS OFTEN SOCIALLY DIFFERENTIATED

Access to climate services and adaptation information can be affected by gender and other dimensions of social difference. Local intermediaries who understand these differences can help to tailor information services and build local capacities, to reach those who might otherwise be excluded.

In the rural communities where we worked, we found that Namibian farmers with higher levels of education were better able to adapt their farming practices using new seed technologies, whereas farmers with lower education levels tended to abandon their lands and look for off-farm work opportunities. In Ghana, younger farmers were more likely than older ones to access and use information from external climate service providers, and male-headed households were more successful in accessing services and support than female-headed households.

Understanding how the social and cultural characteristics of communities affect access and use of information is important if climate and adaptation services are to be effective, especially for socially-disadvantaged groups. These factors are often differentiated along multiple social dimensions, such as gender, caste, ethnicity, age, education and wealth. Local intermediaries – who understand and can tailor information to reach those who might otherwise be excluded – are a vital part of the climate knowledge system.

These intermediaries may be traditional knowledge holders, commercial actors, rural extension services, public and private media organisations, and community-based and non-governmental organisations. However, these intermediaries can also wield power from this position, so careful governance of their roles and activities is also important.

MOBILE TECHNOLOGY OFFERS NEW OPPORTUNITIES FOR DISSEMINATION AND COLLABORATION

Mobile technology can be used to improve farmer access to locale-specific climate and adaptation information. Ensuring that advisory systems are demand-driven and based on farmer needs is vital, as is ensuring that the costs of accessing this information are not prohibitive.

Along with visits by extension officers and other advisors, traditional media, such as radio and television, are still the primary mechanisms through which people in semi-arid areas access climate information on a day-to-day basis. However many of these media forecasts provide information at scales too coarse for local farmers and pastoralists, and in no way tailored to meet individual needs.

In several cases, ASSAR identified mobile phones as an effective channel for disseminating and sharing information. For example, in the Upper West Region of Ghana where there is inadequate access to extension services, and a low base of knowledge about adaptation options, the ASSAR Ghana team saw an opportunity to leverage the rapid increase in smartphone use as a means of disseminating climate information. To this end, they developed 'The Adaptation Hub' mobile application, a platform aimed at extension officers, community development workers, researchers and students, which supports information transfer and knowledge sharing about climate change adaptation. Similarly, in India, the Watershed Organisation Trust (WOTR) uses mobile phones to disseminate crop and locale-specific agro-advisories, based on weather forecasts and particular crop growth stages, in order to reduce farmer risks and improve agricultural productivity. The WOTR advisory system is based on a collaborative partnership with key developmental, scientific and academic institutions, which makes it possible to pool and share valuable resources and expertise. This collaboration facilitates mutual learning, co-generation of practical knowledge, and technology transfer.

However, there are also barriers to mobile phone use, mostly through data costs. These costs can exclude certain groups from accessing climate services provided in this way. An innovation that might open up access is to work with mobile companies to allow free access to certain websites, or for certain climate service applications.

RECOMMENDATIONS

- While effort to enhance near-term climate and adaptation information is still required, additional efforts are needed to provide longer-term information to enable local institutions, communities and households to incorporate progressive climate changes into development plans and household livelihood strategies.

- Climate services need to be systematically expanded to incorporate adaptation information in addition to traditional weather forecasts, seasonal outlooks, and longer-term climate change scenarios.

- Resourcing for collaboration, knowledge exchange, and learning needs to be part of the development process for any climate adaptation service.

- More investment and innovation in the use of mobile phone technology is needed, especially to ensure that no one is left behind in benefitting from this new opportunity for information sharing.

- An effective and resourced network of organisations working locally is key to making sure that climate risk and adaptation knowledge makes it all the way to households, that this knowledge is of use and is used, and that the iterative feedback processes needed for an effective knowledge system can flourish.

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Photographs in this section: Tali Hoffman, Institute for Environment and Sanitation Studies (University of Ghana), Salma Hegga, Irene Kunamwene

COLLABORATIVE RESEARCH CONSORTIA ARE COMPLEX, BUT HAVE GREAT POTENTIAL

Large-scale collaborative consortia provide multiple opportunities for professional and personal growth of those involved. Interactions across disciplinary, geographical, cultural, and sectoral dimensions offer a rich learning environment; and consortia provide multiple opportunities for networking, capacity building, and broadening one's understanding. However, working in consortia can be challenging, involving varied transaction costs given the diversity of partners involved, and their dispersed nature. Bridging the research-practitioner divide, for instance, requires overcoming certain barriers, such as differences in professional language and priorities. Yet continuous and iterative collaboration between researchers and practitioners is critical for research to be impactful and meaningful. Building relationships and trust is one of the most worthwhile investments one can make for the success of large-scale collaborative initiatives

ASSAR's reflective approach

From the outset, in a variety of complementary ways (see Table 1), the ASSAR consortium took a reflective approach, in an effort to learn from the multiple activities that were being undertaken – from research to stakeholder influencing, from managing the workflow to writing collaboratively. The lessons that follow are a result of these reflection processes.

Table 1: Learning processes pursued by ASSAR

Learning process	Purpose
ASSAR annual meetings	Opportunities to reflect on what was working well, what needed to be continued, what should be discontinued, and what new things should be done.
CARIAA programme annual learning meetings	Opportunities to reflect on different aspects of our work, from Research-into-Use, to the process of content synthesis across one or more consortia. One outcome of these meetings was the contribution of ASSAR members to the production of a journal article on CARIAA's insights on transdisciplinary collaboration.
Preparation of ASSAR annual progress reports	Opportunities to look back on our achievements, and the challenges encountered, and to discuss the potential risks that the consortium faced, and how those could be mitigated.
ASSAR mid-point survey (September 2016) and final survey (November 2018)	Opportunities to reflect on ASSAR member learning and highlights, as well as the benefits and challenges associated with being part of a consortium, halfway through, and at the end of the project.
Learning exchanges with other large consortia-based programmes	Opportunities to reflect on common lessons learned across different programmes (including the Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED), the Partners for Resilience alliance, and others). These interactions resulted in a series of guidelines, which were presented in a webinar in November 2018.

KEY INSIGHTS

LARGE-SCALE COLLABORATIVE CONSORTIA PROVIDE MULTIPLE OPPORTUNITIES FOR LEARNING AND BENEFITS TO THOSE INVOLVED

Large-scale collaborations bring together multiple partners from different geographies, disciplines, cultures and sectors (e.g., academic, state and non-state). The learning that occurs at the intersection of these multiple dimensions is inevitably significant. According to the ASSAR survey conducted halfway through the project's duration, the most valuable things learned by ASSAR members revolved around both research content and the process of working together. When learning something new, ASSAR team members referred not only to new knowledge (such as on adaptation, wellbeing, gender and climate science), but also new ways of thinking about and conducting one's research, the importance of Research-into-Use, as well as a broadened understanding of issues – including an enhanced realisation of their complexity. On process, ASSAR colleagues appreciated having learned about the consortium model, including how it works, the inherent challenges involved, and the importance of relationships and spending time together.

ASSAR members also showed an appreciation of the importance of the different types of expertise encompassed by the consortium, referring to its cross-regional, multi-cultural aspect, the variety of disciplinary perspectives, the inclusion of practitioners alongside researchers, and the interactions among different levels of seniority and expertise. When asked about the most useful part of working in a consortium, responses revolved around the access to these diverse perspectives and approaches, networks, sets of expertise and skill, sources of information, funds and research sites – among others – that being part of a consortium affords. The experience of working across different regions and different fields, and the ability to generate knowledge and compare learning across these fields, was deemed invaluable. The many opportunities to strengthen capacities (such as through mentorship, ASSAR-organised training courses and writeshops, ASSAR's small opportunities grants that enabled cross-regional exchanges and the pursuit of distinct individual projects, and participation in conferences) were also highly appreciated, by both junior and senior researchers, as well as practitioners.

The key aspects that participants of ASSAR's last annual meeting (June 2018) aimed to take to a new project mainly revolved around: research for impact (including thinking about target audiences, influencing, stakeholder involvement, communications); more holistic ways of thinking; new skills and approaches; an understanding of the challenges involved in working collaboratively across disciplines, dispersed partners, and varying skill sets and capacities; and insight into the ways of better navigating these collaborations. The relationships forged through the project (and which were the result of both formal and informal interactions, such as during annual meetings), were one of the most valued aspects of the experience, and many partners are building upon them in other collaborations.

WORKING IN CONSORTIA CAN BE CHALLENGING AND INVOLVES NUMEROUS TRANSACTION COSTS

The very same features of consortia that enable learning and add value (such as their disciplinary and geographical diversity) are often responsible for making collaborative work challenging and time-consuming. The number of institutions and individuals involved, dispersed nature of partners, and cultural diversity can lead to difficulties for coordination, communication, maintaining connection, understanding one another, and ultimately working together effectively, particularly in the case of new partnerships where relationships and trust have to be built from scratch. In ASSAR, the first year was particularly challenging, given that most partners had not worked together before.

Added to this was the challenge of building trust given the geographical isolation of the different partners, and the low frequency of face-to-face meetings that allow people to develop working and personal relationships. Setting up the different structures for the project (including ASSAR's integrated research framework, which would enable comparability across study sites) was therefore an arduous process, as a common language and understanding of concepts, across disciplinary, research-practitioner, and geographical divides (including rural and urban), had to be developed.

More than half of the ASSAR survey respondents, when asked about the most difficult aspects of working in a consortium, referred to the transaction costs. These included the complexity of working together in practice given the multitude of partners and physical distance separating most (e.g., to organise online meetings, take decisions remotely, the logistics of setting up shared research). In addition, respondents referred to the dependence on others' contributions to make progress, and the time investment required for all the multiple activities enveloped in a consortium (including project management, administration, reporting, budgeting, communications), which overwhelmed team members most of the time. Politics were also a challenge, particularly those arising from power dynamics (arising for instance from the different disciplines, or lead versus sub-contracted partners), and competing interests and priorities (including tensions between research and impact, between students' interests and the project goals, and between institutional mandates and ASSAR's priority areas). Lastly, different ways and paces of working, differences in understanding and addressing issues, and a lack of collaborative spirit (which was at times due to personal relationships), were also found to complicate the collaborative endeavour at times.

COLLABORATION BETWEEN RESEARCHERS AND PRACTITIONERS IS CRITICAL FOR IMPACT

ASSAR experience indicates that iterative and continuous interactions between researchers and practitioners is key for maximising research impact. But this integration across research and practice is challenging, and requires the removal of certain key barriers, and consolidation of certain key enablers. Barriers that we encountered included the use of different language and terminologies to define activities; differences in project mandates, expectations, impact timelines, and institutional priorities; and rigidity in terms of thinking about outputs and impacts (such as research publications versus stakeholder engagement). Some of the key enablers that emerged included thinking about new ways of integrating knowledge across scales (defined by strategic collaborations and new ways of thinking); a research design that embeds Research-into-Use; and increasing collaborative engagements between researchers, practitioners and communities – both within and across organisations – which could potentially lead to more trust, respect, and recognition across distinct frames of knowledge production and dissemination.

In addition, we found that there are diverse approaches to research-practice collaboration and there is no 'one' silver bullet, or one-size-fits-all solution. All approaches require investments of time and resources. For example, collaborative and strategic alliances between research institutions and practitioner institutions (at all levels, from local to global) must be nurtured to mature over a long period of time.

FIVE WAYS TO MAXIMISE BENEFITS AND IMPACTS OF COLLABORATIVE WORK

Invest in relationship building

Large-scale collaborations of people and partners who have not worked together before require significant investments in relationship-building activities early on, to enable expectations to be cleared and trust to be developed, before (or at least alongside) the hard discussions on deliverables and budgets. Early meetings should also be aimed at developing a joint vision and framing of what is desired, and discuss how work will be undertaken, and challenges (including conflict and risk) dealt with.

Ensure budget to support emerging opportunities

The provision of small seed funds at opportune times (e.g., once relationships have been built and the focus of work is clear) can help to catalyse the production of collaborative, comparative outputs, strengthen capacities, and increase impact. Similarly, such funds can be used to take advantage of windows of opportunity for influencing policy or practice.

Enable collaborative research through training and leadership

Collaborative research can be enabled through a combination of training activities (more effective when these happen early in the project), face-to-face time to enable progress (maximising the opportunities when colleagues are already together), strong leadership, and commitment by the different colleagues involved.

Maintain connection through transparent and regular communication

The dispersed nature of a consortium partnership necessitates dedicating additional, specialised attention to ensuring transparency, keeping communication channels open, and maintaining the flow of information to keep partners engaged and motivated. This could be done through weekly newsletters (e.g., we adopted a weekly digest for ASSAR) to keep everyone updated about important documents, meetings, deadlines and opportunities, and to celebrate achievements across the team. This is particularly important for those involved more peripherally, and who have fewer opportunities for face-to-face interactions.

Invest in face-to-face time

Face-to-face time is critical to maintain momentum and ensure progress. Though expensive, this is probably the most worthwhile investment of funds, particularly to secure commitment and attention to the project when colleagues are only involved in it part time.

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COUNTRY INSIGHTS

Photograph: Jennifer Leavy

BOTSWANA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID BOTSWANA

ASSAR'S FOCUS IN BOTSWANA

Semi-arid regions like eastern Botswana are highly dynamic systems that experience variable and sometimes extreme climates, adverse environmental change, and a relative paucity of and decline in natural resources. Historically, people living in these regions have adopted several coping mechanisms to deal with these conditions. Today, however, many communities exhibit low levels of adaptive capacity due to challenges such as marginalisation, underdevelopment, poverty, inequality, weak governance, maladaptive policies, and increasing population growth. Climate change is expected to augment existing levels of vulnerability as temperatures rise, rainfall decreases, and seasonal climate patterns become more variable.

From 2014-2018, ASSAR's Botswana team worked in the Bobirwa sub-district of the country to better understand these existing and upcoming challenges. In the last year of the project, we expanded our Vulnerability and Risk Assessment (VRA) work to Mahalapye (Central District) and to Chobe District. Made up of a team of researchers and practitioners from the University of Botswana (UB), University of Cape Town (UCT) and Oxfam GB, we worked with stakeholders from national to household levels to understand what makes people vulnerable to climate change and other hazards, what the barriers to adaptation are, and what could enable more effective, sustained and widespread adaptation to climate change and access to fairer, inclusive development pathways.

Key insights

- Botswana is one of the countries in Africa that will experience the most extreme changes in temperature and precipitation under global warming scenarios of 1.5°C-3°C above pre-industrial levels. These changes will have significant negative impacts on agriculture and other water-dependent sectors. There is an urgent need for communities and government to respond to climate change with measures that will build resilience and enhance wellbeing.

- In recent years, there have been adverse changes in the quantity, quality, distribution and timing of certain ecosystem services (ES) due to increasing human pressure and climate change impacts. As dependence on and access to ES varies by gender, men and women are affected differently by these ecosystem changes. ES need to be sustainably and equitably managed through improved monitoring and restrictions on harvesting. Access to alternative livelihood options should also be enhanced.

- To increase the use of seasonal climate forecasts by people with different values, customs and belief systems, meteorological and place-based climate information need to be integrated through participatory processes with traditional and religious leaders. Forecasts should also be tailored and communicated in a way that is relevant and understandable to farmers, and should include information on what actions farmers should take.

- Climate change is causing the frequency, severity, duration and spatial extent of droughts to increase. Yet, institutionally, drought and climate change are managed separately. There is a lack of coordination among departments responsible for drought management, and responses are largely reactive and crisis-driven. While emergency drought response does have an important role to play in drought management, a more proactive and integrated approach is needed to build the longer-term resilience of vulnerable people, ecosystems and the economy.

- Grassroots stakeholders have equally valuable contributions to make as those in positions of power in policy, planning and vulnerability assessment processes. Multi-sector and multi-scalar participatory processes that enable collaborative planning and engagement with and between representative and marginalised stakeholders are thus important for ensuring that climate change responses are legitimate, effective, and tailored to the realities of various social groups.

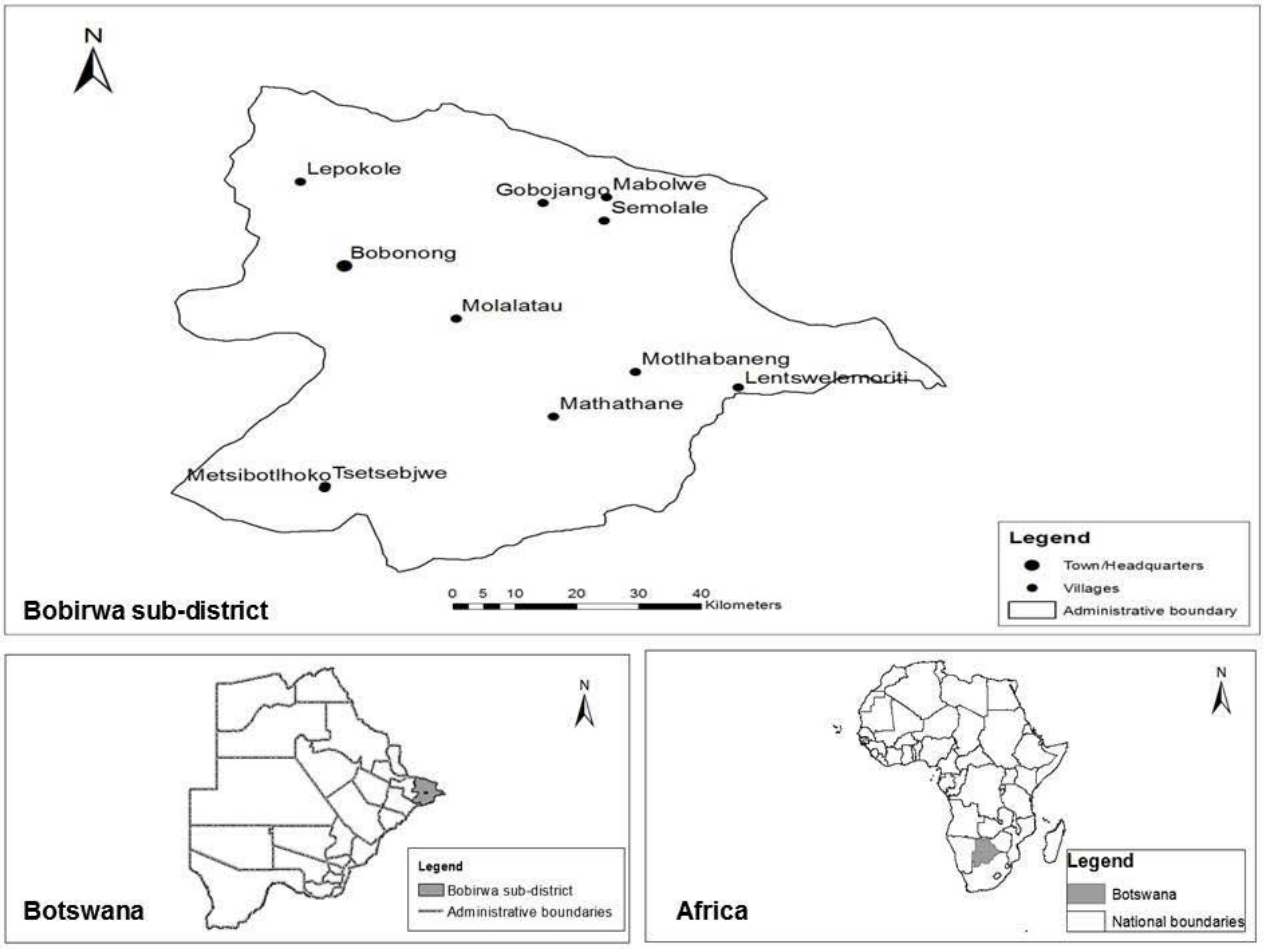
ABOUT THE RESEARCH

Research priorities

ASSAR's research in Botswana had several main focus areas, each of which was considered through the lens of barriers and enablers to climate change adaptation. The first of these priority research areas assessed the most recent global climate change projections to determine how global warming scenarios of 1.5°C-3°C above pre-industrial levels are likely to affect vulnerable sectors in Botswana. A different, although related, body of work considered the challenges and opportunities for producing and communicating seasonal climate forecast information across scales in ways that are relevant and useful to local farmers, as well as credible among people with different belief systems.

A third major area of work assessed the dynamics of ecosystem services in Botswana in the context of climate variability and change. Here we sought to find out which ES are pivotal to human livelihoods in the Bobirwa sub-district, how the availability of and access to these services are changing, and in what ways people are differentially affected by these dynamics.

Our research also focused on the governance of climate change, and drought in particular. In this regard we sought to identify the key institutions that have been responding to and adapting to climate change, and to assess what challenges are being faced.



Gender and social differentiation were cross-cutting themes in all of our research. The survey that we conducted in over 300 households in several villages in the Bobirwa sub-district was one research activity that contributed to our understanding of how men and women of different ages, socio-economic statuses, and ethnicities are vulnerable to climate change.

Research questions

ASSAR research in Botswana was designed to contribute to the project's overarching research question, namely: what are the barriers and enablers to effective, sustained and widespread adaptation to climate change? Through this lens, we sought to answer the following specific research questions:

1. How might Botswana's climate change in future, what are the consequences of these changes for different sectors and social groups, and what actions need to be taken to ensure effective adaptation?
2. What ecosystem services are important for sustaining the livelihoods of resource-dependent communities in the Bobirwa sub-district, how accessible are these services to different social groups, what determines this accessibility, and how can they be sustainably managed in future?
3. How credible and scale-relevant are the seasonal climate forecasts (SCF) that reach communities in Bobirwa sub-district, and how do these factors influence their decision-making and livelihood activities?
4. What institutions are responsible for and/or involved in responding to drought/climate change and how effective are they?
5. What role does participation have in policy and planning processes? Which stakeholders are important to include in such processes, and how might collaboration across sectors and scales – and with marginalised groups – contribute to improved climate change adaptation responses?

Case study sites

Our main study site was the Bobirwa sub-district, which is situated in the Central District of Botswana and has a population of over 72,000 people. Bobirwa sub-district borders Zimbabwe to the east and South Africa to the south, and is characterised by low rainfall, high temperatures, and frequent droughts. Temperatures range from minimums of below 10°C to maximums of over 30°C. The largest village in Bobirwa is Bobonong, with a population of about 20,000 people. In total, there are 14 villages in the sub-district. We included eight of these in our household survey, in which 310 households participated.

Livelihoods in Bobirwa are largely dependent on natural resources and primary production, with rain-fed agriculture, livestock rearing, and harvesting of Mopane (phane) caterpillars being key livelihood activities. This makes people highly susceptible to climate variability and change. Vulnerability to climate is augmented by non-climatic drivers such as poverty, inequality, and HIV/AIDS. Cattle in the Bobirwa sub-district also experience frequent outbreaks of foot-and-mouth disease. In addition to increasing livestock mortality, this disease restricts trade beyond the sub-district due to the establishment of veterinary borders, across which the movement of exposed animals and related products is prohibited.

Approach

Our work in Botswana began in December 2014 with a preliminary introduction of ASSAR to the sub-district administration and tribal leadership, including chiefs and headmen from all 14 villages in Bobirwa. Then, in January 2015, we introduced the project to key stakeholders at both national and local levels, including government representatives from various ministries, non-government stakeholders and community members.

The findings from this introductory phase of ASSAR contributed to a regional diagnostic study, which was completed in early 2015. A literature review and feedback from community (*kgotla*) meetings and focus group discussions also informed the diagnostic study. These initial engagements were critical for establishing traction for the project at an early stage, and for gaining early insights into the community's perceptions around climate change, as well as the impacts thereof on people's livelihoods and wellbeing.

Throughout the project, we also collected data through questionnaires, key informant interviews and focus group discussions, which looked at a range of issues including: drought and climate change governance (conducted by Kulthoum Motsumi as part of her PhD), barriers to and enablers of adaptation, gender and social differentiation, the credibility and scale-relevance of SCF, and people's perceptions with regards to the dynamics of ES (conducted by Ephias Mugari as part of his PhD). We also conducted analyses of historical, remotely-sensed climate data and field observations to determine how climate variables such as temperature, rainfall and evapotranspiration have changed from 1982 to the present. We used the normalised difference vegetation index (NDVI) from remote sensing data as a proxy to show trends in vegetation condition, and to indicate the capacity of the local ecosystem to generate provisioning services.

But we consciously wanted to add a strong element of stakeholder consultation and co-creation to our work in Botswana. To that end, towards the end of 2015 we held a VRA workshop in Bobonong, which was attended by 22 participants, making up what was known as the 'Knowledge Group'. The VRA workshop revealed what the stakeholders (comprised of community members, private sector and government) jointly considered to be major hazards, which social groups they thought to be most vulnerable to these hazards, and what measures could be taken to adapt, reduce vulnerability, and enhance resilience. Some key hazards included drought and high temperatures, foot-and-mouth disease, a lack of access to markets and non-agricultural based livelihoods, and under-resourced extensions services, amongst others. The VRA process was well received and, as a result, we were requested by the national government's Office of the President to train district managers across the country to conduct the VRA process in-house as a way of doing more inclusive and participatory development and adaptation planning. In preparation for this training workshop, we held a half-day stakeholder mapping exercise in Mahalapye Sub-District in July 2018. A total of 28 stakeholders attended this workshop, and the whole VRA process eventually crystallised in a national-level event where economic and planning officers from all districts of the country were trained on VRA in August 2018. A final VRA was conducted in Chobe in January 2019.

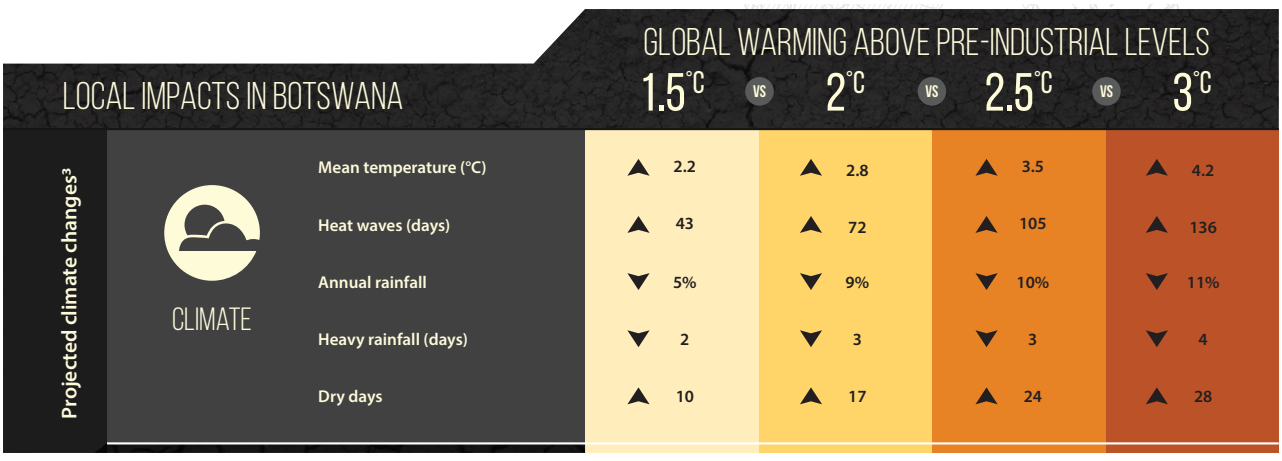
In 2016, the ASSAR research team and several stakeholders from the sub-district attended a training workshop on TSP with Reos Partners. Subsequently, in October 2017 and January 2018, we held two TSP workshops in Bobirwa, attended by an average of 30 stakeholders. The main cross-cutting issues identified during the TSP process were: (i) the future of land for productive agricultural use; and (ii) human-wildlife conflict. Over the course of these two workshops, stakeholders realised the importance of working together rather than in isolation, and the groundwork was laid for collaboration on these important issues in the longer term.

The final research activity in Botswana was a household survey, during which we interviewed 310 households from eight villages in the Bobirwa sub-district. The survey investigating livelihoods and vulnerability and responses to climate change of households, which was completed in March 2018, was preceded by the training of 10 enumerators who subsequently conducted the survey and entered the survey data into SPSS, a statistical analysis programme. At the end of the project, we produced a documentary summarising the project's main objectives, activities and key findings. We shared the video documentary, alongside some printed communications materials, with stakeholders at feedback events in Gaborone and Bobirwa in November 2018.

FINDINGS AND RECOMMENDATIONS

BOTSWANA IS HEATING FASTER THAN OTHER COUNTRIES GLOBALLY AND NEEDS TO URGENTLY RESPOND

Climate projections indicate that temperatures in Botswana are rising more rapidly than most other countries globally. Without concerted action to adapt to a hotter, drier future, Botswana's people, ecosystems and economy will suffer. It is imperative that communities and government respond to climate change with urgency by implementing measures that will build resilience and enhance wellbeing, both now and in the long term.



Botswana is likely to get hotter, drier and more water-stressed in future, and is also likely to experience greater climate extremes, including more frequent and intense droughts, floods, and heatwaves. By 2024 Botswana may already be, on average, 2°C hotter than pre-industrial temperatures, which is a substantially more rapid rise in temperature than other regions of the world. The effects of higher temperatures will be felt across all sectors, including those that are essential to the prosperity of people and the economy, such as agriculture, health and water. Agriculture is particularly vulnerable to shifts in climate, and farmers are likely to experience reduced crop yields and increased livestock losses. Rain-fed agriculture – a key livelihood activity in the Bobirwa sub-district – is already marginal, and anticipated climate change may well make current agricultural practices unviable, even if global warming is capped at 1.5°C above pre-industrial levels.

The progressively serious climate impacts from 1.5°C to 3.0°C global warming in Botswana demand concerted action, both locally and internationally. Botswana needs to anticipate and plan for rapid changes in local weather and climate. It needs an acceleration in the development of adaptation strategies, which should be implemented in a way that works for all people and economic sectors. The time for pilot adaptation projects and experiments is over, and the moment to start mainstreaming climate resilience into the public, private and community sectors has arrived.

Recommendations

- Ongoing collaboration between government, researchers, practitioners and communities is required to find joint solutions to the challenges of global warming of 1.5°C and higher. Communities and governments need to understand the current and potential impacts of climate change on different sectors, stakeholders and social groups. This is crucial for targeted adaptation planning, and for responding urgently and effectively to these impacts.

- Capacity needs to be built for identifying, monitoring and communicating early warnings about extreme climate events. This will require investments in technology, infrastructure and skills development, which should form part of longer-term, strategic plans that are aimed at, and budget for, building resilience to climate change.

- Awareness raising and education about climate change, its impacts and possible adaptation interventions are important for building resilience across scales. Generating this knowledge together is key, and climate change data should be jointly analysed with communities and vulnerable groups, and shared in a way that is easy to understand.

- Mainstreaming climate-smart agricultural practices into policy and planning, and enabling farmers with the capacity and resources required to implement these measures, will be essential for ensuring that the agricultural sector is well adapted to hotter, drier conditions, and that the country is food secure in future. Policy makers also need to be strategic in planning for future water security, and should encourage rainwater capture and storage, and the implementation of water saving measures.

- Addressing the underlying causes of vulnerability to climate change impacts is critical for ensuring that responses are sustainable in the long term. In doing so, the focus should be on the interconnection of existing environmental and climatic conditions, and the interplay of governance, socio-economic, health, education, and cultural issues. The consideration of gender dynamics and gender equality is particularly important in this context.

ECOSYSTEM SERVICES NEED TO BE MANAGED MORE SUSTAINABLY AND EQUITABLY, AND ALTERNATIVE LIVELIHOODS ARE NEEDED

Provisioning ES are fundamental to the livelihoods and wellbeing of communities in the Bobirwa sub-district. The enforcement of restrictions on harvesting, monitoring of government programmes to improve agricultural productivity, and the enhancement of alternative livelihood options could all help to reduce the pressure and overreliance on vulnerable ES.

With few alternative livelihood options, communities in the Bobirwa sub-district are heavily reliant on ES, whether directly or indirectly. Crop and livestock production, and the exploitation of timber and non-timber forest products are particularly important for maintaining food security and wellbeing. However, in recent years, there have been adverse changes in the quantity, quality, distribution and timing of certain ES. Contributing factors include less predictable rainfall, more pervasive droughts, an increased demand for agricultural land, and an expansion of villages. Phane caterpillars, which local people have harvested for centuries, are one important ecosystem service that has seen a significant decline in the last decade. An overexploitation of woodlands has also been observed, while the clearing of shrubs for crop cultivation has resulted in trade-offs with other provisioning ES, such as communal grazing land.

Dependence on and access to ES varies by gender. Women are most affected by changes in the availability of water for the household, firewood, wild vegetables and palm leaves for basket-making. On the other hand, men are disproportionately affected by changes in the availability of timber, pasture and water for livestock. Both men and women are affected by the fluctuating availability of phane caterpillars, firewood, and fertile soils for crop production. Part of the challenge around declining natural resources is that there is a mismatch between how national authorities and local communities view ES. While the latter feel that ES in Bobirwa belong to them, at the national level ES are considered a common resource. Competition from people residing beyond the sub-district therefore means that local communities have little incentive to sustainably manage ecosystem services.

Recommendations

- ES need to be sustainably managed through regulatory measures, including permitting and restricting the timing of harvesting activities, as well as the volume of resources collected. Given their dwindling numbers, it may be necessary to place a ban on the harvesting of phane caterpillars for two or three consecutive breeding seasons to allow the population to recover, and to avoid losing this important source of protein and income entirely.

- All decisions around ES should be made through inclusive and participatory processes that emphasise the integration of community knowledge and values into plans for the management and use of ES under a changing climate. This is important for ensuring buy-in among traditional leaders, local authorities, and importantly, the grassroots people dependent on ES.

- Shifts in the availability of ES in Bobirwa impact people differently. For example, women and children are particularly vulnerable to declines in the availability of phane caterpillars as they are sometimes forced to camp far away from their homesteads in unhealthy conditions in order to access this dwindling resource. Such socially-differentiated vulnerabilities should be a key focus of policy and planning around ES.

- To ensure more sustainable management of ES, possible ways of engaging communities and resource users in enforcing regulatory measures, and monitoring the state and trends in ES should be explored.

- Key to supporting the communities that depend on declining ES is to ensure that they have other ways to make a living or survive off the land. Access to alternative livelihood options is required, although enhanced diversification (especially for women) needs to be accompanied by support systems that ensure they are not overburdened. The monitoring of government programmes aimed at increasing agricultural productivity should also be improved. This is also important for reducing the increasing pressure being placed on towns and cities from the in-migration of rural youth in search of work.

CLIMATE INFORMATION SHOULD BE RELEVANT, CREDIBLE, AND ACCESSIBLE TO STAKEHOLDERS

Meteorological and place-based climate information need to be integrated, tailored to the needs of the users, packaged in ways that resonate with traditional and religious narratives, and communicated in ways that are understandable.

The large spatial and geographical resolution of national meteorological seasonal climate forecasts limits their usability and relevance to local farmers in the Bobirwa sub-district. As such, some farmers use ecological indicators and place-based observations instead of, or in addition to, these forecasts. However, the number of people that still have skills in traditional forecasting is declining, thereby making meteorological climate data an increasingly important source of information. Even so, some farmers do not use SCF at all. While in some cases this can be attributed to a lack of understanding or access

to meteorological forecast information, a major reason for their low uptake is that some farmers perceive SCF to lack credibility, due to them having been inaccurate in the past.

The use of both meteorological and place-based climate forecasts is affected by traditional norms and religious beliefs. Some farmers, for example, disregard forecasting information because they prefer to farm as they always have done, or because they are required by custom to wait for the chief's permission before they can start planting. Other farmers believe that God controls the rain and that it is not possible for humans to predict the future. Hence, they have faith that God will provide for them, and do not change their farming practices in accordance with the forecasts. If farmers don't take heed of climate forecasts and information on adaptation options, then it is likely that they will be more vulnerable to climate variability and change in future.

Recommendations

- For farmers to be better equipped for future climatic conditions, they need to be more forward-looking in their decisions. To enable this, awareness needs to be raised across sectors and governance levels about climate change and adaptation options, so that farmers understand how their vulnerability might shift and so that they are empowered to make informed decisions about their farming practices and livelihoods.

- Ongoing conversations need to be held among the producers, disseminators and users of climate forecast information. This is important for improving coordination and for ensuring that forecast information is packaged in ways that resonate with the diverse needs, values and perspectives of the target audiences.

- For forecast information to be more useful to farmers, meteorological and place-based forecast information should be integrated through a participatory process that enables meteorologists to collaborate with traditional forecasters. This process should seek synergies and identify discontinuities between the different sources and types of information, and integrated forecasts should be communicated in ways that are understandable and relevant to farmers.

- Forecast information should be made accessible to their users through different entry points, which might include platforms such as the radio, *kgotla* meetings or church services. Importantly, this information should be communicated through messengers that are relevant to and trusted in the community, be they local councillors, traditional authorities, village headmen or religious leaders, for example. This will increase the likelihood that people with different values and belief systems will use the information that is provided.

- Any climate forecast information that is communicated to farmers, or communities in general, should include advice on what adaptation actions (if any) should be taken. Where relevant, climate-smart agricultural practices should be a key focus of such recommendations. The advice that is provided should also be paired with on-site demonstrations and the practical training of farmers through capacitated extension services.

EFFECTIVE ADAPTATION TO DROUGHT REQUIRES A MORE STRATEGIC AND PROACTIVE GOVERNANCE PARADIGM

Short-term, crisis-driven responses to climate-related disasters such as drought are no longer appropriate in the face of increasing climate variability and extremes. Instead, emergency responses should be viewed as complementary to a more long-term, proactive and integrated approach to governance. This is important for enabling more effective adaptation to drought, and to climate change more broadly.

Drought has always been considered a natural part of Botswana's climate. As such, there is no official definition of drought, nor any overarching policy framework to guide the management of drought at the state level. However, anthropogenic climate change is causing the frequency, severity, duration, and spatial extent of drought periods to increase. There is now an urgent need for a more effective approach to drought governance which, to date, has been largely in the form of piecemeal, emergency-led interventions, whereby authorities only respond to disasters once they have already happened. Part of the problem is that, institutionally, drought has been managed separately to climate change, and there is a lack of coordination among the departments responsible for drought management itself, which work in silos. While the official mandate for managing drought sits with the Ministry of Local Government, the sectors that are most affected by drought – such as water and agriculture – are dealt with in different ministries, and within different policy environments.

In the absence of proper coordination and planning, reactive and crisis-driven responses have ensued. A major oversight of this approach is that there is a lack of early warning systems and other processes to inform local authorities and farming communities timeously about impending droughts, or other climate-related disasters. While emergency drought responses do have an important role to play in drought management, they only help those affected by drought to cope in the short term, leaving them no less exposed to future impacts. Some people have even become dependent on emergency drought relief, which has undermined their capacity to adapt autonomously. In this light, and in recognition of the vulnerability of the country's people, ecosystems and economy to the impacts of drought, the Government of Botswana has initiated the development of a national policy and strategy for drought management. As it embarks on this process, the below recommendations should be taken into consideration.

Recommendations

- The institutional and technical links between drought and climate change need to be emphasised. The dominant policy framing of drought should be from a more holistic perspective, rather than one that focuses primarily on agricultural production and poverty eradication. This will require an improved understanding around the complexities of drought, the effects of which do not act in isolation but intersect in a myriad ways to impact national and local economies, affecting all sectors, livelihoods and wellbeing.

- Improved collaboration and coordination between all ministries and departments responsible for drought management is required if an integrated approach to governance is to be achieved. In addition to vertical (from local to national level) and horizontal (across different sectors) integration within government, it is important that government speaks, on an ongoing basis and iteratively, with local leaders, community members, NGOs, academics and other actors who could – and should – play a key role in the management of drought and climate change in Botswana, to avoid the development of policies that could result in unintended consequences for certain groups.

- Proactive planning and risk management are important for shifting away from a crisis-based approach to drought management, towards more effective strategies that target the underlying drivers of vulnerability to drought, and emphasise the role of disaster preparedness and long-term resilience building alongside short-term emergency responses, such as drought relief. It is also important that drought risk management and resilience building is focussed on the human dimensions of drought, and addresses socioeconomic and gender asymmetries of drought impacts.

- A critical component of dealing with drought, and indeed other climate-related disasters, is the provision of timely and accurate information to local authorities and communities. The establishment of an effective early warning system that is developed and implemented in an integrated manner is essential for enabling this, and for ensuring that the most vulnerable groups are able to prepare and adapt effectively.

- The roll-out of a long-term, proactive and integrated approach to drought management will depend on the availability of and access to the financial resources needed to do so. Botswana should thus seek innovative sources of funding and establish a portfolio of funds that predefine where and how these resources will be allocated and disbursed. The financial and accounting system set up for drought management should be flexible enough to allow funds to be rapidly re-allocated, or existing programmes rapidly upscaled, in the event of an emergency.

PARTICIPATION AND COLLABORATION ARE KEY FOR REALISING INTEGRATED CLIMATE CHANGE RESPONSES

Multi-sector and multi-scalar participatory processes that enable engagement with and between representative and marginalised stakeholders are important for enabling collaborative planning and eliciting integrated responses to climate change.

Climate change is a wicked problem that requires innovative, integrated approaches to identifying and implementing adaptation solutions. These approaches, and the adaptation proposals and decisions emerging from them, should be aimed at addressing the root causes of vulnerability and seek to build the long-term resilience of the people and systems most severely affected by climate impacts. Multi-stakeholder participatory processes are one way of enabling this, as they allow people with diverse interests, objectives and values to start collaborating to improve their understanding of common problems, and to begin planning and co-creating solutions that will lead to a more resilient future for everyone. Such processes are also needed to move beyond incremental forms of adaptation, towards more transformational thinking and action.

The VRA and Transformative Scenario Planning (TSP) processes that we carried out in Botswana were found to be highly enlightening and useful for the stakeholders that participated. An important outcome of the VRA was that it allowed the voices of the most marginalised groups to be heard in a safe and trusting environment. For instance, the challenges faced by women whose livelihoods depend on harvesting phane caterpillars, and who are therefore disproportionately affected by declining quantities thereof, were brought to light. This was achieved by engaging with power relations, and establishing a narrative of inclusivity and participation throughout the VRA process. On the other hand, the TSP process was valuable because it allowed key issues to be prioritised (in this case the optimal use of land and the reduction of human-wildlife conflict), and enabled the diverse group of participants to begin collaboratively identifying solutions to these problems. In doing so, emphasis was placed on what *can* and *must* be done by the people in the room.

- Multi-stakeholder participatory processes open up the possibilities for social learning. For example, government authorities can learn from local knowledge and gain practical insight into key issues being faced on the ground, which are often different or more complex than they appear at face value. On the other hand, communities can learn about existing or proposed policies, programmes, projects, and communication channels that might benefit them.

- Participatory workshops are only a first step toward realising more inclusive and collaborative responses to climate change in practice. For this approach to be effective in the long-term, open dialogue and ongoing engagement with and between representative and marginalised stakeholders should be encouraged and enabled beyond the confines of multi-stakeholder workshops.

Recommendations

- Top-down approaches to conducting vulnerability assessments, and to adaptation policy and planning more generally, are not sufficient – and indeed can be misleading – for dealing with complex challenges in the context of climate change. More inclusive, participatory approaches that allow important socio-economic and governance issues to be surfaced from a range of perspectives should be embraced.

- Grassroots stakeholders and their knowledge should play an equally important role in participatory processes as those in positions of power. Such processes should thus bring together diverse groups of actors who are representative of different sectors, levels of governance and socioeconomic backgrounds. This is important for surfacing issues that may otherwise be overlooked due to dominant power relations that typically determine patterns of inclusion and exclusion in decision making.

- About 80% of households in Bobirwa are female-headed, and women and men are differentially affected by the impacts of climate change. Similarly, factors like age, ethnicity, marital status and household composition affect people's vulnerabilities to climate change, and their adaptive capacities. To facilitate the inclusion of gender and social differentiation in policies, practices and extension services, these nuances should form a fundamental focus in participatory dialogue spaces like VRA and TSP. To surface the differences between different groups it is often critical to engage with them separately.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

ASSAR has successfully worked across scales in Botswana, from national to regional and local levels. Given the differing capacity and needs of stakeholders at these scales, we adapted our communication and capacity-strengthening strategies to suit different audiences. These audiences included government representatives from a range of different sectors and governance scales; non-government stakeholders including those from NGOs, development agencies and the private sector; professionals from research/ academic institutions; local community members and tribal authorities. Through a range of research and engagement activities, we worked to enhance stakeholder understanding of vulnerability and adaptation, and encouraged an increase in the uptake of adaptation measures.

Ultimately, one of the goals of adaptation is to reduce the vulnerability of different actor groups to climate-related impacts. For this to happen, people need to have the right information to make appropriate decisions. Prior to ASSAR's work in Botswana, the Bobirwa sub-district was a very under-researched site. The challenges being faced by local people, and the socially-differentiated nature of their vulnerabilities to climate change, were thus not well understood. The information generated from the project has therefore been very well received by the local government administration who expressed a need for such data at the start of the project, and during the course thereof. The tribal administration of Bobirwa, including the Senior Chief, found the work of ASSAR to be equally valuable.

Engaging stakeholders in our work has greatly enhanced the potential for uptake of our findings as well as the work's impact, in the short and long term. At the national level, we achieved impact with our research in two main areas. Firstly, we contributed to the development of a national drought policy and strategy through the publication of a 'strategy-ready' background paper. Secondly, we held a national-level workshop aimed at training District Economic Planners (from the Ministry of Local Government and Rural development) and District Development Officers (from the Ministry of Presidential Affairs) from all districts in Botswana in how to conduct a VRA process.

This was hailed as a significant contribution to capacitating these development planners and practitioners, who work directly with local communities, with the skills required to influence adaptation actions at the local community level as well as at the national level. This came about after holding a participatory VRA in Bobirwa sub-district which caught the attention of national government, who in collaboration with Oxfam GB and the University of Botswana organised the country-wide training. The case study of the VRA training was also included in a UNFCCC document.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Botswana is experiencing temperature increases at a far more rapid rate than most other countries globally. This necessitates an urgent and collaborative response that integrates scientific research, influencing and awareness raising activities focused on the trends and implications of rising temperatures, with clear adaptation options for policy and practice that are mainstreamed into inclusive and participatory development planning across all sectors. In doing so, emphasis should be placed on the importance of improving natural resource management and building the resilience of people and systems to climate change. Key to realising a more sustainable and climate-resilient future in practice will be facilitating the agency of stakeholders (especially those at the margin) and enabling alternative livelihoods for communities through the provision of training and skills development, and the creation of jobs, markets, and economic opportunities. Research also has an important role to play in the area of climate change and development, and there is an increasing need for knowledge to be co-created with stakeholders through participatory processes like those undertaken by ASSAR.

A more integrated response to climate change is also critical and requires that emergency-led responses to climate-related disasters such as drought are complemented by more long-term, strategic, and proactive approaches to planning and management. Greater vertical and horizontal integration between sectors and governance scales is critical for enabling this, and for enhancing the effectiveness of adaptation at the local level. In addition, the implementation of adaptation measures requires that relevant information and advice is available to authorities, as well as to community members, so that they can make more informed decisions about how best to respond to climate change.

This information needs to be co-produced among relevant stakeholders and should frame the climate change challenge at the intersection of biophysical and social pressures that, for example, include both meteorological and place-based forecast information, as well as information on practical adaptation options, such as climate-smart agriculture, alternative livelihood opportunities, and the formation of empowered civil society groups.

In summary, response to the climate challenge requires a number of next steps:

- There is need for research on heat stress and its impact on people and economically-important sectors, as well as the appropriate responses that are required.
- Policy needs to incorporate a longer-term stance that mainstreams climate change and adaptation across sectoral and development policies.
- Tailored adaptation information needs to be developed and disseminated across different sectors and levels of government.
- As has been recognised by national government through their experience of the VRA process, there is a need for more inclusive decision-making spaces for adaptation planning. These should include marginalised groups who can gain more power and influence in this setting, and decision makers who can benefit from a richer understanding of ground-level realities.

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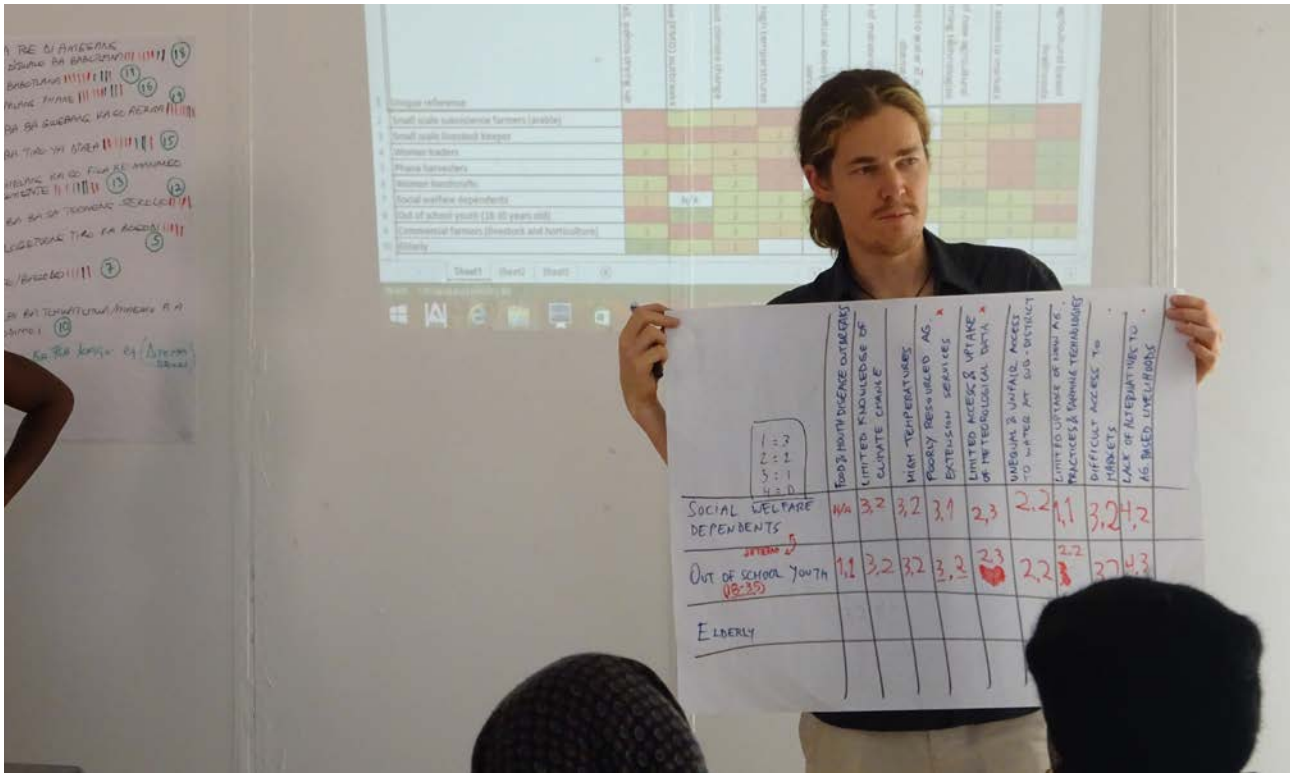

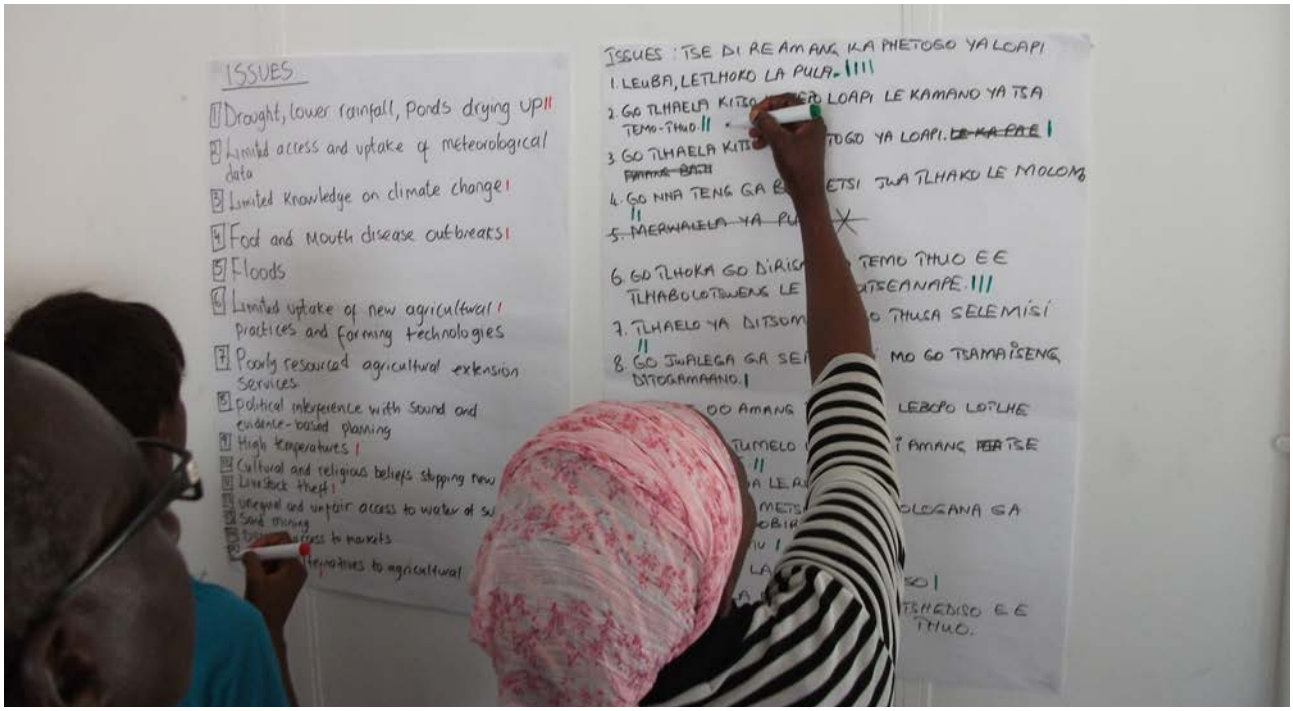

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NAMIBIA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID NAMIBIA

ASSAR'S FOCUS IN NAMIBIA

Semi-arid regions like north-central Namibia, are highly dynamic systems that experience variable and sometimes extreme climates, adverse environmental change, and a relative paucity of and decline in natural resources. Historically, people living in these regions have adopted several coping mechanisms to deal with these conditions. Today, however, many communities exhibit low levels of adaptive capacity due to challenges such as marginalisation, underdevelopment, poverty, inequality, weak governance, maladaptive policies, and increasing population growth. Climate change is expected to augment existing levels of vulnerability, as temperatures rise, rainfall decreases, and seasonal climate patterns become more variable.

From 2014-2018, ASSAR's Namibia team worked in the Onesi Constituency in the Omusati region of Namibia to better understand these existing and upcoming challenges. Made up of a team of researchers and practitioners from the University of Namibia (UNAM), University of Cape Town (UCT), Oxfam GB and the Desert Research Foundation Namibia (DRFN), we worked with stakeholders from national to household levels to understand what makes people vulnerable to climate change, what the barriers to adaptation are, and what could enable more effective, sustained and widespread adaptation to climate change.

Key insights

- Adaptation policy approaches should consider that factors like gender, ethnicity, age, household composition, marital status, social capital, and class are important determinants of people's vulnerabilities, and of their capacities to respond to climate risks and impacts. These intersecting factors need to be considered explicitly to enable the most marginalised to adapt.

- Building on Namibia's decentralised water reform, water and drought governance could be strengthened if there was a better understanding of and support for local challenges. This could be partly achieved by increasing the awareness and willingness of decision makers to be more inclusive of the knowledge that community members and other marginalised groups provide, building the capacity of local actors to proactively engage in governance, and by providing more targeted support for managing water better at the village level.

- Improved collaboration – among government, non-governmental organisations (NGOs), academia and communities – can lead to the production of climate and adaptation information that is reliable and relevant to local subsistence farmers. It can also ensure that this is disseminated to those who need it in a timely manner.

- By engaging with traditional and religious leaders, and considering their value systems, adaptation policy makers and practitioners can promote adaptation responses that work in conjunction with cultural and social norms. Doing so will assist in helping to reduce group-specific vulnerabilities. This should also be done on a case-by-case basis considering the implications of these social norms on gender equality and human rights more broadly.

- More long-term, targeted responses to climate change are needed. Government needs to support people's livelihoods by building adaptive capacity, providing vocational training and jobs, and creating markets. These efforts must also lead to rural development processes that address water scarcity, food insecurity, and human development needs.

ABOUT THE RESEARCH

Research priorities

ASSAR's research in Namibia had two main areas of focus. The first aimed to explore the socially-differentiated nature of vulnerability to climate change by understanding how different people vary in their sensitivity, exposure, and capacity to respond to climate risks and impacts. To do this, we worked to explicitly incorporate into our research and engagement activities the experiences of different ethnic groups, and of men and women, as well as their relations of power and influence. As our work progressed and new findings emerged, we also began to explore in more detail the way that factors such as age, household composition, and social networks augment or reduce vulnerability and adaptive capacity.

Our second research focus was on the barriers and enablers to effective adaptation to climate change in relation to agriculture, water and drought management, and climate information. Here, we specifically worked to understand how access to water is governed at the local level and what the capacity constraints are, why farmers don't adopt new agricultural approaches and resist selling livestock, how drought is managed, whether rural to urban migration contributes to improved wellbeing of rural households, and the demand for and dissemination of climate information.

Throughout our work we aspired to work with communities, government, and other actors to understand how they can adapt to climate change and co-develop solutions. Educating communities on what climate change is, and highlighting what other countries are doing to adapt, was key. Finally, we sought to influence the development of project proposals for adaptation funding and the implementation of interventions.

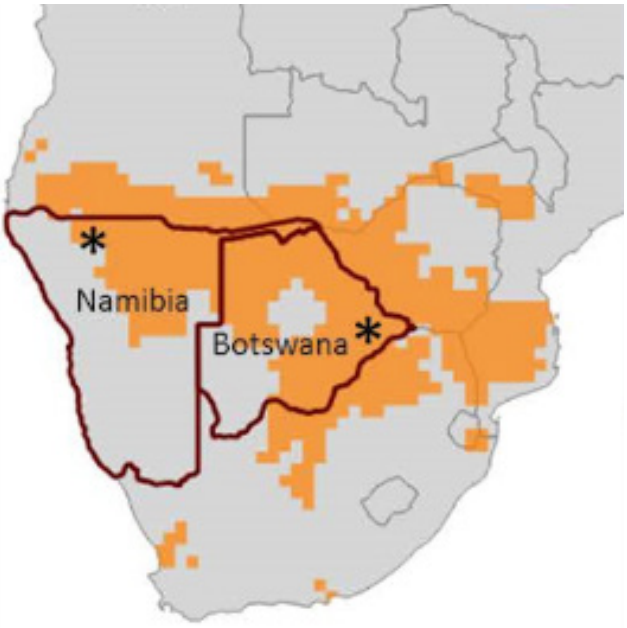
Case study sites

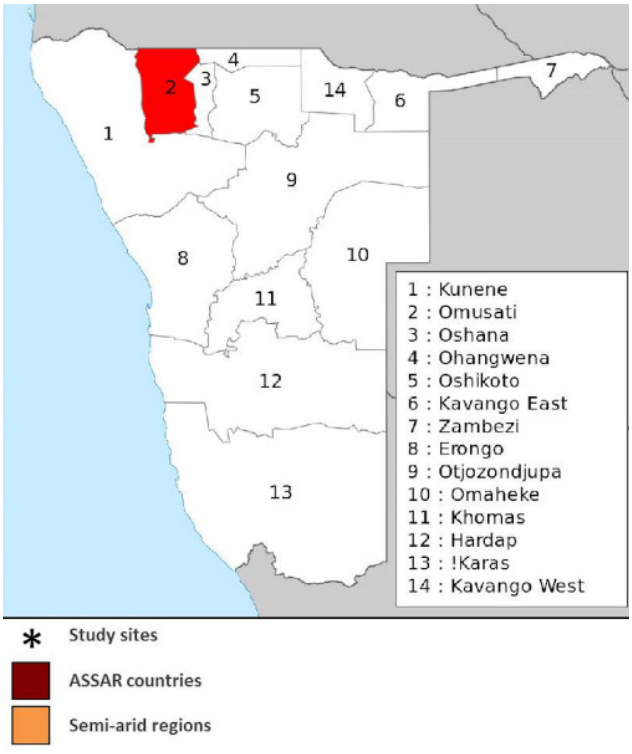
Our main study site was the semi-arid Omusati region in north-central Namibia. Our household survey spanned a wider area and was carried out in seven constituencies across three neighbouring regions in the north, including the Omusati, Oshana and Oshikoto regions. Most of our research took place in the Onesi Constituency in Omusati, where we worked with local communities in several different villages. However, we also engaged with stakeholders at a regional level in Outapi and Ongwediva, and at the national level in Windhoek.

In Omusati, agriculture – in the form of subsistence and small-scale cropping and livestock farming – is fundamental to people's food security, income, and cultural identity. There is little opportunity for livelihood diversification and many people rely on cash remittances sent from relatives in urban areas, financial grants from the state (e.g., for pension or disability), and drought relief. There is also a lack of investment in critical infrastructure and poor access to basic services in the north of the country, despite the fact that most of Namibia's population resides in this largely-rural region. A high dependence on natural resources, combined with underlying factors such as poverty, inequality, marginalisation, governance challenges, and natural agro-constraints, means that local communities are highly vulnerable to climate variability and change. Consequently, droughts, floods and increasing rainfall variability are of particular regional concern.

Approach

We began our stakeholder engagement with initial meetings with key state and non-state actors, in which we introduced ASSAR and discussed the issues stakeholders considered to be most important in the adaptation field. We then conducted key informant interviews (KIIs) at regional and national levels, with the aim of gaining a better understanding of the adaptation landscape and barriers to adaptation in Namibia. The interviews were conducted by a postdoctoral researcher, PhD student, and master's degree students.





During a stakeholder influencing mapping workshop that we held in Windhoek early on in the project, together with stakeholders we noticed how different groups of actors (e.g., government and NGOs) have different perspectives on who has the most influence with regards to adaptation. The findings from this workshop formed the basis of a stakeholder power and influence mapping exercise and helped to inform who should attend a Vulnerability and Risk Assessment (VRA) workshop. The VRA illustrated how climate variability and change affects different social groups in different ways, depending on their exposure and sensitivity to climate impacts, and their capacities to adapt to these impacts. Through this participatory workshop, government stakeholders came to recognise that community members have valuable knowledge. As stakeholders had also requested more information on climate change and adaptation options, we produced a documentary on climate change impacts and solutions in Omusati.

Effective climate change adaptation requires effective governance. Governance was thus the focus of a set of KIIs and focus group discussions (FGDs) that we conducted at the national, regional, and local levels with government stakeholders from various line ministries and departments. These interviews highlighted the disconnects between the local and national levels in terms of what adaptation activities were being planned, and what was actually happening on the ground. They also led us to focus our work on water governance.

The theme of water fed into our Transformative Scenario Planning (TSP) process, which involved a training event and two workshops during which we explored the future of water for productive use in Omusati. Participants at these workshops included government officials, traditional authorities, community members, village headmen, farmers, NGOs, members of parastatal organisations and development agencies, the private sector, and academic/research institutions, among others. From the feedback gathered through questionnaires and short video interviews, we found that the participants highly valued the TSP methodology, and recognised the need for more integrated planning and improved water harvesting, capture, and storage.

We focussed other KIIs on issues surrounding the adaptive capacities of crop and livestock farmers, as well as trends in livelihoods based on non-timber forest products. We also used a life history approach to interview stakeholders in Omusati. We fed findings from these interviews into cross-regional work looking at mobility as a strategy for adapting to climate variability and change. Following a pilot survey, we carried out an extensive household survey across three neighboring regions in north-central Namibia. We fed findings from the survey into our work on migration, climate information, and social differentiation. We also used risk and choice experiments from the field of economics alongside the household survey to research how behavioural attitudes, climate information, subsidies, and trust affect technology choice in climate change adaptation.

We supplemented our field data with iterative feedback from workshops and in-depth literature reviews (including of relevant grey literature, and for both the Regional Diagnostic Study (RDS) phase of ASSAR and specific research themes).

Through our methods, we were able to explore differentiated vulnerability, livelihoods, and adaptive capacity profiles of different groups and households. We were further able to understand adaptation barriers and enablers across different themes and governance scales – from village and constituency levels, to regional and national scales, and across the rural-urban continuum.

FINDINGS AND RECOMMENDATIONS

ETHNICITY, GENDER, AND AGE AFFECT THE ABILITY OF PEOPLE TO RESPOND TO CLIMATE CHANGE

Factors like gender, ethnicity, and age intersect with social and economic characteristics like household composition, social capital, marital status, income, and education level to determine people's capacity to effectively respond to climate risks and impacts. These intersecting factors need to be considered explicitly to enable the most marginalised to adapt.

In north-central Namibia, the patriarchal influence on decision making, agency, and resource control can leave women more vulnerable than men. However, this is not always the case: some unmarried women and widows have greater autonomy than married women, and some unemployed men can be more vulnerable than women employed in off-farm labour (e.g., domestic work). Nonetheless, because of their household responsibilities, women can seldom take part in activities that are far from their homes. This limits their livelihood and adaptation opportunities, as well as their access to information and services. On the other hand, men and youth do have the option of migrating to urban areas to find work, although they are also often faced with vulnerability in urban areas when they don't find well-paying jobs. Their freedom to travel and spend time away from their villages means that men tend to be better represented in multi-stakeholder workshops and policy processes.

Of the women who do attend engagement and planning events, those who are formally employed and who can speak English are more thoroughly involved than those working informally (e.g., female farmers).

Ethnic nuances can also determine household-level differences in vulnerability and adaptive capacity. For example, married Kolonkadhi women typically have more say in household decision making than do married Dhemba and Ndongona women. Kolonkhadi women also participate more frequently in governance and have greater access to information and social networks than do Dhemba and Ndongona women. Socioeconomic factors linked to ethnicity can have influence too, with the poorer, less educated, and more marginalised Kolonkadhi and Dhemba people being more affected by climate variability and change than the better-off Ndongona people.

People living within the same household also have different vulnerabilities. For example, age can significantly constrain people's adaptive capacity, with the very old and very young being particularly exposed to drought and flood risks. A converse of this, however, is that young male household heads who cannot access pension or disability grants may be more financially vulnerable than elderly females. Furthermore, as households become more food insecure, so youth become more likely to engage in risky behaviour. All of these nuanced risks and their consequences can affect relationships within the household; when household cohesion is weakened, so is the resilience of the family to climate-related impacts.

The intersection of social, economic, and other aspects largely contributes to determining levels of vulnerability at an individual level. As such, it is neither possible nor helpful to categorise people and the way they are affected by climate change nor their (in)ability to respond to climate change impacts based solely on gender, ethnicity, or age.

Recommendations

- Adaptation and risk-reduction strategies are often based on assumptions about who is most vulnerable, how people respond to risk, and what needs to be done to help them. However, greater collaboration with communities is needed to better understand local contexts and the specific vulnerability profiles of communities and households.

- Households should not be treated as homogenous units. Instead, researchers, practitioners, and decision makers should recognise the diversity of each household, the ways in which power and responsibilities are shared, the relationships that exist within them, and how these factors lead to particular risk management outcomes and levels of wellbeing for different household members.

- Regional government-driven participatory approaches aimed at strengthening communities' adaptive capacity should ensure that there is equal opportunity for all participants to engage in a safe and welcoming environment. This means unpacking the relations of power, inclusion and exclusion in decision making. Open dialogue between men and women, and among people from different ethnic groups, age categories, and socio-economic backgrounds, should be encouraged both within and beyond the confines of multi-stakeholder workshops.

- Adaptation policies and programmes should be more sensitive to the socially-differentiated nature of people's everyday realities and experiences. Rather than considering only sex-disaggregated data, these strategies should seek to address the underlying causes of vulnerability and question the traditional and cultural norms that have led to unequal rights and opportunities among different groups. Changing aspirations (e.g., from rural to urban livelihoods) should also be considered when planning adaptation and development strategies.

- Vulnerable men and women need support from government to deal with the multiple challenges they face. They should be equipped with the technical capacity, basic skills (e.g., literacy), infrastructure (e.g., for improved access to potable water), and services (e.g., childcare, agricultural extension services) that they need to become more resilient. Providing information and improving access to jobs, resources, and markets can help vulnerable people to diversify their livelihoods and reduce the likelihood that some may be driven to risky or illegal behaviour out of desperation.

IMPROVED WATER GOVERNANCE NEEDS INCREASED UNDERSTANDING AND TARGETED SUPPORT

In semi-arid Namibia, there are ongoing efforts to increase community participation in water governance through decentralisation. However, local actors do not have enough capacity to participate effectively, nor do decision makers involved in water governance properly understand local challenges. If the intended goals of this water reform are to be achieved, then capacity building and enhanced awareness at both ends is needed.

Since 1997, Namibia has followed a community-based water management strategy. This means that rural communities are responsible for managing and paying for water services. The strategy is implemented through the Directorate of Water Supply and Sanitation Coordination, although it is locally-elected volunteer members of community Water Point Associations (WPA) who are tasked with running and maintaining water points in their villages. The aim of this decentralised approach is to shift the responsibility for water provision and management across levels so that local actors are also involved. In reality, though, decentralisation has not had the desired impacts of inclusive water governance and effective participation. Although water access has improved in many places, within villages there is differential access, making some people more vulnerable than before.

Part of the problem is that most of the WPA volunteers have high levels of illiteracy and live in poverty. They find it difficult to balance their water point responsibilities with doing what they need to survive, like farming. Due to the demand placed on their time, in many villages people have been unable to continue volunteering at the water points, which have hence had to close. Committee members have also not been equipped with the technical and managerial skills needed to run water points properly, nor do they have enough funds for maintenance and logistics. When infrastructure breaks, volunteers often don't know who they should tell, and don't have the skills to make repairs themselves. Often, government responses are slow and extension officers do not have enough funds to visit all the villages frequently. Many local people would like to voice their concerns with government about water issues, but they do not know what communication lines to follow to do so.

Recommendations

- The management of a resource as scarce and susceptible to change as water is increasingly critical, especially since future climate conditions are set to put more pressure on Namibia's water sector. Our findings indicate that a clear division of responsibilities and proper platforms for coordination are needed to make water governance more effective and inclusive at the local level.

- While technical solutions are important, successful water reform equally requires meaningful participation from local actors. As part of this, decision makers need to understand the unique context of each community and consider how factors like gender, age, wealth, education level, and ethnicity impact people's abilities to participate in water governance.

- People taking part in local water governance need to be supported and empowered to fulfill their responsibilities. This requires local government to work with traditional leaders to build the skills and capacity needed for the management and provision of water resources and the maintenance of water infrastructure, as well as developing 'soft' skills for mediation and conflict resolution. Decision makers also need increased awareness of their role in this process.

CLIMATE ADAPTATION INFORMATION SHOULD BE RELEVANT, ACCESSIBLE, AND DELIVERED IN TIME

There is a shortage of climate and adaptation information that is both reliable and relevant to local subsistence farmers, and often a mismatch between the information that is available, and that which is needed. Improved collaboration – among government, NGOs, academia and communities – can address this mismatch and ensure that relevant information is disseminated timeously to those who need it.

Local farming communities in north-central Namibia rely largely on traditional ecological knowledge to inform their practices. Some receive climate information, such as forecasts, from the radio, while others get information from friends or relatives. In general, however, there is a lack of awareness around climate change, and limited knowledge about adaptation options at the local level. Part of the problem is that very few households have access to extension services and communications infrastructure. There also seems to be a lack of coordination and collaboration between the generators, communicators, and users of knowledge. The co-creation and dissemination of adaptation information to intended targets is particularly poor.

There are also other nuances, such as age, culture, and religious beliefs, that need to be considered when communicating climate information at the local level. With an increasing rate of rural to urban migration among younger members of the population, many remaining farmers are older and subscribe to traditional norms, while others believe that events such as droughts, floods, and the timing of seasonal rainfall are God's will. These norms and beliefs have implications for people's trust in external information, their propensity to take risks, and the degree to which they are willing to change their practices.

Recommendations

- Most farmers agree that if they had access to information, they would use it to inform and modify their practices, or to adopt new practices and adaptive technologies. Consequently, local and regional authorities, and traditional and religious leaders need to: help communities gain access to relevant climate information; share information about appropriate adaptation options; and increase awareness on climate change, its impacts, and what can be done about it.

- However, farmers must simultaneously be equipped with the capacity, resources, and skills that will enable them to act on and respond to the information provided. While government has a key role to play in this regard, it is important for different government departments to work collaboratively with NGOs, researchers, communities, and the private sector to ensure the most effective outcomes.

- As part of these efforts, government should promote new adaptive technologies to farmer groups through village-level outreach and engagement activities and on-farm demonstrations. This will help to ensure wider acceptance and adoption of these new technologies and enable the development of self-help groups.

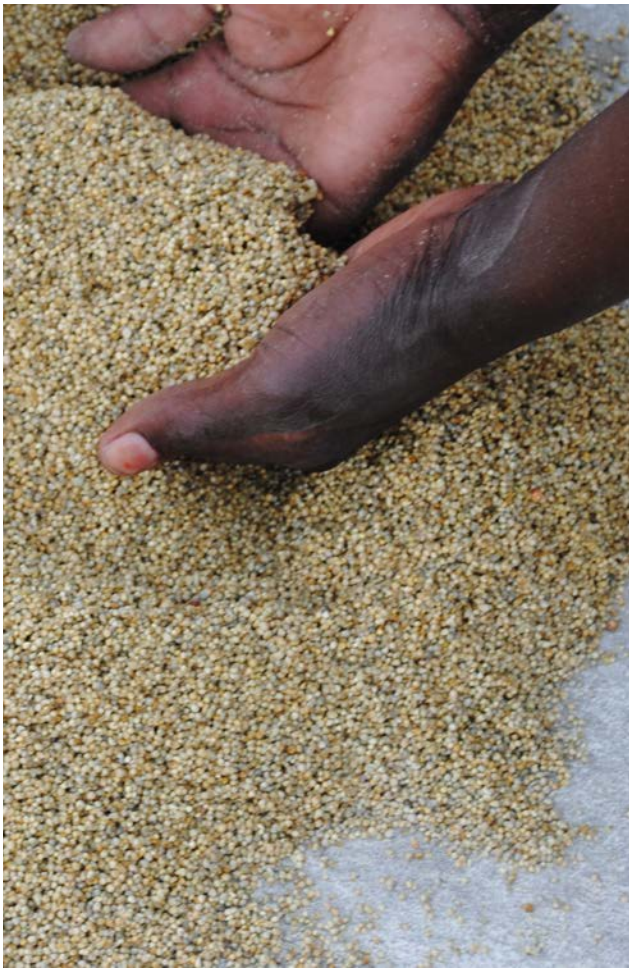
- Workshops and field meetings should be used to improve the collaboration among government, NGOs, academia, and communities in knowledge sharing and production, as well as in the dissemination and uptake of climate information (including seasonal climate forecasts), adaptive technologies (e.g., drought-resistant seeds), and adaptive practices (e.g., conservation agriculture).

- Integrating traditional ecological knowledge with climate information provided by the meteorological office is important for building people's trust in external information. Information also needs to be communicated in a manner in which people are likely to use it (e.g., using familiar narratives and through trusted sources). This requires ongoing collaboration between traditional leaders and scientists, frequent engagement with communities, and regular training of extension officers. Government subsidies and improved access to micro-loans and insurance would also increase people's willingness to take risks and experiment with new practices and technologies.

CULTURE AND SOCIAL NORMS PLAY A NOTABLE ROLE IN ADAPTATION

Culture and social norms may prevent or hinder the uptake of adaptation measures, thereby making certain groups more vulnerable. When promoting adaptation responses, adaptation policy makers and practitioners need to engage with traditional and religious leaders and consider their value systems while at the same time being cognisant of gender inequality and human rights.

Smallholder farmers in northern Namibia have been slow to shift to 'climate smart' ways of farming, such as switching to drought-resistant crops, using seasonal climate forecasts, adopting conservation agriculture methods, and selling off livestock when drought conditions are predicted. This is due to a number of reasons, including a lack of awareness of changing climatic conditions, insufficient access to resources, poor technical support, and low market prices for animals.



In Omusati, we found that another major factor that keeps farmers farming the way that they have always done, is their adherence to traditional norms. For example, when making decisions about planting their crops each year, many farmers do not use seasonal forecast information. Instead, they wait for the go-ahead from a traditional leader, or will rely on generations of learned knowledge about seasons and the weather. Although this approach has been effective in the past, increasing climate variability and change means that this information is becoming less reliable, and farmers who do not adapt their practices are at greater risk to climate-related impacts. Other farmers choose to continue planting certain crops that have a strong cultural significance, even if these are not well-suited to harsher climatic conditions. Oshiwambo traditions also make many farmers reluctant to sell off their livestock, even when they are warned that a drought is coming, as cattle are a symbol of affluence, status, prestige, and security. The value of cattle is true in a literal sense too: for many farmers, their cows are akin to a bank account, and growing their herd is how they accumulate wealth. Religious faith is yet another reason that farmers in northern Namibia don't embrace the seasonal climate forecasts produced by the meteorological services. Many believe that only God knows what the future holds, and that any anomalies in climate are a form of punishment for people displeasing God in some way.

Recommendations

- Understanding the complex reasons why farmers choose not to change their practices, even when it puts their livelihoods and investments at risk, can help policy makers and practitioners to respond appropriately as Namibia's climate becomes hotter, drier, and more drought-prone.

- With religion and tradition playing such a significant role in the lives of northern Namibian farmers, it is important for government to consider how extension officers can work with communities to introduce adaptation measures that honour these beliefs, while also encouraging farmers to make decisions that help them absorb the shocks of climate variability and change.

- Positioning religious and traditional leaders as climate change champions, and integrating scientific information with traditional knowledge, could help to promote and initiate behaviour change, including the use of climate forecasts and the uptake of novel agricultural practices.

- If agricultural advisers recommend that farmers sell their livestock before a drought, then they can frame their recommendations as being financially and ecologically sound, as well as a way of preserving a farmer's social status and ability to take part in traditional cultural practices. For example, livestock play a key role in weddings and funerals. If farmers don't manage their herds adaptively and their livestock die, then they will have lost the capital needed to pay for *lobola* (bride price) and ceremonial events.

ADAPTING TO CLIMATE CHANGE MEANS DEVELOPING LONG-TERM, TARGETED PLANS

Most development activities in Namibia are aimed at reducing poverty. However, many interventions fail to effectively address climate change, while others, such as drought relief, create dependency. Instead, Namibia needs longer-term and more targeted and co-developed responses. There is a need to build the capacity of individuals and communities to adapt to changing climatic conditions.

Local communities in Namibia have historically relied on traditional coping mechanisms to maintain their livelihoods under harsh environmental conditions. However, many people today are struggling to cope in the face of increasing climate variability and extremes, which are going to get worse. The government has committed to addressing climate change and has implemented a number of responses related to water security, agricultural production, and disaster-risk reduction. However, these are mostly short-term, project-based interventions. Where more strategic policies and programmes do exist, these have often been financed externally and implemented by NGOs. Many existing responses are also not specific to climate change but are aimed at reducing poverty and inequality, which is a priority of the national government.

One way that vulnerable communities manage to cope in times of stress is by drawing on social protection mechanisms like state pension and disability grants, support grants for orphans and vulnerable children, and government programmes like 'food-for-work.' In extreme dry periods, the state also provides drought relief. Although this helps the most marginal groups to survive, drought relief has also created a problem of dependency and led to a lack of innovation and limited self-organisation in communities.

For community members to have a good life, they consider food security and crop farming, peace and social cohesion, access to government services and rural development, and education and employment for their children to be very important. Communities currently feel a sense of hopelessness and hardship with regard to crop farming (which is key to their cultural identity and wellbeing) as well as food security, with some households often not having enough food. However, communities are not adopting new farming practices that could improve their food security. There is some satisfaction with the level of community cooperation and intrahousehold relationships, which are seen as important for sustaining livelihoods and accessing labour and support. However, very few households are part of groups. Government support through the provision of tractors, seeds, water, and health facilities are seen as important, and people have average satisfaction with this. However, there is a low level of satisfaction regarding education and employment opportunities for children. Few children have tertiary or vocational training. Many do not find jobs when they move to urban areas and are therefore unable to send money home to support their relatives.

Recommendations

- More long-term, targeted and co-developed responses to climate change are needed. Rather than being incremental and compartmentalised, climate change responses need to be integrated into longer-term development planning such that future development takes place in a climate compatible manner across all sectors. This includes the need for mainstreaming climate change adaptation across sectors in policies and planning.

- Local government needs to support people's livelihoods by building adaptive capacity, and enabling alternative livelihoods and people's agency more broadly, which will also prevent an over-reliance on government handouts. This includes the skills needed to self mobilise and self organise to form self-help groups. It also means investing more intensively in skills development, sharing information more effectively, demonstrating adaptation techniques, ensuring access to resources, extension services and markets, and stimulating local economies. People also need to be given alternatives to agriculture-based livelihoods. Government needs to ensure that communities have access to rural and urban economies, so that they can sell their produce at markets or find alternative work to support themselves and their families. Ultimately, considering people's wellbeing and aspirations is critical to sustained and equitable adaptation.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

ASSAR has successfully worked across various scales in Namibia, from national to local levels. Given the differing capacity needs of stakeholders at these scales, we adapted our communication and capacity-strengthening strategies to suit different audiences. Through a range of activities, we worked to enhance stakeholder understanding of vulnerability and adaptation, and encourage increased uptake of adaptation measures.

Ultimately, one of the goals of adaptation is to reduce vulnerability to climate impacts for different actor groups. For this to happen, people need to have the right information to make appropriate decisions. Principle 4 of Namibia's National Policy on Climate Change — on awareness generation, education, training and capacity building — resonates with the work that ASSAR has done through its Research-into-Use (RiU) approach to ensure that research is more relevant to people in semi-arid regions, as well as decision makers.

At the national level we identified various windows of opportunity and formed strategic partnerships with key institutions and individuals who play important roles with regards to climate change. These stakeholders appreciated the contribution of the project to the National Climate Change Strategy and Action Plan; and lastly, there was a demand for evidence-based research and findings, which ASSAR was able to provide. The project was also represented on the National Climate Change Committee (NCCC). As a result we could report quarterly on project activities, solicit partnerships for project activities, and share key research findings, such as the outcomes of our VRA workshop and our research on barriers to adaptation. We also inputted into key platforms, such as the vulnerability and adaptation section of the third National Communication on Climate Change, and the gender and climate projections sections of the fourth national communication on climate change.

Engagement with the Omusati Regional Council (ORC) through various fora – including the Africa Drought Conference and our VRA and TSP processes – led to the co-development and co-hosting of the Omusati Regional Climate Change Conference focused on water and food security. Following the conference, we developed concept notes with ORC for funding for water harvesting, including the deepening of the Olushandja Dam and regional water channeling. A delegation from ORC presented these concept notes to the Environmental Investment Fund (EIF) and the Ministry of Environment and Tourism (MET). The involvement of the ORC in ASSAR activities helped to enhance its understanding of, and ability to plan for, climate change. The ORC has subsequently integrated multi-sectoral adaptation responses into its development planning.

An issue that emerged in both the VRA and TSP workshops was the need to develop the capacity of all stakeholders, from community to national levels, to understand and respond to climate change. With this in mind, we trained the Onesi Constituency Development Committee (CDC) to understand climate change and its impacts in Omusati. We included a Vulnerability Capacity Assessment (VCA) and – as part of disaster risk management training done in partnership with the Red Cross – helped the CDC to develop a contingency Action Plan. Both the VCA and Action Plan were shared with the Office of the Prime Minister as blueprints for disaster risk reduction in the region. The Onesi CDC is now recognised as a model for good practice in sustainable development.

In addition to our face-to-face engagement with stakeholders, we have reached audiences through several newspaper articles, focused on some of the main issues related to adaptation in Namibia (e.g., water governance, published in *The Namibian*, *New Era* and *Patriot* newspapers). We also produced and co-hosted a radio series to reach Oshiwambo audiences nationwide on these same issues (e.g., the sale of livestock and management of drought).

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Climatic conditions in the Omusati region of Namibia are getting harsher, and the coping methods that people used previously are no longer working well. As the number of people relying on the land has increased, along with the frequency of extreme events such as droughts and floods, food insecurity has worsened. In the past people used to help their neighbours by working in each other's fields and sharing food, but now reciprocity is dwindling as people struggle to feed themselves and become more desperate. Instead, there is increased dependency on the government to provide subsidies for farm inputs and services, such as ploughing and weeding, as well as food relief.

Consequently, it is important to develop the agency of communities to enable them to work together, become more innovative, and diversify their livelihoods.

While times are harder for everyone, some people are more affected than others. Ethnicity, gender, age, religious beliefs, and traditional norms all affect people's vulnerabilities to climate change, and their responses to it. However, for everyone, a primary barrier to adaptation is the lack of availability of information on adaptation. Tied to this is a lack of understanding of climate change, and a lack of awareness of climate change vulnerabilities and what can be done about them.

Resolving this situation requires a number of next steps:

- There is need for research on heat stress and its impact on people and economically-important sectors, as well as the appropriate responses that are required.
- Participatory and collaborative planning processes are needed, such as VRA and TSP, that bring together stakeholders from different sectors and governance levels to co-create solutions.
- There is a need for co-development of adaptation information that can be made available to different levels of decision makers, from farmers to national government, in a manner that compels them to take action.
- The challenge at hand also suggests that traditional roles assigned to researchers (providers of information), development practitioners (implementers of actions), decision makers (assigning priorities and budgets) and, in this case, people living in the Omusati region (recipients of a combination of the above), need to change and become more integrated and dynamic. This will require a transformation in the way institutions and individual view one another and the ways in which each can contribute to the adaptation challenge.
- The urgency of the impending impacts of climate change in Namibia (including temperature increases) requires a shift from reactive drought management to longer-term responses to climate change. These should include strategies, which consider gender and other social groupings, to build adaptation agency, and enable alternative livelihoods to those based on agriculture and other sectors heavily impacted by climate change.

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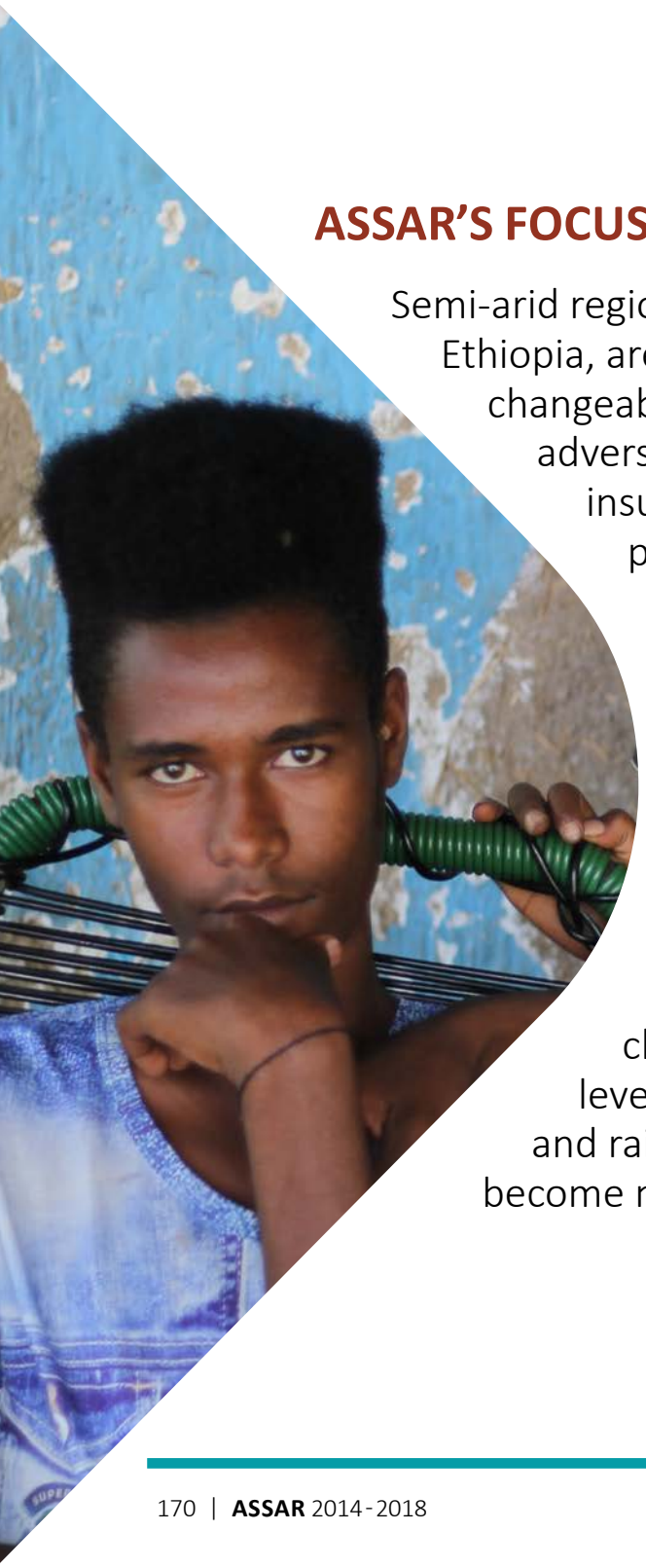
Photographs in this section: Irene Kunamwene, Sophie Lashford

ETHIOPIA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID ETHIOPIA



ASSAR'S FOCUS IN ETHIOPIA

Semi-arid regions like the extensive drylands of Ethiopia, are highly dynamic systems that experience changeable and sometimes extreme climates, adverse environmental change, and a relative insufficiency of natural resources. Historically, people living in these regions have practiced livelihoods that are well-suited to deal with these conditions. Today, however, many communities are showing increased vulnerability due to challenges such as political marginalisation, underdevelopment, poverty, inequality, unfair governance systems, maladaptive policies and increasing population growth. Climate change is expected to exacerbate existing levels of vulnerability, as temperatures rise, and rainfall and seasonal climate patterns become more variable.

From 2014-2018, ASSAR's East Africa team worked in Ethiopia and Kenya to better understand these existing and upcoming challenges. Made up of a team of researchers and practitioners from the Addis Ababa University (AAU), University of Nairobi (UoN), University of East Anglia (UEA), and Oxfam GB, we concentrated most of our work in Ethiopia in the woredas (equivalent to districts) of Awash Fentale and Amibara in southern Afar region (our case study area). In both Ethiopia and Kenya we used a parallel case study approach in order to best analyse how changing social and environmental conditions interact in practice. We combined these analyses with activities at regional and national levels to generate transferable insights for policy and practice on the changing nature of vulnerability and response to environmental change. We hope that this detailed work can contribute to knowledge on how to enhance the ability of communities, local organisations, and government to adapt to climate change in ways that minimise vulnerability and promote long-term resilience.

Key insights

- Factors like gender, age, location, livelihood and status intersect with social and economic characteristics such as household composition, social capital, marital status, income and education level to determine people's capacity to respond effectively to climate risks and impacts. Adaptation policies need to consider these intersecting factors explicitly to enable the most marginalised to adapt.

- Although decentralisation has strengthened the ability of local officials to respond to local needs flexibly, greater coordination between levels and sectors of government, as well as more resources and better provision of timely and relevant information, would further strengthen action on water governance and disaster risk management.

- Policies and interventions on key issues such as villagisation, irrigation and invasive species management need to balance the competing needs of different stakeholders and population groups to enable more sustainable and equitable approaches to natural resource management and livelihood support in the face of climate change.

- Recognising that interventions will result in trade-offs, with some people winning and others losing, is important. Including affected populations more concretely in decisions about interventions will help to identify the main trade-offs, support more effective design and implementation of interventions, avoid unintended consequences – especially for the most vulnerable, and help to ensure that the needs of those typically excluded from decision making are heard and valued.

ABOUT THE RESEARCH

Research priorities

ASSAR's research in Ethiopia was structured around three overarching dimensions that were identified through an in-depth review of literature, and the insights and priorities of stakeholders at local, county and national levels. The first dimension was land and water use/access through which we examined the connection between human wellbeing, land tenure, resource access (such as water and pasture for livestock or crops for domestic use), and resource governance (including traditional mechanisms). Our second dimension was linkages at higher scales. Here the objective was to understand issues like the dynamics of pastoral mobility across larger-scale landscapes (such as districts and countries) and the ongoing process of fiscal and political decentralisation. The third and final distinctive dimension of our research was to understand how vulnerability, adaptive capacity, and the implications of different adaptation responses are socially differentiated – within communities, between individuals, and according to ethnicity, gender and age.

Research focus

Drawing on the three dimensions of adaptation outlined above, ASSAR's research in Afar focused on four specific research topics that were critically important in the semi-arid regions of Ethiopia.

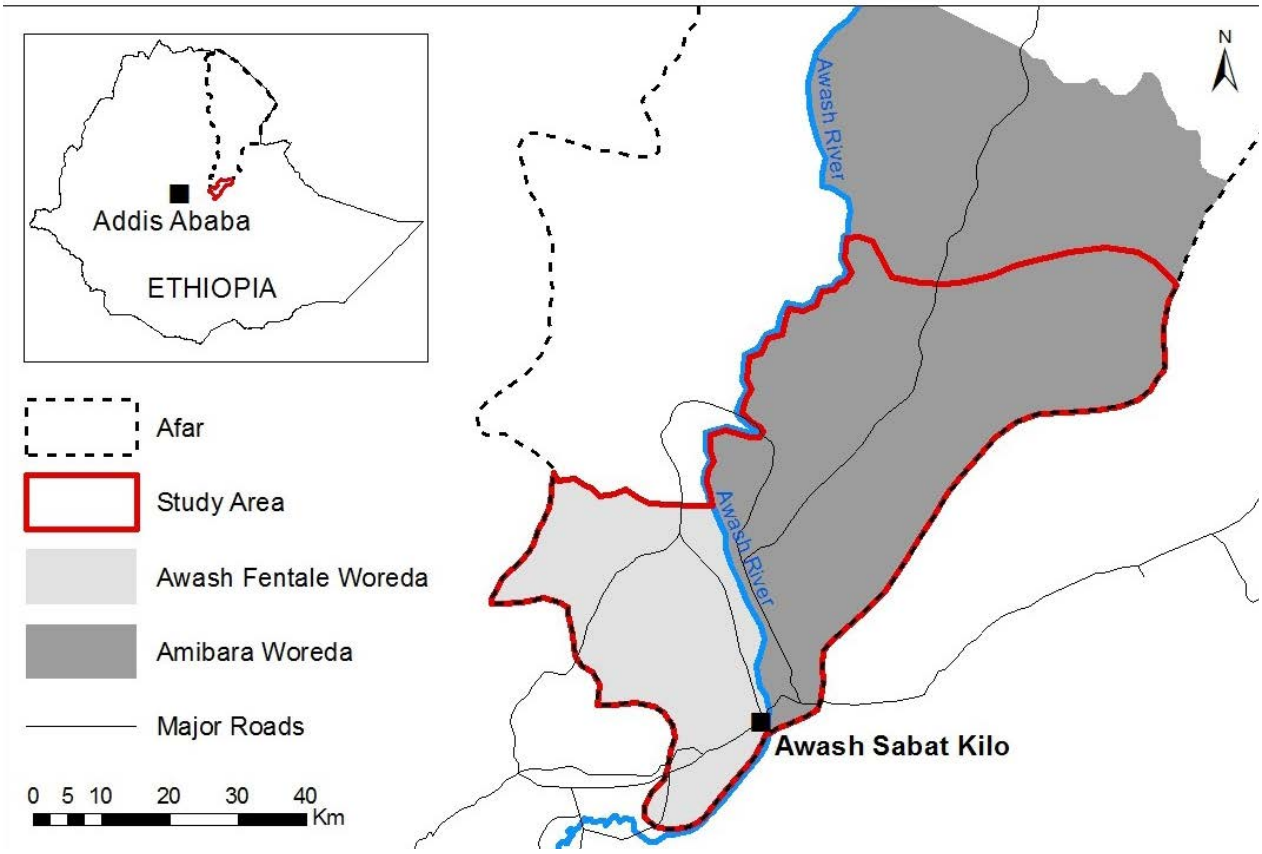
- *Intra-household dynamics* and resource access under social transition: We explored the association between changing resource access and household dynamics under social transition (agro-pastoral and urbanisation), including intra-household change in roles, relations, aspirations, livelihoods, and translocal risk and responses.

- Decentralisation and *governance for adaptation:* We examined how governance for adaptation is articulated through the decentralisation process (including key sectors such as water resources and disaster risk reduction), covering cross-scale dimensions from policy drivers to community / woreda interaction.

- *Villagisation*, small-scale irrigation, and water resource management: We analysed the implications of villagisation for vulnerability and adaptation to scarce water supplies in the context of wider livelihood advantages and disadvantages.

- Management of *Prosopis juliflora*: We analysed problems of invasive species in the rangeland and socially-differentiated perspectives on the management of *Prosopis*, a dryland exotic shrub that is spreading rapidly through the environment.

Our research was grounded in the prevailing dynamics of the case study sites (such as economic, development, migration, social, gender, cultural and policy change) and set within the broader dynamics of agro-pastoral transitions and the ongoing process of decentralisation (of planning and resources). Issues of gender and other forms of social differentiation were embedded within all the selected research topics. Through this research, we generated knowledge of who the current winners and losers are in relation to adaptation to climate-related, socio-ecological risks and some more critical understanding of the probable implications in terms of barriers and enablers as we look to the future (over the next 20-30 years).



Case study sites

Our main study site in Ethiopia covered two woredas – Awash Fentale and neighbouring Amibara – which lie in Zone 3 in the south of Afar Region adjacent to the borders with Oromiya region to the south-west, south and south-east, and Somali region to the east. Apart from isolated uplands, this is a lowland zone bounded by the perimeters of the Rift Valley, with a hot and dry climate and primarily semi-arid conditions. The Awash river runs through the southern section of Awash Fentale and then heads north, forming the border between the two woredas and continuing as the western border of Amibara. Several minor and seasonal watercourses join the main channel of the Awash river through the two woredas, but two major permanent tributaries, the Kessem and the Kabena rivers, cross eastwards through the northern section of Awash Fentale. The largest urban site in the case study area is Awash Sebat Kilo (Awash Town), which has a strategic location along the Djibouti-Addis Ababa highway, close to a river crossing and the junction with the main highway east toward the Somali region. A new railway linking to Djibouti has been constructed along the Awash valley and passes across the northern edge of the town. Two major conservation areas lie within the case study area. The Awash National Park occupies around half the area of Awash Fentale and is covered predominantly by acacia woodland and grassland, and the Aledegi Wildlife Reserve occupies much of the eastern rangeland of Amibara.

Historically the case study area and the Afar region as a whole have been a pastoralist zone, with traditional patterns of mobility and seasonal pasture areas. However, the region is undergoing transition, with changes in both livelihoods and settlement patterns associated with a shift from pastoralism to agro-pastoralism, and more intensive land uses. For several decades, agro-industrial developments based on government and private investment in large-scale irrigated plantations of banana, cotton and, increasingly, sugar cane cultivation have become a feature of the central part of the case study area. The communities across the case study area are confronted with multiple livelihood risks, resulting primarily from: rainfall variability, water scarcity and frequent droughts; changes in access to water and pasture resources; invasive plant species spreading across the rangeland; and limited alternative livelihood opportunities.

Approach

ASSAR's integrated research approach in Ethiopia was to operate primarily at the national level during the inception phase, before narrowing and deepening the research work, ultimately to focus in the latter stages of the project on a set of researchable topics that are important for communities, local government, non-governmental stakeholders, and national-level institutions.

Our initial work in Ethiopia began in November 2014, with meetings with stakeholders, including policy makers, NGOs and local government working on climate change adaptation, and with communities on the ground. These provided an important opportunity for the team to hear about activities and priorities in-country at a range of levels. We introduced the ASSAR programme and shared information about what ASSAR planned to do in the region. This was also a first opportunity for feedback from national-level stakeholders on the project approach. Discussions centred on: i) what people thought were the most critical issues relating to climate impacts, vulnerability and adaptation in semi-arid regions (including wider development pressures or challenges); ii) what they saw as the main research needs in order to address these issues and strengthen resilience (especially of the more vulnerable social groups); and iii) what key initiatives, projects, events and documents the project team should take into account.

The initial scoping work with stakeholders both built on and fed back into the stakeholder mapping exercise carried out during the inception period, which identified major actors (governmental, non-governmental, private organisations) working at national level, regional level (East Africa), and international level on various cross-cutting issues of climate change adaptation and vulnerability.

This early work with stakeholders also contributed to the Regional Diagnostic Study, which was completed in early 2015, together with a broad-ranging review of existing academic and non-academic literature. The diagnostic study highlighted that people's vulnerability to climate change is rooted in wider aspects of livelihoods and development trajectories, and that adaptation to climate change may need to look beyond business-as-usual approaches in development and environmental management.

Over ASSAR's lifetime, we engaged with stakeholders across scales, from the community level up to national policy makers in the relevant departments, as well as key NGOs and civil society organisations working in climate change adaptation and related areas in the region. For example, we held two workshops in February 2016 at national and local levels at the midpoint of the project to feedback to stakeholders, and to gain their feedback on emerging results and research priorities. These activities formed part of our Research-into-Use (RiU) strategy, which integrated our research work with uptake and dissemination activities to realise impact on the ground, and which used stakeholder engagement to focus on efforts which were most relevant for disempowered groups. Our Participatory Scenario Analysis (PSA) research on the issue of invasive species management provides a practical example of this integrated thinking. Through our applied approach – and by integrating research, RiU and capacity building activities – we supported stakeholders to analyse issues that were relevant to them, identified preferred solutions, and provided additional support to enable them to work towards achieving meaningful change on the ground. Building on the research and engagement work undertaken through the PSA process, ASSAR identified the issue of invasive species, particularly *Prosopis juliflora*, as an urgent field for additional research-for-impact activities, engaging both community and local government stakeholders in activities following on from the research. At a national level, members of the ASSAR team (Oxfam and AAU) actively worked with the National *Prosopis* Taskforce, and subsequently the Pastoral and Agro-Pastoral Taskforce (PAPTF) to disseminate findings and influence policy and practice.

Below, we detail the approaches taken for each of our research topics (intra-household dynamics and resource access under social transition, decentralisation and governance for adaptation, villagisation and water resource management, management of *Prosopis*) in the next section.

FINDINGS AND RECOMMENDATIONS

GENDER, AGE, LOCATION AND STATUS AFFECT THE ABILITY OF PEOPLE TO RESPOND TO CLIMATE CHANGE

Factors like gender, age, location, livelihood and status intersect with social and economic characteristics such as household composition, social capital, marital status, income and education level to determine people's capacity to respond effectively to climate risks and impacts. Adaptation policies need to consider these intersecting factors explicitly to enable the most marginalised to adapt.

What we did: Our study of intra-household dynamics and adaptation under social transition was based on in-depth interviews with households in the Awash River basin, conducted in October 2017. These comprised life history interviews with a selective sample of 35 households from the pastoralist village Dileyu (13 people), the agro-pastoralist and peri-urban centre Melka Sedi (six people), and the urban neighbourhood Awash Sabat Kilo (16 people). Where possible two people were interviewed in each household, typically the household head and senior man or woman, depending on the gender of the head. We looked specifically at monogamous, polygamous, divorced, widowed, and young households to see how household type can mediate adaptation to climate change. Given the centrality of age, gender and location in jointly shaping household structures and relationships, and consequently, the nature of risks as well as adaptation, our overarching research question was: How do men and women (of different groups, ages and statuses) use changing household structures and relationships to respond to risks and adapt more effectively?

What we found: We found that Afar pastoralists were not only 'stepping up' (increasing activity in an attempt to address climate-related impoverishment), but also 'stepping out': shifting from pastoralism into agriculture and salaried employment. This often involves splitting households across multiple locations, and we looked at the ways in which these splits change natal, conjugal and intergenerational relationships. Sometimes these have positive effects, but we also observed households that have 'fallen down and out' and discussed the reasons for this. Our findings suggest that youth aspirations, particularly in urban centres at least, are increasingly impossible to achieve. Further evidence suggests that government support to urban centres in relation to food security and livestock is insufficient, relative to that provided in rural areas. The gendered negotiation of intra-household relationships and resource access, and how this varies across different household structures, is not well understood in literature on climate change adaptation, and our dataset enables us to make a unique contribution to these debates. Numerous respondents observed the continued importance of migration (moving with their animals), which was under threat from the growth of *Prosopis juliflora*, the erosion of or encroachment on traditional grazing grounds, and clan warfare. Constraints on migration have particularly severe impacts on women and the elderly: Fatuma (pastoralist, monogamous) described how she and her husband *'suffered in times of drought by staying home and suffering the consequences due to [our] age*'. She emphasised how '*women will severely be affected by the problem as they have to stay home and suffer the consequences while the men look for pasture… it will be good for women to move with others and with the cattle in order to get what she needs such as milk, butter, etc.*'

Recommendations

- Adaptation and risk-reduction strategies and interventions are often based on external assumptions about who is most vulnerable, how people respond to risk, and what needs to be done to help them. However, greater collaboration with communities is needed to better understand local contexts and the intersecting factors leading to specific vulnerability profiles of communities and households.

- Households should not be treated as homogenous units. Instead, researchers, practitioners and decision makers should recognise the diversity of each household, the ways in which power and responsibilities are shared, the relationships that exist within them, and how these factors lead to particular risk management outcomes and levels of wellbeing for different household members.

- Adaptation policies and programmes should be more sensitive to the socially-differentiated nature of people's everyday realities and experiences. These strategies should seek to address the underlying causes of vulnerability and question the traditional and cultural norms that have led to unequal rights and opportunities among different groups.

- More support is required to increase employment opportunities that are not reliant on natural resources or affected by the vagaries of the weather and climate to help build adaptive capacity and resilience. For example, providing opportunities for young people such as skills training that matches up with the realities of the job market, taking into account youth aspirations for work outside farming. Recognising that currently there are few formal jobs outside regional centres, this could include access to affordable credit and initial capital to start micro-enterprises and ongoing training and mentoring to support these.

- For people who continue in natural resource-based livelihoods, support could include: increased access to drought-resistant livestock species or seed varieties that ripen quickly when rainfall is available; reduced infestation of plants such as *Prosopis;* and strengthening people's capacity to access agriculture insurance and low-cost water-saving technologies such as drip irrigation and rainwater harvesting. Pastoralist livelihoods should be underpinned by improved basic services such as health, including maternal health, and strengthened productive and social safety net programs to help more households recover from environmental shocks and stresses.

DECENTRALISATION PRESENTS OPPORTUNITIES AND CHALLENGES FOR ADAPTATION

Although decentralisation has strengthened local officials' responsibility to respond to local needs flexibly, greater coordination between levels and sectors of government, as well as more resources and better provision of timely and relevant information, would further strengthen action on water governance and disaster risk management.

What we did: Ethiopia has a long history of decentralisation (since the 1990s) which has been practiced in the natural resources sectors for years. However, there have been recentralisation tendencies at times, characterised by restricted freedom of expression, and limited civil society engagement. Our research asked how the decentralisation process and transfer of authority to local governments (also including institutions outside of formal governance) have influenced adaptation processes and outcomes in two key sectors of water and disaster risk management. Our analysis is based on 18 semi-structured interviews (mostly conducted at woreda and kebele levels in Awash) during two rounds of fieldwork in April 2016 and November 2017.

What we found: We found that there is insufficient 'nestedness' in policies, practices, and decision making across different levels and sectors of governance in Ethiopia. Despite the fragmented transfer of authority and power among various line agencies in Ethiopia, devolved power and authority has enabled woreda- and kebele-level officials to respond to local needs more effectively. For example, there have been positive impacts in terms of service delivery with improved water management and drought management responses, including positive impacts on livelihoods, especially for pastoralist women and children. However, access to timely and required information (e.g., climate and weather data, market information) is still lacking. Furthermore, a majority of actors and institutions at the woreda and kebele levels have problems of resource constraints. Resource allocation is determined at the federal level (mediated through the regional level), with only limited influence at the zonal and other levels. For example, woreda governments do not receive additional money in the case of emergency situations. The support from the federal government is more in the form of food aid. Local governments have to use contingency budget or part of other budgets for the purpose. Allied to the lack of resources are capacity deficits that often mean external assistance is valuable and necessary for interventions (e.g., the support of CARE for early warning systems on floods and drought). However, the greater freedom afforded by decentralisation means that there is greater flexibility to select and manage responses and infrastructures as required at a local level. For example, regional and woreda officials (e.g., Emergency Information Centre and Early Warning Systems) have found it useful to involve traditional forecasters and mix their knowledge with scientific systems.

Recommendations

- The management of a resource as scarce and susceptible to change as water is becoming increasingly critical, especially since future climate conditions are set to affect Ethiopia's water sector. Our findings indicate that a clear division of responsibilities and strong platforms for coordination are needed to make water governance more effective and inclusive.

- While technical solutions are important, successful management of scarce water resources and better disaster risk reduction requires meaningful participation from local actors. As part of this, decision makers need to understand the unique context of each community, and consider how factors like gender, age, wealth, education level and ethnicity impact people's abilities to participate in water governance.

- Effective governance of adaptation in the water and disaster risk management sectors requires a coordinated response between sectors and across different levels of government. Decentralisation is creating new institutional and political spaces for the governance of water and disaster risk reduction that need to be used to help integrate responses both horizontally and vertically.

- A key aspect of integration is the linking of different levels of decision making through 'nested' institutional arrangements that also address the issues of coordination, representation, inclusivity, capacity building, and knowledge sharing. These are critical to support more effective approaches to climate change adaptation.

IMPROVING WATER ACCESS IS IMPORTANT TO MAKE COMMUNITIES SETTLED THROUGH VILLAGISATION LESS VULNERABLE TO CLIMATE CHANGE

Villagisation has brought improvements in services and infrastructure that are often highly valued by settled populations. However, because the needs of large-scale commercial farms are prioritised, the provision of water and land for small-scale farming is currently inadequate.

What we did: We investigated the links between villagisation and water resource use and management, and the implications of these for current and future climate change adaptation efforts. We conducted 15 group interviews and 38 semi-structured interviews in Amibara and Awash Fentale woredas in the Middle Awash Valley, assessing impacts across different social groups differentiated by age, gender and economic status.

What we found: In our discussions with local communities, we found that villagisation has brought both benefits and challenges. Many people were positive about the social and infrastructural service developments associated with villagisation. They described enhanced water supply for domestic and field uses, and the provision of social services (school and health services, access to roads) – benefits that were regarded as particularly significant among women and older people. The introduction of small-scale irrigation allowed many residents to diversify their livelihood strategies in a way that may serve to increase their resilience to climate change related shocks. However, the practice of small-scale irrigation was largely challenged by shortages of water and land resources. The government of Ethiopia has jointly promoted irrigation development alongside the policy of villagisation of pastoral communities, encouraging communities to form villages where small-scale irrigation would be possible, usually near to commercial irrigation water supply canals. For this reason, the water supply system to a community is controlled by government agencies, such as the Awash Basin Authority (ABA). Villagers reported that ABA has prioritised supply to the commercial farms, leaving inadequate irrigation water for them to succeed in their new (agro-pastoral) livelihood strategies. Some also complained that they had not been allocated sufficient irrigation land to make a farming-based income viable. The overall problem has also been exacerbated by fluctuation in the volume of the Awash River (the main irrigation water source), mainly related to the occurrence of drought conditions in the rivers' upper streams in recent years.

This combination of resource management practices and recurrent drought has made small-scale irrigation a less effective and less attractive livelihood activity for many resettled households.

Recommendations

- To support local livelihoods and wellbeing, greater attention needs to be given to ensuring that water allocation and distribution schemes in villagised areas are both efficient and equitable. To this end, stakeholders from community, local, regional and national levels should work together to prepare policy guidelines on sustainable access to water resources between clan members of different communities, and among different age-groups. It is also critical that ABA and Kessem Sugar Corporation give equal opportunities to villagised communities in their water allocation schemes and do not prioritise state and private investors' irrigation farms.

- An additional priority should be the implementation of watershed management activities throughout the Awash river basin, in order to regulate and stabilise the water supply to the river, and to help ensure that water is available for both irrigation and home use. For example, the government could construct more water reservoirs in the Middle Awash Valley, develop existing underground water resources, and introduce water-efficient irrigation technologies. Irrigation methods such as drip or sprinkler irrigation could help to save water and minimise the risk of soil becoming salinised.

- Villagised communities should receive training on farming practices and forage improvements. The government and NGOs could also consider ways of supporting villagised communities that need to make upfront investments in order to switch to crop farming (e.g., seeds, fertilisers and irrigation water motor pumps).

- Now that farmers can grow locally marketable crops such as fruit and vegetables, it is important that the federal and regional governments, in collaboration with NGOs, help to create adequate market linkages. One option could be to create links with Consumer Associations, which are established for customers in different areas and institutions, particularly in large cities nearby such as Addis Ababa and Adama.

- Growing perennial fruit trees around homesteads and in farms (e.g., mango, papaya trees) would serve the dual purpose of providing cash crops for sale in the local market, and shade in the hot, dry climate. Research centres (e.g., Worer and Melkasa Agricultural Research Centres, ABA) could help support tree planting.

TACKLING THE PROBLEM OF INVASIVE SPECIES SUCH AS PROSOPIS REQUIRES APPROACHES THAT ACTIVELY ENGAGE WITH, RECOGNISE, AND RESPOND TO THE DIFFERENTIATED NEEDS OF AFFECTED COMMUNITIES

Interventions create winners and losers, and opinions vary about the best way to address the issue of *Prosopis*. Including affected populations more concretely in decisions about how best to tackle this invasive plant species will help to ensure that their needs and concerns are met.

What we did: One of the biggest problems the Middle Awash Valley faces is the spread of the invasive thorny shrub *Prosopis* (*Prosopis juliflora*), which is increasing rapidly in the region, reducing the availability of pasture, closing off access to water resources, and posing health threats to livestock and people. To date, management interventions have seldom been effective. In our research on *Prosopis* we focused on understanding both the problem and its potential solutions, including understanding how different ways of managing the problem are viewed by different people, and what helps or hinders different management approaches. We conducted PSA with three communities to explore the positive and negative trade-offs associated with different scenarios or visions for future *Prosopis* management, and assess the relative preferences for these. To augment our PSA work we used key informant and semi-structured group interviews to understand how the *Prosopis* problem was perceived and which solutions were most preferred. We also analysed remotely sensed data to understand the distribution (and change) of *Prosopis* in the study area.

What we found: The current rate of spread of *Prosopis* creates an urgent need for effective management interventions. However, attempts to control or contain the shrub have struggled not only because of the rapidity and tenacity of its spread but also because such initiatives have commonly suffered from design

and operational issues. For example, attempts to stimulate sustainable use have been hampered by the use of inappropriate technologies that have failed to operate effectively, and economic barriers that deny widespread access to livelihood opportunities associated with the harvesting of *Prosopis* wood and seed pods. Moreover, many interventions have been designed with generally little voice given to grassroots perspectives, increasing the likelihood that interventions will fail, with potentially negative consequences for populations already experiencing the impacts of the invasive plant. Making *a priori* assumptions about how people in a particular setting are likely to perceive and prioritise a specific form of intervention would be a risky endeavour.

Results from our PSA research show that marked differences in preferences for different management scenarios were evident between the three participant communities – despite their proximate locations – as well as between participants within the same workshop. The communities understood the risks and trade-offs associated with each of the scenarios, and were able to critically appraise both the stated (overt) and potentially more hidden (covert) motivations of implementing actors and agents. We found a divergence in scenario preference when comparing the community workshops with the NGO and government workshops. A scenario that encompassed a community-focused approach was highly favoured by NGOs and, to a lesser extent, by government, but that view was not mirrored in the communities. This indicates that interventions might represent the perspectives of more remote stakeholders rather than the concerns and priorities of those living daily with the risks and consequences of the invasive species. The divergent viewpoints exhibited between participants within the same workshop also highlights the importance of consulting in a way that is sensitive to the socially-differentiated nature of communities. Any intervention will result in winners and losers; recognising this should form an important element of design and implementation.

Recommendations

- Present available technology makes it difficult to completely remove *Prosopis* from the landscape. This may never be a viable goal. It is advisable instead to propose a mosaic of management methods suited to specific geographical settings: strategies that are likely to comprise both its use in some less productive areas, and removal from some of the most productive areas used for irrigation cropping and rangelands.
- The views and perspectives of affected communities must be included within decisions on the most appropriate ways and means to manage environmental change. In the context of *Prosopis*, this is important because the invasive plant is likely to result in ecosystem 'bads' and disservices as well as ecosystem 'goods' and services, which will be distributed unevenly across affected populations. Policy and action cannot rely on decontextualised narratives and aggregated notions of wellbeing that pre-define and structure how institutional actors see, understand and, by implication, frame solutions.
- Affected populations experience the impacts of *Prosopis* in socially-differentiated ways and, crucially, have a plurality of views and opinions on the most appropriate responses to the issue in hand. Any intervention will result in winners and losers. Recognising the potential for unintended social consequences should form an important element of the design and implementation of any intervention, with efforts taken to minimise negative impacts on the most vulnerable groups.
- Intervention on such a complex and difficult problem as *Prosopis* management will produce trade-offs. Exposing and making these trade-offs explicit, particularly those that affect marginalised populations, can aid institutional actors identify not only which interventions are preferred, but by whom and at what cost or benefit.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

ASSAR has successfully worked across various scales in Ethiopia, from national to local levels. Given the differing capacity needs of stakeholders at these scales, we adapted our communication and capacity-strengthening strategies to suit different audiences. These audiences included local community members, government and NGOs working at woreda and regional levels; representatives from ministries at national government and those with international funding agencies. Through a range of activities, we worked to enhance stakeholder understanding of vulnerability and adaptation, and encourage increased uptake and support for the policy and practice interventions highlighted by our findings.

Ultimately, one of the goals of adaptation is to reduce the vulnerability of different groups to climate-related impacts. Through our partnership work with different stakeholders we have actively sought to embed ASSAR findings into the practices of local governmental and non-governmental organisations in Afar. Using the existing networks cultivated by AAU and Oxfam, and fostered through the research activities, we have been able to engage in depth over a sustained period of time with representatives of government and NGOs alike. Through the relationships that we have built up over this period, we have been able to exchange knowledge and explore ways in which ASSAR research can contribute to changes in policy and practice. We are currently engaging with key contacts supportive of RiU engagement in the Ministry of Agriculture and Livestock, the Ministry of Water, Irrigation and Energy, and the Ministry of Environment, Forest and Climate Change.

The stakeholder mapping helped us to identify who to engage with in a more strategic and sustained way over the life of the project at a national level. For example, ASSAR supported officers of the Ministry of Agriculture and Livestock and the Ministry of Water, Irrigation and Energy to attend the Climate Science Winter School in Cape Town, building capacity and good working relationships. This engagement has been maintained through the lifetime of the project and has provided ASSAR with an important means of disseminating key findings and influencing organisations that sit at the interface of policy, practice and research with national reach.

One of the primary ways we engaged with stakeholders was through the PSA process. As outlined above, the PSA work sought to achieve impact on the ground by boosting capacity of participants to analyse key challenges and identify possible solutions. Building on the engagement in the PSA work, we brought together stakeholders to discuss the findings of the *Prosopis* research at a local scale and identify priorities for ongoing support and advocacy. We also contributed research findings to the strategic discussions of the National *Prosopis* Taskforce and subsequently the Pastoral and Agro-Pastoral Taskforce (PAPTF).

In addition to these targeted, face-to-face engagement with stakeholders, we reached audiences through blogs, social media and research outputs (infographics, photo essays, multimedia, and journal articles). ASSAR team members have also organised additional local capacity development work on *Prosopis* management in the Afar region, and are developing proposals for expanded socio-environmental research on *Prosopis* expansion, impacts, management, and use in the region and beyond. Collectively, with these activities ASSAR has embedded its key messages in a coalition of stakeholders that should be able to communicate the findings and help to translate them into action long after ASSAR has finished.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Climatic conditions in the arid and semi-arid regions of Ethiopia are becoming less predictable. This unpredictability, along with other changes that are occurring, is increasing the pressure on many people's lives and livelihoods. Whilst many initiatives have been implemented in these areas, too many tend to be short lived and run the risk of increasing the dependency of communities on handouts. One of the most effective ways to support communities in these areas is to increase their own agency and give them a stake in the decisions that affect them. People in these communities are not just agentless victims, they can and do actively manage the risks to which they are exposed. Supporting these people to give them more agency and power to enact changes in their own lives and influence the decisions that impact on them, is crucial.

While times are hard for everyone, some people are more affected than others. Ethnicity, gender, age, religious beliefs and traditional norms all affect people's vulnerabilities to climate change, and their responses to it. There is a clear need to recognise and value these differences when designing, planning and implementing interventions. People and communities in the semi-arid regions are not all the same yet are often treated as such. Our research has highlighted how there are substantial differences between people. For example, micro-finance initiatives typically target women, yet young men would also benefit from this form of support. Similarly, older women and men tend to have different vulnerabilities and capacities from younger groups, highlighting the value in targeting different types of support at different groups of people.

Much rhetoric about reducing vulnerability focuses on the need to take a long-term approach. Too often, however, efforts seem to concentrate on crisis management rather than tackling the more fundamental and structural issues that are at the root of many of the more episodic events more commonly attributed to drought or poor rainfall. Tackling vulnerability to climate change means acknowledging that much progress can be achieved by addressing the many developmental challenges that exist. For example, providing safe water and sanitation, and supporting enterprise and increasing livelihood opportunities are all as (if not more) important for building resilience in arid and semi-arid regions as the interventions that are targeted more specifically at risks linked to a changing climate.

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ADDITIONAL RESOURCES

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Photographs in this section: Lucia Scodanibbio, Jennifer Leavy, Mark Tebboth

KENYA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID KENYA

ASSAR'S FOCUS IN KENYA

Semi-arid regions in northern and eastern Kenya, are highly dynamic systems that experience changeable and sometimes extreme climates, adverse environmental change, and a relative insufficiency of natural resources. Historically, people living in these regions had livelihoods that were well-suited to these conditions. Today, however, many communities are showing increased vulnerability due to challenges such as political marginalisation, underdevelopment, poverty, inequality, unfair governance systems, maladaptive policies, and increasing population growth. Climate change is expected to exacerbate existing levels of vulnerability, as temperatures rise, rainfall decreases and seasonal climate patterns become more variable.

From 2014-2018, ASSAR's East Africa team worked in Kenya and Ethiopia to better understand these existing and upcoming challenges. Made up of a team of researchers and practitioners from the University of Nairobi (UoN), Addis Ababa University (AAU), University of East Anglia (UEA), and Oxfam GB, we concentrated most of our work in Kenya in the counties of Isiolo, Meru and Samburu (our case study area). In both Kenya and Ethiopia we used a parallel case study approach in order to best analyse how changing social and environmental conditions interact in practice. We combined these analyses with activities at regional and national levels to generate transferable insights for policy and practice on the changing nature of vulnerability and response to environmental change. We hope that this detailed work can contribute to knowledge on how to enhance the ability of communities, local organisations and government to adapt to climate change in ways that minimise vulnerability and promote long-term resilience.

Key insights

- Factors like gender, age, location, livelihood and status intersect with social and economic characteristics like household composition, social capital, marital status, income and educational attainment to determine people's capacity to effectively respond to climate risks and impacts. Adaptation policies need to consider these intersecting factors explicitly to enable the most marginalised to adapt.

- Although decentralisation has enabled local officials to respond to local needs flexibly and effectively, greater coordination between levels and sectors of government, as well as more resources, better alignment of planning and development cycles, and better provision of timely and relevant information, would further strengthen action on water governance and disaster risk management.

- Conservancies have benefitted communities with improved governance, more livelihood opportunities, and enhanced social services. To continue to build resilience, further improvements are required to reduce tensions between communities within and outside conservancies, enable more sustainable and equitable approaches to natural resource management and livelihoods, and address ongoing problems associated with human-wildlife conflict.

- Recognising that interventions will result in trade-offs, with some people winning and others losing, is important. Including affected populations more concretely in decisions about interventions will help to identify the main trade-offs, support more effective design and implementation of interventions, avoid unintended consequences – especially for the most vulnerable – and help to ensure that the needs of those typically excluded from decision making are heard and valued.

ABOUT THE RESEARCH

Research priorities

ASSAR's research in Kenya was structured around three overarching dimensions that were identified through an in-depth review of literature, and the insights and priorities of stakeholders at local, county and national levels. The first dimension was land and water use/access through which we examined the connection between human wellbeing, land tenure, resource access (such as water and pasture for livestock or crops for domestic use), and resource governance (including traditional mechanisms). Our second dimension was linkages at higher scales. Here the objective was to understand issues like the dynamics of pastoral mobility across larger-scale landscapes (such as districts and counties), and the ongoing process of fiscal and political decentralisation. The third and final distinctive dimension of our research was to understand how vulnerability, adaptive capacity and the implications of different adaptation responses are socially differentiated – within communities, between individuals, and according to ethnicity, gender and age.

Research focus

Drawing on the three dimensions of adaptation outlined above, ASSAR's research in Kenya focused on four specific research topics that are critically important in the semi-arid regions of Northern Kenya.

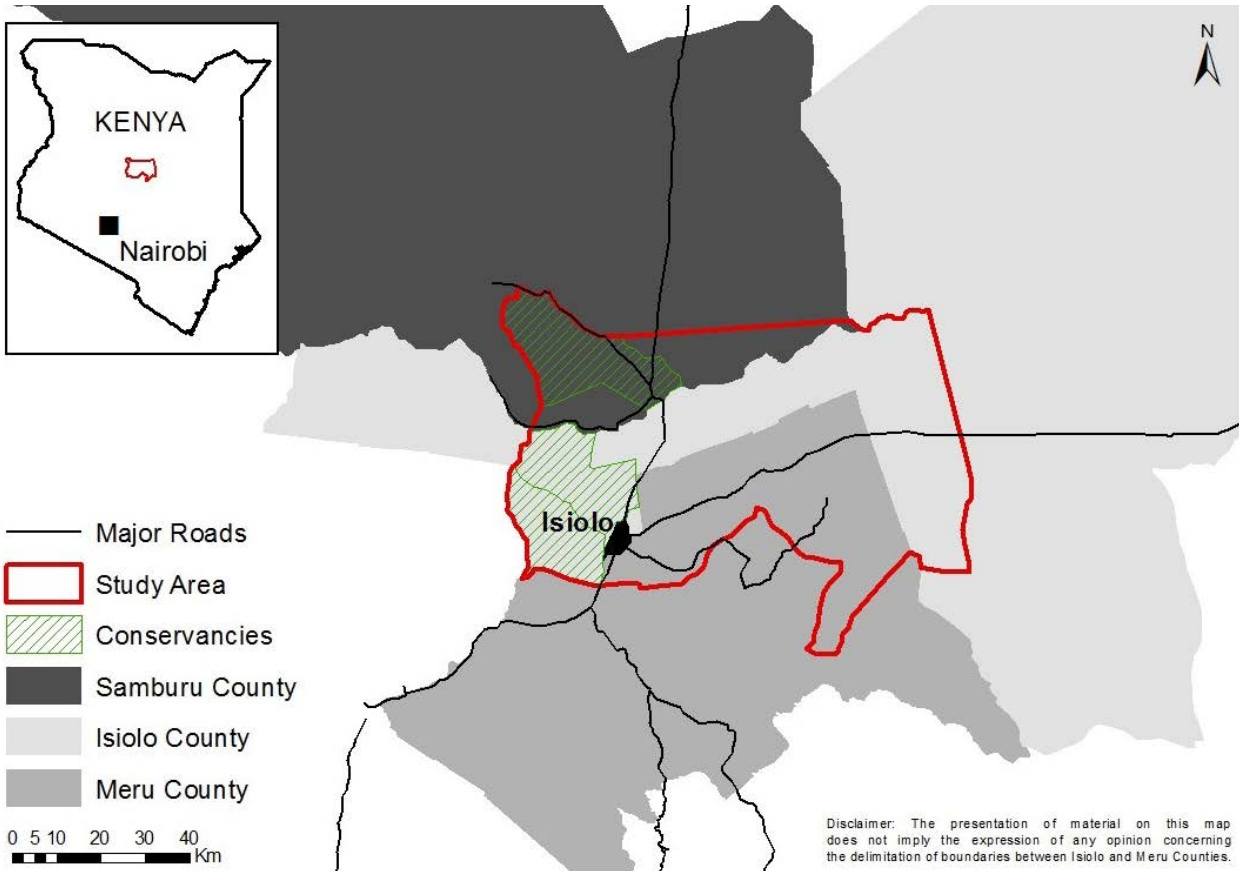
- *Intra-household dynamics* and resource access under social transition: We explored the association between changing resource access and household dynamics under social transition (agro-pastoral and urbanisation), including intra-household change in roles, relations, aspirations, livelihoods, and translocal risk and responses.

- Decentralisation and *governance for adaptation:* We examined how governance for adaptation is articulated through the decentralisation process (including key sectors such as water, resources, disaster risk reduction, climate services), covering cross-scale dimensions from policy drivers to community/district interaction.

- *Conservancy model* for resource management: We analysed the implications of conservancies for vulnerability and adaptation (especially via access to resources and decision making).

- Perspectives on *pasture scarcity*: We generated insights on socially-differentiated perspectives of pasture scarcity, and the social justice and equity implications of different management interventions.

Our research was grounded in the prevailing dynamics of our case study sites (such as economic, development, migration, social, gender, cultural and policy change) and set within the broader dynamics of agro-pastoral transitions and the ongoing process of decentralisation (of planning and resources). Issues of gender and other forms of social differentiation were embedded within all the research topics. Through this research, we generated knowledge of who the current winners and losers are in relation to adaptation to climate-related, socio-ecological risks, and some more critical understanding of the probable implications in terms of barriers and enablers as we look to the future (over the next 20-30 years).



Case study sites

Our main study site was at the intersection of the drier, more arid, pastoralist parts of northern Kenya and the wetter, more humid, and agricultural areas of central Kenya, and comprised parts of three counties: Isiolo, Meru and Samburu. The area exhibits a strong climate gradient and range of agro-ecological conditions due to the proximity of Mount Kenya. On the highland belt around Mount Kenya and the Nyambene Hills, agro-pastoral farming communities within the dry sub-humid zone can be seen cultivating a diverse range of crops including rain-fed maize, sorghum and *miraa*. At lower elevations, agroecological conditions become progressively dry and arid with livelihoods focused more exclusively on pastoralism. The three counties are dotted with a mosaic of land uses such as national parks, private/community conservancies, and game reserves under county governments. The local communities are confronted with multiple livelihood risks, resulting primarily from: the effects of climate variability and change; insecurity; breakdown in effective systems to manage resources, and other changes resulting from ongoing development interventions; and limited livelihood opportunities.

Approach

ASSAR's integrated research approach in Kenya was to operate primarily at the national level during the inception phase before narrowing and deepening the research work, ultimately to focus in the latter stages of the project on a set of researchable topics that are important and of interest to communities, local government and non-governmental stakeholders, and national level institutions.

Our initial work in Kenya began in November 2014, with meetings with stakeholders, including policy makers, NGOs and local government working on climate change adaptation, and with communities on the ground. These provided an important opportunity for us to hear about activities and priorities in-country at a range of levels. We introduced the ASSAR project and shared information about what ASSAR planned to do in the region. This was also a first opportunity for feedback from national-level stakeholders on the project approach. Discussions centred on: i) what people thought were the most critical issues relating to climate impacts, vulnerability and adaptation, including wider development pressures or challenges in semi-arid regions; ii) what they saw as the main research needs in order to address these issues and strengthen resilience especially of the more vulnerable social groups; and iii) what key initiatives, projects, events and documents we should take into account.

The initial scoping work with stakeholders both built on and fed back into the stakeholder mapping exercise

carried out during the inception period, which identified major actors (governmental, non-governmental, private organisations) working at national, regional (East Africa), and international levels on various cross-cutting issues of climate change adaptation and vulnerability.

This early work with stakeholders also contributed to the Regional Diagnostic Study, which was completed in early 2015, together with a broad-ranging review of existing academic and non-academic literature. It highlighted that people's vulnerability to climate change is rooted in wider aspects of livelihoods and development trajectories, and that adaptation to climate change may need to look beyond business-as-usual approaches in development and environmental management.

Over ASSAR's lifetime, we engaged with stakeholders across scales, from the community level up to national policy makers in the relevant departments, as well as key NGOs and civil society organisations working in climate change adaptation and related areas in the region. For example, we held two workshops in February 2016 at national and local levels at the midpoint of the project to feedback to stakeholders, and to gain their feedback on emerging results and research priorities. These activities formed part of our Research-into-Use (RiU) strategy, which integrates our research work with uptake and dissemination activities to realise impact on the ground, and which uses stakeholder engagement to focus on efforts which are likely to be most relevant for disempowered groups. Our Participatory Scenario Analysis (PSA) research on the issue of pasture scarcity provides a practical example of this integrated thinking.

Through our applied approach – and by integrating research, RiU and capacity building activities – we supported stakeholders to analyse issues that are relevant to them, identify preferred solutions, and provide additional support to enable them to work towards achieving meaningful change on the ground. Building on the research and engagement work undertaken through the PSA process, ASSAR also brought together stakeholders for dialogue on the issue of conservancies. This dialogue arose out of the conservancy research that generated insights on this relatively new form of natural resource governance in northern Kenya.

FINDINGS AND RECOMMENDATIONS

ETHNICITY, GENDER AND AGE AFFECT THE ABILITY OF PEOPLE TO RESPOND TO CLIMATE CHANGE

Factors like gender, age and location intersect with social and economic characteristics like household composition, social capital, marital status, income and education level to determine people's capacity to effectively respond to climate risks and impacts. Adaptation policies need to consider these intersecting factors explicitly to enable the most marginalised to adapt.

What we did: Our study of intra-household dynamics and adaptation under social transition is based on in-depth interviews with households in Isiolo and Meru counties, conducted in May-June 2017. These comprised life history interviews with a selective sample of 10 households each from three sites: two rural sites, one Meru (Gituli) and one mixed Borana/Meru (Kachuru); and one peri-urban largely Borana site (Kambiodha). Where possible we interviewed two people in each household; in the peri-urban site this was often two women. We looked specifically at monogamous, polygamous, divorced/separated, and widowed households to see how household type can mediate adaptation to climate change. Our overarching research question was: How do men and women (of different groups, ages and statuses) use changing household structures and relationships to respond to risks and adapt more effectively?

What we found: We found a clear difference in adaptive responses by gender, age and location. Older people – both men and women – were more easily able to adapt than the younger generation, given their positions of power and authority within households. Younger men lacked livestock and alternative employment, hence were frequently unable to contribute to household incomes, and often took to drugs. Their inability to earn pushed younger women into a range of enterprises, to ensure the survival of themselves and their children, adding to their work burdens. Apart from a lack of time, some of these women were also involved in risky ventures aimed at fulfilling their educational aspirations for their children, with adverse consequences for their health and wellbeing. The nature of these risks varied – from engaging in casual sex-work or unprotected relationships with men for short-term security (Kambiodha and Kachuru), to expanding their activities into pasture areas that were prone to conflict (farming by Meru women), to taking on excessive work burdens in terms of long hours of arduous labour. In the absence of adequate state support, young women in particular found it difficult to manage both productive and care work. Forming household units with their mothers or female kin was increasingly common as an adaptation response. New household types and forms of cooperation are emerging, and these need to be understood and better supported.

Recommendations

- Adaptation and risk-reduction strategies are often based on external assumptions about who is most vulnerable, how people respond to risk and what needs to be done to help them. However, greater collaboration with communities is needed to better understand local contexts and the intersecting factors leading to specific vulnerability profiles of communities and households.

- Households should not be treated as homogenous units. Instead, researchers, practitioners and decision makers should recognise the diversity of each household, the ways in which power and responsibilities are shared, the relationships that exist within them, and how these factors lead to particular risk management outcomes and levels of wellbeing for different household members.

- Adaptation policies and programmes should be more sensitive to the socially-differentiated nature of people's everyday realities and experiences. These strategies should seek to address the underlying causes of vulnerability and question the traditional and cultural norms that have led to unequal rights and opportunities among different groups. Changing aspirations (e.g., from rural to urban livelihoods) should also be considered when planning adaptation and development strategies.

- Livelihood diversification is often promoted as an adaptation and risk management strategy, yet what people diversify into is critical. While it may increase incomes, it does not always improve resilience or enhance wellbeing. To counteract any negative effects, improved social protection and social safety nets should accompany livelihood diversification efforts.

- Vulnerable men and women need support to deal with the multiple challenges that they face. They should be equipped with the technical capacity, basic skills (e.g., literacy), infrastructure (e.g., for improved access to potable water), and services (e.g., childcare, agricultural extension services) that they need to become more resilient. Providing information and improving access to jobs, resources and markets can help vulnerable people to diversify their livelihoods and ensure they are not driven into risky or illegal behaviour out of desperation.

DECENTRALISATION PRESENTS OPPORTUNITIES AND CHALLENGES FOR ADAPTATION

Although decentralisation has enabled local officials to respond to local needs flexibly and effectively, greater coordination between levels and sectors of government, as well as more resources, better alignment of planning and development cycles, and better provision of timely and relevant information, would further strengthen action on water governance and disaster risk management.

What we did: Decentralisation is a strong policy issue in Kenya following the adoption of the 2010 constitution; some sectors are more devolved than others. Despite the importance of decentralisation, there exists limited empirical evidence on the effects it has on local adaptation processes in the country, particularly so in the context of arid and semi-arid regions. Our research in Kenya focused on the impacts and outcomes of decentralisation on the management of water-related issues (water stress, drought and flooding). We focused on analysing different policy drivers (e.g., Kenya's Vision 2030), devolved planning processes (e.g., formulation of County Integrated Development Plans in Isiolo), and local experiences and expectations (at community/village levels). Our analysis was based on 24 semi-structured individual and group interviews at the local, county, and national levels conducted during two rounds of fieldwork in March 2016 and February 2017.

What we found: Devolution has afforded more opportunities for flexibility (e.g., Isiolo County's response to water crises) and public participation, and there are some beacons of good practice to learn from – although these remain the exception rather than the norm. For example, the National Drought Management Authority's (NDMA) use of Ward and County Adaptation Planning Committees and a County Steering Group has resulted in better coordination of actions. Devolution has been accompanied by increased resources and there has been some improvement in access to services and information. However, there is also more competition between sectors, often greater bureaucracy and shortfalls in capacity and skills. Furthermore, a shortfall exists in coordination and integration between different sectors and levels of government and with activities of other non-state actors in Kenya. The distance and disconnect between different stakeholders and levels of government is more pronounced between national and county levels than between county and local levels. There is also incoherence between planning and development cycles. Devolution has seen a substantial transfer of power and authority to county and local levels. However, different institutions and actors appear to have overlapping and competing relationships due to the incomplete nature of devolution (for example, national bills and legislation clarifying responsibilities are yet to be passed, or changes have not been implemented).

Recommendations

- The management of a resource as scarce and susceptible to change as water is becoming increasingly critical. Our findings indicate that a clear division of responsibilities and strong platforms for coordination are needed to make water governance more effective and inclusive.

- While technical solutions are important, successful management of scarce water resources and better disaster risk reduction requires meaningful participation from local actors. As part of this, decision makers need to understand the unique context of each community, and consider how factors like gender, age, wealth, education level, and ethnicity impact people's abilities to participate in water governance.

- Similarly, better preparedness and actively promoting responses that reduce the risk and impacts of disasters also requires a clear division of responsibilities and effective and inclusive platforms for coordination.

- Devolution is creating opportunities and the potential to do things in new ways. Beacons of good practice need to be shared and applied at different levels of government and with other stakeholders to help further integrate and improve coordination.

- A key aspect of integration is the linking of different levels of decision making through institutional arrangements that also address the issues of coordination, capacity building and knowledge sharing. These are critical to support more effective approaches to climate change adaptation.

HARNESSING CONSERVANCIES TO REDUCE VULNERABILITY

Conservancies have benefitted communities with improved governance, more livelihood opportunities, and enhanced social services. To continue to build resilience, further improvements are required to reduce tensions between communities within and outside conservancies, enable more sustainable and equitable approaches to natural resource management and livelihoods, and address ongoing problems associated with human-wildlife conflict.

What we did: Community wildlife conservancies have been put forward as a good way to support livelihoods and promote community-based conservation. In

northern Kenya, community wildlife conservancies were introduced in the early 2000s and have altered the way land is managed for livestock and wildlife through the introduction of new institutions as well as governance structures. The approach has been adopted by a number of communities and, as of 2017, there were over 30 conservancies established with support from the Northern Rangeland Trust (NRT). Our research focused on understanding the impact of these conservancies, and the ways their governance changes have affected access to grazing resources among the pastoral communities. The study involved 20 key informant interviews and 12 focus group discussions with the communities within and outside the conservancies, as well as with government officials and non-governmental conservation agencies.

What we found: We found that the establishment of conservancies has brought benefits to communities in three main areas: governance, livelihoods, and the provision of social services. First, the new governance structure that includes the elders in the committees and/or consults the elders on certain decisions, alongside a more representative approach (through the inclusion of women and youth), has enabled more inclusive governance within conservancies. Second, in terms of livelihoods, the conservancies have provided employment opportunities for members of local communities as rangers, managers, and lodge attendants. Additionally, micro-financing through cooperatives has supported community members to start small businesses. Third, through the conservancies, social amenities such as schools, health centres, and water facilities have been provided, and bursaries have increased access to schooling. However, a number of challenges persist. The co-existence of livestock and wildlife has increased, rather than decreased, human-wildlife conflict. Communities continue to lose livestock and crops to predators, with no compensation for their losses.

Perhaps more significantly, some community members report that wildlife are prioritised above their own interests. This issue is compounded by the inadequate provision of preventive health interventions for livestock, as the presence of wildlife increases the opportunities for disease transmission. The relationships between communities inside the conservancy and those outside remain problematic. For example, issues persist in terms of finding suitable ways to manage resources within the conservancy, especially during times of scarcity. Furthermore, the effectiveness of grazing management bodies is undermined by actions of some members who use their positions to facilitate access to conservancy resources by non-members (by passing off livestock as their own, and selling livestock from outside the conservancy instead of resident stock under the NRT trading livestock offtake programme).

Recommendations

- As long as the main source of livelihood for Kenyan pastoralists is extensive livestock production conservancies must ensure that pastoral communities have sufficient access to pasture and water. This is critical, as restricting access to conservancy resources renders members and neighbouring non-member communities vulnerable to the impacts of droughts, climate variability and climate change.

- Community wildlife conservancies established in future should adopt landscape-level thinking to ensure that members and non-members can collaborate and benefit equally. For example, some successful eco-lodges now benefit from thriving wildlife populations despite being situated hundreds of kilometres away from protected areas.

- It is necessary to strike a balance between conservation and pastoral livelihoods. For example, the incentives for communities to co-exist with wildlife should be significant enough to compensate for (1) the opportunity costs of dedicating critical grazing areas for conservation, and (2) the ongoing wildlife-related losses of crops and livestock.

- Practical measures to support conservancy functioning include:

    - All conservancies would benefit from a register of members for ease of identification. This is important for key decision making that may require voting (such as election of officials), as it will help to ensure that only genuine members vote.

    - Each conservancy needs to brand its livestock with unique marks for ease of identification. This will help for theft reports, to identify any non-member livestock grazing on the conservancy, and to identify 'genuine stock' during offtake by NRT Trading.

    - For successful co-existence of wildlife and livestock, a livestock disease prevention plan is needed to counteract potential health challenges associated with the possible increase of wildlife populations.

MANAGEMENT OF NATURAL RESOURCES REQUIRES BETTER ENGAGEMENT WITH TRADITIONALLY-MARGINALISED STAKEHOLDERS

Interventions create winners and losers, and opinions vary about the best way to address the issue of pasture scarcity. Including affected populations more concretely in decisions about interventions will help to identify the main trade-offs, support more effective design and implementation of interventions, avoid unintended consequences – especially for the most vulnerable – and help to ensure that the needs of those typically excluded from decision making are heard and met.

What we did: Pasture scarcity is a major issue for pastoral and agro-pastoral populations in the semi-arid regions of Kenya, impacting on livestock and the wellbeing of populations, contributing to increased levels of population mobility, creating conditions for conflict, and leading to other negative impacts. In our research on pasture scarcity we focused on understanding both the problem and its potential solutions, including understanding how different ways of managing the problem are viewed by different people, and what helps or hinders different approaches. We used PSA with three communities in the case study area to explore the positive and negative trade-offs associated with different scenarios or visions for future resource management, and assess the relative preferences for these. The PSA work was augmented by key informant and semi-structured group interviews on how the pasture scarcity problem was perceived, and which solutions were most preferred in the study area.

What we found: Urgent and effective approaches are required to address the issue of pasture scarcity. As the climate becomes more unpredictable and interacts with other causes of vulnerability, maintaining access to adequate pasture is likely to become even more pressing. However, attempts to manage the availability of pasture fairly have only been partially effective because such initiatives have commonly suffered from design and operational issues. For example, attempts to stimulate sustainable land management have been hampered by the competing stakeholder interests and power imbalances that prioritise the interests of certain groups over others, increasing the likelihood that interventions will fail, with potentially negative consequences for populations already experiencing pasture scarcity. Making *a priori* assumptions about how people in a particular setting are likely to perceive and prioritise a specific form of intervention would be a risky endeavour. Results from our PSA research show that across the three communities and for the government and NGO groups, two scenarios – (1) zoning of land to establish regulated patterns of land use and seasonal pasture, and (2) changing herd composition to encourage a shift from grazers (cattle and sheep) to browsers (camels and goats) – were the most supported. The strong favouring by community members of a zoned pattern of land management, compared with a more individualised basis of private pasture enclosure (which was the least favoured scenario), matches the arguments being made by many commentators on sustainable management of pastoral lands and, at least in part, reflects equity concerns. With regard to the changing herd composition scenario, in both government and NGO groups there was a sense that this change in livestock composition toward more drought-resistant animals was something already happening and likely to continue. This scenario also had slightly higher support among women. In two of the communities, a scenario of transitioning out of pastoralism also performed quite well. Many community members, while nervous of the economic risks of transitioning, and its familial and cultural implications, may be actively considering or aspiring to a different livelihood arrangement.

Recommendations

- Whilst the views of communities were reasonably consistent there was some divergence between the socially-differentiated groups (older men, younger men, older women and younger women) within each community. Consequently, it is necessary to recognise that affected populations experience the impacts of pasture scarcity in socially-differentiated ways and, crucially, have varying views and opinions on the most appropriate responses to the issue at hand.

- The views and perspectives of affected communities must be included within decisions on the most appropriate ways and means to manage environmental change. To achieve this, meaningful and effective consultation that carefully considers power imbalances is required to allow a plurality of opinions and voices to be heard. One way to achieve this is to consult with socially-differentiated groups of people separately.

- Any intervention will produce trade-offs. Exposing and making these trade-offs explicit, particularly those that affect marginalised populations, can aid institutional actors in identifying not only which interventions are preferred, but by whom and at what cost or benefit.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

ASSAR has successfully worked across various scales in Kenya, from national to local levels. Given the differing capacity needs of stakeholders at these scales, we adapted our communication and capacity-strengthening strategies to suit different audiences. These audiences included local community members, government and NGOs working at county level; representatives from ministries at national government and with international funding agencies such as DFID. Through a range of activities, we worked to enhance stakeholder understanding of vulnerability and adaptation, and encourage increased uptake and support for policy and practice interventions that our findings have highlighted.

Ultimately, one of the goals of adaptation is to reduce the vulnerability of different groups to climate-related impacts. Through our collaborative work with different stakeholders we have actively sought to embed ASSAR findings into the practices of local governmental and NGOs in Isiolo County. Using the existing networks cultivated by the University of Nairobi and Oxfam, and fostered through the research activities, we have been able to engage in depth over a sustained period of time with representatives of government and NGOs alike in Isiolo County. Through the relationships that we have built up over this period, we have been able to exchange knowledge and contributed to changes in policy and practice stemming from ASSAR research. For example, we have engaged with the Office of the Deputy Governor, the Ministry of Environment, and the Ministry of Agriculture, Fisheries and Livestock to support the development of key policies on land tenure and climate change that are currently before the County Assembly.

The stakeholder mapping helped us to identify who to engage with in a more sustained way over the life of the project at a national level. For example, ASSAR supported an NDMA officer to attend the Climate Science Winter School in Cape Town, building capacity and good working relationships. This engagement has been maintained throughout the lifetime of the project and has provided ASSAR with an important means of disseminating key findings and influencing a boundary organisation that sits at the interface of policy, practice and research with national reach. Further work at the national level has recently commenced, ASSAR has provided findings to the Council of Governors, and our findings have also influenced the strategic priorities and programme design of DFID in their work in Kenya.

One of the primary ways we engaged with stakeholders was through the PSA process. As outlined above, the PSA work sought to achieve impact on the ground by boosting capacity of participants to analyse key challenges and identify possible solutions. Once a set of solutions was identified, ASSAR supported learning and capacity building using a peer-to-peer approach whereby participants interacted with other communities that had experienced similar problems and implemented solutions (e.g., the reinvigoration of the *Dedha* system of land management, pasture production, and increasing the numbers of camels and goats). Through the peer-to-peer process communities learned about potential solutions to pasture scarcity.

Building on the engagement in the PSA work, we brought together stakeholders to discuss the findings of the conservancy research. Conservancies are an emotive issue and the debate about the benefits (or otherwise) has become polarised. We sought to reset the debate locally in Isiolo by bringing together key stakeholders (including communities affected by conservancies) for open dialogue. This work helped to undo some of the myths about conservancies and provided a channel through which communities and implementing organisations can more openly discuss the opportunities and drawbacks of conservancies, supporting more informed decision making.

In addition to these targeted, face-to-face engagement with stakeholders, we reached a wide range of audiences through blogs, social media and research outputs (infographics, photo essays, and multimedia). Collectively, with these activities ASSAR has embedded its key messages in a coalition of stakeholders that should be able to communicate the findings and help to translate them into action long after ASSAR has finished.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Climatic conditions in the arid and semi-arid regions of Kenya are becoming less predictable. This, along with other changes that are occurring, is increasing the pressure on many people's lives and livelihoods. Whilst many initiatives have been implemented in these areas, too many tend to be short lived and run the risk of increasing the dependency of communities on handouts. One of the most effective ways to support communities in these areas is to increase their own agency and give them a stake in the decisions that affect them. People in these communities are not just agentless victims, they can and do actively manage the risks to which they are exposed. Supporting these people to give them more agency and power to enact changes in their own lives and influence the decisions that impact on them, is crucial.

While times are hard for everyone, some people are more affected than others. Ethnicity, gender, age, religious beliefs and traditional norms all affect people's vulnerabilities to climate change, and their responses to it. There is a clear need to recognise and value these differences when designing, planning and implementing interventions. Moreover, this situation suggests that research – especially that done in the context of developmental challenges – needs to focus on directly addressing challenges and opportunities faced by the most vulnerable and disempowered. People and communities in the semi-arid regions are not all the same yet are often treated so. Our research has highlighted how there are substantial differences between people. For example, micro-finance initiatives typically target women, yet young men would also benefit from this form of support. Similarly, older women and men tend to have different vulnerabilities and capacities from younger groups, highlighting the value in targeting different types of support at different groups of people.

Much rhetoric about reducing vulnerability focuses on the need to take a long-term approach. Too often, however, efforts seem to concentrate on crisis management rather than tackling the more fundamental and structural issues that are at the root of many of the more episodic events more commonly attributed to drought or poor rainfall. Tackling vulnerability to climate change means acknowledging that much progress can be achieved by addressing the many developmental challenges that exist. For example, providing safe water and sanitation, and supporting enterprise and increasing livelihood opportunities are all as (if not more) important to build resilience in arid and semi-arid regions as the interventions that are targeted more specifically at risks linked to a changing climate.

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Photographs in this section: Daniel McGahey, Dave Loubser, Jennifer Leavy, Musa Jillo, Mark Tebboth

GHANA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID GHANA

ASSAR'S FOCUS IN GHANA

West Africa's semi-arid regions are home to an incredibly rich history of cultures that have thrived despite highly demanding environmental conditions. Today, people living in these dryland areas face a suite of complex challenges. These are related to increasingly erratic rainfall, rising temperatures, droughts, poor soil fertility and floods, combined with high population growth, gender inequalities, ineffective decentralisation of governance, and reliance on climate-dependent livelihoods.

From 2014-2018, ASSAR's Ghana team worked in the Lawra and Nandom districts of Ghana's Upper West region to better understand how these interlinked challenges are impacting people's capacity to adapt. Our team comprised researchers and technical officers from the University of Ghana's Institute for Environment and Sanitation Studies (IESS) along with master's and PhD students from IESS and other university programs. We worked with partners and stakeholders from national to household levels to understand differentiated vulnerabilities, identify barriers to adaptation, and explore what needs to happen to support more effective, sustained and widespread adaptation.

Key insights

- Intersecting climatic and non-climatic challenges manifest in varied ways for different groups and individuals. Therefore, researchers, policy makers and practitioners should view these combined stressors holistically and use this more complete understanding when making decisions that will impact livelihoods and adaptation options of different social groups.

- Measures can be taken now to ameliorate non-climatic challenges and bolster adaptive capacities. These include developing market support services, expansion of veterinary services, enforcement of regulations on bush burning, and better grading and packaging of produce.

- Policy makers, government ministries and practitioners should tailor water management to the needs of different social groups, prioritise provision of accurate and timely rainfall information, and strengthen technical capacities for maintaining water infrastructure. Further, to increase uptake among farmers, measures need to be taken to integrate traditional irrigation approaches that are culturally accepted with more modern mechanised approaches and financing.

- Migration is often seen, in an overly simplistic manner, as a favourable adaptation response to combined stressors, but this is not necessarily the case. Migration is not always an available or desirable option. A focus should be placed on supporting sustainable adaptation options for those for whom migration is not a viable option.

- Traditional patriarchal norms have favoured males and promoted structural inequalities among females in terms of decision making, access to and control over land for agricultural activities, and the ability to engage in more productive livelihoods. Recognising gendered dimensions of land tenure, and improving access and ownership rights for women and marginalised groups, is central to identifying successful adaptation strategies for the future.

ABOUT THE RESEARCH

Research priorities

Our team sought to better understand what the current situation is with regard to how people are adapting to climatic and non-climatic changes occurring in the Upper West region, especially in relation to food security and in the context of trends toward agricultural intensification in Ghana and beyond. We set out to understand how the current situation developed and what may be needed to better ensure successful adaptation to potential future changes. Exploring how combined stressors affect different social groups in different ways, and how adaptation options are shaped by cultural traditions, social norms, and associated power relations was also key. Through this work we were able to identify certain barriers and enablers of adaptation, particularly as these link to water, migration, land tenure, farm production and marketing, and livelihoods.

ASSAR investigated differing vulnerabilities and response options among and within different groups of people in Ghana's Upper West and what these mean for adaptation. We also investigated barriers and enablers to adaptation relating to:

- Water resource management at local and district levels
- Migration
- Gendered access to and control over agricultural land
- Production and marketing of farm produce
- Agricultural and off-farm livelihoods

Case study sites

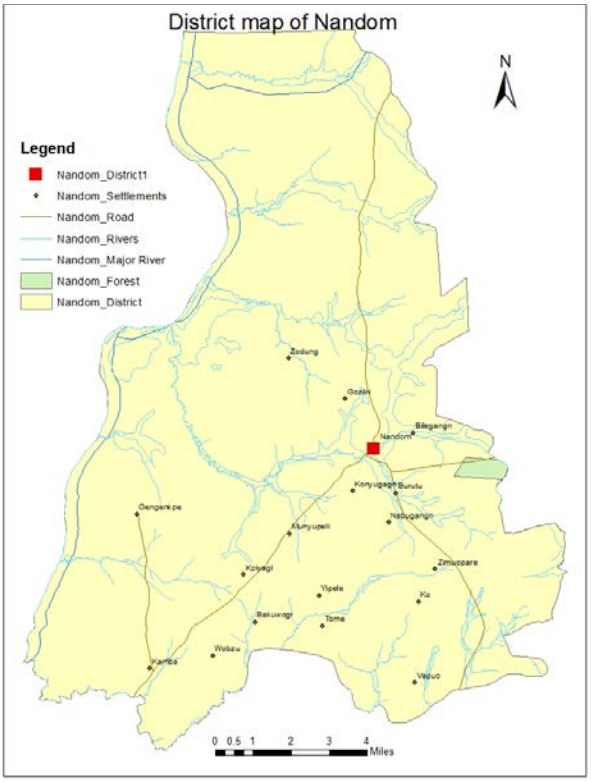
We focused on the Wa portion of the dry sub-humid band that extends from the Upper West region of northern Ghana through southern Mali, referred to as the Wa-Bobo-Sikasso transect. The region experiences high exposure to dry spells, and has medium-high to high drought risk and strong multi-decadal fluctuations in climate. Our team worked in two districts, Lawra and Nandom, in the Upper West region. Smallholder farming is the dominant livelihood in the area with over 80% of all households in the districts engaging in agriculture. Most farms grow crops including yam, cereals, maize, sorghum, millet, and guinea corn. Women often practice groundnut farming and processing along with shea butter processing and soap making. Livestock such as goats, cattle, sheep, pigs, and poultry are kept on a small scale. Other activities include smock weaving and pito brewing.

Approach

We began our work with the Regional Diagnostic Study (RDS) that investigated current dimensions of risks, vulnerabilities, and adaptation responses across different groups of people in the study sites and through cross-referencing at the national level. For this study, two sets of national and local level workshops were held. The first set of workshops engaged stakeholders at the local and national level to obtain their perspectives on barriers and enablers of climate change adaptation in semi-arid Ghana. The second set of workshops was to disseminate results and get feedback from the stakeholders on the findings at both levels. During this phase, we found diverse, and sometimes conflicting, interests in terms of policies, strategies, and investment priorities. Further, overly complex management systems where people have conflicting interests, different skills and capacities across institutions and individuals, differing monitoring and evaluation systems, and differences in terminology, were also found to be barriers for prioritising and achieving adaptation goals. With regard to enablers we found that policy measures that support greater availability and sharing of climate and agricultural data, increased use of established data quality control protocols, and use of more comparable language with appropriate and consistent definitions and terminology would support greater adaptation.

This information helped to shape the way in which we contextualised and approached the research questions in the first round of studies conducted by master's and PhD researchers from the University of Ghana (UG), and through research done by the core research team (comprising UG faculty members and master's graduates who served as technical officers). We explored our target issues primarily through: 1) focus group discussions, surveys, and key informant interviews, 2) targeted sampling and mapping of the biophysical attributes of local ecosystems, 3) investigation into ecosystem-based livelihoods and natural resource management, and 4) careful analysis of adaptation-related policies and regulations across scales. Throughout, we maintained a special focus on gendered dimensions of vulnerability and adaptation options in Upper West.

Our research further encompassed work on life histories in Lawra and Nandom, mental modelling approaches, and participatory stakeholder engagement processes. In turn, the evidence gained from this initial research then served to inform our Transformative Scenario Planning (TSP) phase of the project. For this, we held two workshops in Wa, a city in Upper West, in 2016 where we used TSP to build stories about what plausibly might happen to agriculture and food security in the Upper West Region until the year 2035.



Insights gathered during the TSP process then informed the second phase of our regional research program that centered on migration options, vulnerability of different social groups, institutional capacities, food security, ecosystem services and management, governance, livestock management, and adaptation strategies. Throughout all stages of the research, special attention was given to recognising how gender and other intersecting categories of social difference shape the vulnerabilities, capacities, and responses of different people. Over the course of the project our team's Research-into-Use (RiU) dimension progressed to building on information from the research and the TSP and using this knowledge for more targeted capacity building activities with stakeholders.

FINDINGS AND RECOMMENDATIONS

INTERSECTING CLIMATIC AND NON-CLIMATIC CHALLENGES SHAPE PEOPLE'S LIVELIHOOD OPTIONS AND DECISIONS

In Lawra and Nandom districts, climate change and perceptions of climate change are influencing decisions about agricultural and ecosystem-based livelihoods. However, this is not the only nor most influential factor in some cases. Policy makers and practitioners working to support adaptation need to seek a holistic view of the challenges and needs of different groups in order to strengthen overall abilities to cope with combined stressors.

Climate change is only one of many integrated challenges farmers must navigate on a daily basis. For livestock farmers, age, access to veterinary and extension services, decreased rainfall and increased temperatures, and membership of farmer organisations all play a role in shaping their decisions on whether to adopt certain management strategies for their animals. For production and marketing of smallholder produce, climate change is not perceived as a major challenge. Instead, postharvest losses, low prices for farm produce, poor packaging, poor grading, and absence of market infrastructure are more pressing concerns. These issues could translate to negative impacts on adaptation though, as incomes and food crops are affected. Similarly, groundnut farmers, who are largely women, are facing combined climatic (erratic rainfall and higher than normal temperatures) and non-climatic (poor soils and unequal access to land) challenges. Adoption of different responses to these depends on factors including age, gender and land tenureship.

Ecosystem-based livelihoods are providing important alternatives or support to conventional farming activities, but these are also facing combined climatic and non-climatic challenges that could impact their future viability. For example, in Lawra there are at least 76 non-timber forest product (NTFP) species that contribute significantly to local livelihoods and act as safety nets for residents in times of dwindling outputs from farming. These species and their sustainable use are facing several major threats including climatic changes (higher temperatures and irregular rainfall), animal and plant invasions, access restrictions, and the absence of specific laws on NTFP management, harvesting and processing. Harvest and use of medicinal plants is also being impacted by intersecting climatic and non-climatic challenges, especially in the form of bush burning, drought and high temperatures, and degrading harvesting practices.

Recommendations

- Policy makers, traditional authorities, and others seeking to design or implement targeted adaptation measures need to take a holistic view of combined climatic and non-climatic stressors that impact the vulnerability and adaptive capacity of different social groups and individuals. This will involve deeper engagement and communication with target communities and room for flexible feedback and adjustment of policies.

- Certain measures can be taken now to ameliorate non-climatic challenges that would bolster the health, financial security, and safety nets for communities in Upper West. These measures include developing market support services, expansion of veterinary services, enforcement of regulations on bush burning, and better grading and packaging of produce. These measures could bolster overall adaptive capacities for dealing with climate change impacts.

STRENGTHENED MANAGEMENT OF SCARCE WATER RESOURCES IS CRITICAL FOR REDUCING CONFLICT AND ENABLING ADAPTATION

Rising temperatures, unpredictable rainfall, and increased pressures from growing populations are shaping a complex landscape around water resources, especially groundwater and water from the Black Volta River which forms the border between Ghana and Burkina Faso. Supporting greater technical capacities and more integrated management of these resources will be essential for lessening negative impacts of climate change in the future and for reducing conflicts among users.

Droughts, floods, and increasingly variable rainfall are impacting the quantity and quality of water sources in Upper West. Nitrate levels are elevated across many water sources due to the proximity of farming activities, and microbial levels from the Black Volta exceed the guidelines for domestic use. These issues can be harmful to human health and can impact negatively on adaptive capacities. Likewise, seasonal drying of rivers and streams, and of some boreholes during more extreme conditions, is contributing to increased conflict between water users at boreholes, as well as between livestock and irrigation farmers along rivers. For example, recent decreases in the water level of the Black Volta have resulted in a struggle between dry season farmers and semi-nomadic Fulani herdsmen. Factors such as age, ethnicity, and gender can greatly shape how and to what degree these challenges impact different people. For example, it is women and girls who are primarily in charge of fetching water for households, while young men are often in charge of moving livestock.

Concerning governance and management, decisions are spread across different decision makers at multiple scales. For example, regulations designed at the district level are enforced by local level Water and Sanitation Committees (WATSAN). Then, there are traditional authorities who pass and enforce bylaws. These multiple layers of governance all aim for increased protection of water in the region. However, there are disconnects between community-level capacities and district-level management goals, and between traditional and formal government strategies. Lack of sufficient funding and technical expertise to maintain water harvesting infrastructure is perceived as contributing to a greater risk of increasing conflicts around water in the future.

Recommendations

- To reduce vulnerability of smallholder farmers in the Upper West region to increasing water scarcity and other interrelated challenges, policies and programmes should target smallholder farmers at the level of disaggregated social groups, instead of considering them as a homogeneous group.

- The Ministry of Food and Agriculture and other development organisations should focus on reducing vulnerability to drought and flooding through: 1) the provision of accurate and timely rainfall information, 2) strengthening of technical capacities for maintaining water infrastructure, and 3) more transparent communication and inclusion of different water user groups in the development and updating of regulations.

- Education of community members by government and non-governmental organisations on water quality issues and related health hazards should be prioritised where possible.

- Government institutions, including district assemblies and departments of agriculture, along with the Ghana Irrigation Development Authority (GIDA), should take measures to integrate traditional irrigation approaches that are socially and culturally accepted with more modern mechanised approaches, climate smart agriculture, and well-targeted financing in order to increase uptake among farmers.

MIGRATION IS NOT ALWAYS A FAVOURABLE ADAPTATION OPTION FOR ALL GROUPS

Migration continues to be one of the more popular responses to integrated climatic and non-climatic stressors in Upper West. But not everyone in Lawra and Nandom has the desire or the ability to move away from their homes and established social networks. Alternative adaptation options for those who choose not to, or cannot, migrate should be identified and supported, as should decision-making rights for marginalised groups.

Communities in Upper West can experience more than seven months of dry spells each year, affecting agriculture and food security for many households. During this period of dryness, vulnerable farmers have to make the difficult choice between migrating to southern Ghana as an adaptation option, staying and engaging in dry season farming with scarce water resources, relying on food and resources from other family members, or seeking limited off-farm employment. In parts of Upper West there is nearly an 80% migration rate among members of farming households.

Important, though, is that not all groups and individuals have equal access to migration. This ability is shaped by social factors. For instance, an individual's marital status influences their power over migration decisions. Married men, and single women and men, are freer to make such decisions than married women, who cite having children and deferring to their husbands as restrictions. Single women may permanently migrate. Married women, whose husbands live in these communities, often practice seasonal migration. These married women note that, although there are times that their husbands cannot afford their basic needs (such as cooking utensils, cloth, and other household items), they still prevent them from travelling to other parts of the country to earn income. They believe that their husbands prevent them from migrating because of the labor they provide on men's farms. Marriage restricts these women's mobility, even when such movements may enhance their and their family's adaptive capacities.

There is no homogenous view of the desirability of migration either. Age can play an influential role. For instance, young people tend to respond to stressors with migration, whereas older people rely instead on their local social safety nets. Some groups also have greater access to off-farm livelihood activities in their communities. For instance, women in Upper West are better able to secure local off-farm livelihoods that are not as vulnerable to climatic impacts, whereas men are often more solely dependent on farming activities that are highly vulnerable to climatic impacts. This means men are more likely to migrate south for farming opportunities.

Recommendations

- Migration decisions are based on diverse reasons, but underlying push factors are usually linked to food and financial security. Those who have access to off-farm activities are more likely to remain in place than those who have run out of response options to climatic risks and shocks. Governments and other institutions should focus on supporting sustainable adaptation options for those for whom migration is not a viable option.
- Creation of vocational training programmes should be prioritised by civil society, traditional authorities, and governments in the districts, when possible, to train young people in different livelihood activities that can sustain them during dry spells and droughts.
- Effort is needed to empower women to be part of household and community decision making activities. NGOs and institutions engaged in the district should ensure fair representation and participation of women in all meetings and decision making processes. Such efforts could build on progress made by the ASSAR Ghana team with strengthening capacities of women's groups in Lawra and Nandom.

STRENGTHENING LAND ACCESS RIGHTS AND LIVELIHOOD OPPORTUNITIES FOR WOMEN IS CRUCIAL FOR SUCCESSFUL ADAPTATION

Climate variability interacts with socio-economic, cultural, and political inequalities to shape vulnerability. Gender, in particular, largely influences access to land, a vital resource on which households depend. Understanding these gendered dimensions, and improving access and ownership rights for women and marginalised groups is central to identifying successful adaptation strategies.

Access to land is critical for adaptation in Lawra and Nandom, as it is intricately linked to livelihoods and food security. However, the ability of certain groups to access and use this resource is heavily influenced by social norms and traditions. For example, there are vast differences between male and female farmers with respect to owning farmland. Most female farmers have access to far less land than men do, and they must borrow or rent land instead of inheriting it as most men do.

Connections to agricultural land are not identical across social groups though. Married women have greater access through their husbands, and therefore more control over adaptation options. Comparatively, single women have less access and therefore less control over adaptation options. Indigenous women also have better access to land as compared to migrant women. Access to farmlands by married women, however, is by no means guaranteed as lands can easily be taken from them at any time by their husbands. This tenuous control over agricultural lands impacts the decisions different women can and do make regarding adaptation responses.

In part due to restricted access to farmland, women and young farmers are more likely to engage in off-farm livelihood activities. These tend to be impacted less by climate change and include the sale of local drinks, shea and groundnut processing, basket weaving, and petty trading for subsistence. While these additional livelihoods may increase women's agency (income is often used to support household food and other needs), they also increase work burdens and curtail leisure time. For some, increases in agency do not equal greater decision making power because of persisting patriarchal norms and power structures that continue to suppress the decision making abilities of women.

Recommendations

- Recognising the ways that gender and other social differences affect access and control over vital adaptation options for different groups is a central first step for successful adaptation planning. Policy makers and practitioners need to regularly engage with different social groups and their representatives in order to more thoroughly incorporate their perspectives and needs into adaptation policies and programming, with an explicit aim of more effectively addressing the needs of marginalised groups.

- In supporting women's agency and demand for recognition, interventions need to work with both women and men to challenge social norms and patriarchal traditions but also to invest in supportive structures (e.g., access to credit, markets, and improved transport networks).

- Women's access to land is vital for influencing adaptation strategies among agrarian societies. To improve this situation, the Ministry of Gender and Social Protection should sensitise communities on women's land rights, and the need for improved land access and tenure security among women and youth.

- Traditional authorities and civil society organisations should support dialogue and collaboration between men and women on gender equality, land access and rights, and adaptation.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

Beginning with the RDS and exploratory trips of graduate student researchers, we built relationships with local and district level stakeholders that provided a strong foundation for each subsequent step of our project. Consistent engagement with stakeholders, and the inclusion of their voices and perspectives into our research and participatory processes, along with prioritisation of their needs in our capacity building activities, formed the core of our RiU strategy. These relationships first helped to facilitate more open student access to communities and key individuals with knowledge about different dimensions of the research. Later, as the team moved toward the TSP phase of the regional research programme, these relationships served as key connections for helping us bring the right people to the table for the scenario workshops which was key to their success.

Prioritisation of climate-smart water management during the TSP directly led the team to work with farmers on promotion of dry season farming through smart water management that enhances sustainable livelihoods for vulnerable communities through our Scenario Based Capacity Building (SBCB) award. The TSP also highlighted the need for more and better dissemination of research findings, weather and climate information, and adaptation strategies to stakeholders. Limited communication channels can make this challenging so the team created four Climate Advisory Resource Centres (CARCs) as part of their SBCB activities. The goal for these centres is to make farming advisories more meaningful and relevant to ordinary farmers and to support extension work. These observed gaps also led members of the team to develop a mobile application, Adaptation Hub, to promote communication and information sharing on climate and adaptation.

In 2018, the team used their work on smallholder irrigation with the SBCB award as a building block to partner with ASSAR colleagues at the University of East Anglia for developing a proposal for an action group of the Africa-EU Innovation Alliance for Water and Climate (AfriAlliance). Their proposal for the Planning for Drought (P4D) action group was among four out of 80 applications selected for this round of the project.

The activities of the P4D will be based on key ASSAR research findings on water management for vulnerable communities in Upper West and is focused on promoting dry season farming by enhancing the capacities of vulnerable farmers and local agriculture stakeholders (extension officers and input dealers/marketers). This will be achieved through participatory planning processes to enhance farmers' capacities in efficiently managing water resources, especially during drought and dry spells. The working group also aims to share experiences and knowledge gained with other stakeholders within and outside the Upper West region.

Our work in Lawra and Nandom also revealed that those involved with women's self help groups were a part of the local population whose vulnerability to combined climatic and non-climatic risks was greater than others in the region. This informed the team's priorities for our Grants for Local Adaptation Support work. The aim of this work was to enhance the adaptive capacities of women by introducing them to eco-inclusive businesses, advocacy skills, and business networking, and also to inform them of where and how they can access credit and register businesses.

Another gap emerging from our stakeholder engagements was youth education and empowerment. In an effort to motivate action in this area, we supported Climate Change Innovation through Youth Innovation (CATYI). CATYI promoted dialogue and information exchange on climate and environmental issues through a school competition, and through building students' capacities in identification and communication of local environmental problems. The competition involved three schools and six teams and consisted of oral presentations on thematic areas identified as critical to agriculture and food security. The first and second prize winners paid a visit to the University of Ghana in Accra. The students used the opportunity to share their award-winning ideas with other students, toured the university campus, and visited coastal Accra to see differences in climatic challenges and livelihoods there.

At the national level, the ASSAR team was instrumental in the incorporation of the term 'Research-into-Use' - along with its underlying philosophy - into two national policy documents, namely *The Ghana National Science Technology and Innovation Policy* and *The New Directions Science Plan (2018 - 2028) of the Earth Systems Governance Programme*. In April 2016, we received an invitation to be part of the National Climate Change and Green Economy Learning Strategy Information Session to solicit views on the principles of Green Economy for integration into the National Climate Change and Green Economy Learning Strategy (CCGELS). As part of the Education Committee, we helped shape the document through contributions facilitated by research findings based on the RDS, and stakeholder engagement activities thus ensuring that critical concerns regarding climate education are taken on board, bearing in mind the variable climate and information gaps that exist across the country.

Overall, our targeted work on research for impact in Ghana has led to stronger links between previously unfamiliar stakeholders at the local and district levels, critical reflections about group and individual capacities to effect change with regard to strengthening adaptation, and the introduction of new ways of thinking and working into national policy spheres with a focus on using evidence-based research to boost positive impacts on adaptive capacities of vulnerable populations.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

For the people of Ghana's semi-arid areas, a future with global warming of 1.5°C and higher looks quite bleak, in the absence of adaptation, since local warming will be greater than the global average. Currently, semi-arid regions of Ghana experience about 6-7 months of dryness each year. By 2030-35 this could extend to 8-9 months. This would likely worsen existing vulnerabilities, including poverty and inequality, among different social groups. This would also mean extended hunger periods (the time between stock depletion and the next harvest) from current levels of 5-6 months to 7-9 months. Though this would have dire impacts across the population, the brunt of the burden of this lengthened food shortage would fall largely on women who are tasked with the daily responsibility of feeding their households. As described earlier, with women's already-precarious land tenure status, prolonged drought could lead to women losing more of their current arable farming lands to fully tenured land owners (primarily men). This in turn could increase women's dependence on non-farm resources, such as firewood and charcoal, that come from forests, which could further degrade forest ecosystems. The existing conflicts around water resources we have highlighted in our research would also almost certainly escalate with prolonged periods of drought. Lastly, all of these combined stressors would motivate more and more people to migrate, which would bring new vulnerabilities and challenges to them (e.g., marginalisation from host populations, no social safety nets, and vulnerability to crime) and those who are not able to move (e.g., increased labour burdens, decreased social safety nets, and increased climate-related impacts).

Enhancing and building the capacities of different social groups (e.g., women's groups, farmer groups, religious groups, and youth) to respond to different vulnerability needs in their communities will be critical. These groups represent important social safety nets and points for local resource mobilisation toward adaptation efforts. For researchers, policy makers, and practitioners this will mean incorporating measures of social difference beyond disaggregation only between men and women into seeking more nuanced and contextualised understandings of vulnerabilities and adaptation strategies of different groups. In this vein, policy makers and practitioners need to aim for working with both women and men to challenge the ability of particular social norms and patriarchal traditions to serve the best interests of vulnerable communities in the context of a changing climate. This is especially true of those norms and traditions that prevent women from owning land.

Identifying and empowering community champions for vulnerable communities can be a valuable asset for adaptation and poverty reduction efforts. Providing these champions with needed technical and leadership skills can help drive enthusiasm for practical action on the ground. Investments should be made by government and the private sector in delivering accurate and reliable weather, climate, and adaptation information to vulnerable communities in timely, culturally appropriate, and effective ways. Researchers and practitioners have a role to play in making this happen, as evidenced with our work with the Climate Advisory Resource Centres and the Adaptation Hub mobile app.

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MALI

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID MALI

ASSAR'S FOCUS IN MALI

West Africa's semi-arid regions are home to an incredibly rich history of cultures that have thrived despite highly demanding environmental conditions. Today, people living in these dryland areas face a suite of complex challenges. These are related to increasingly erratic rainfall, rising temperatures, droughts, poor soil fertility and floods, combined with high population growth, gender inequalities, ineffective decentralisation of governance, and reliance on climate-dependent livelihoods.

From 2014-2018, ASSAR's Mali team worked in the Koutiala district, in the Sikasso region, to better understand how these interlinked challenges are impacting people's capacity to adapt to current and future stressors. Our team was made up of researchers and practitioners from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Michigan State University (MSU), l'Association Malienne d'Éveil au Développement Durable (AMEDD), and master's and PhD students from Mali-based universities. The Mali universities included Institut Supérieur de Formation à la Recherche Appliquée (ISFRA), Université des Sciences des Techniques et des Technologies de Bamako, Institut Polytechnique Rural de Formation et de Recherche Appliquée, and Institut Universitaire de Développement Territorial et Local de Bamako. We worked with partners and stakeholders from national to household levels to understand differentiated vulnerabilities, identify barriers to adaptation, and explore what needs to happen to support more effective, sustained and widespread adaptation, including intensification of agriculture.

Key insights

- New ways of conducting climate change research jointly with a wide range of stakeholders are needed. Nuanced information, including that on gender and social difference, should inform understandings on how different people, even within the same household, make decisions, and how policies might affect their ability to adapt in times of stress.

- Building continuous communication and flexible design into policy and governance systems that encompass all involved stakeholders and scales is crucial. This helps to avoid disconnects between national-level policies and local-level needs, and also helps decentralised governance structures become more transparent and effective.

- Alternatives to migration should be explored as adaptation strategies in order to avoid potential risks to the health and wellbeing of migrants and those who stay at home.

- It is essential to recognise the ways in which climatic and non-climatic stressors interplay to create new adaptation challenges and address/include these in policy.

- Participatory processes such as Transformative Scenario Planning are valuable tools for identifying and prioritising issues, building relationships, and fostering learning. These processes should be built into broader stakeholder engagement strategies in order to stimulate meaningful changes.

ABOUT THE RESEARCH

Research priorities

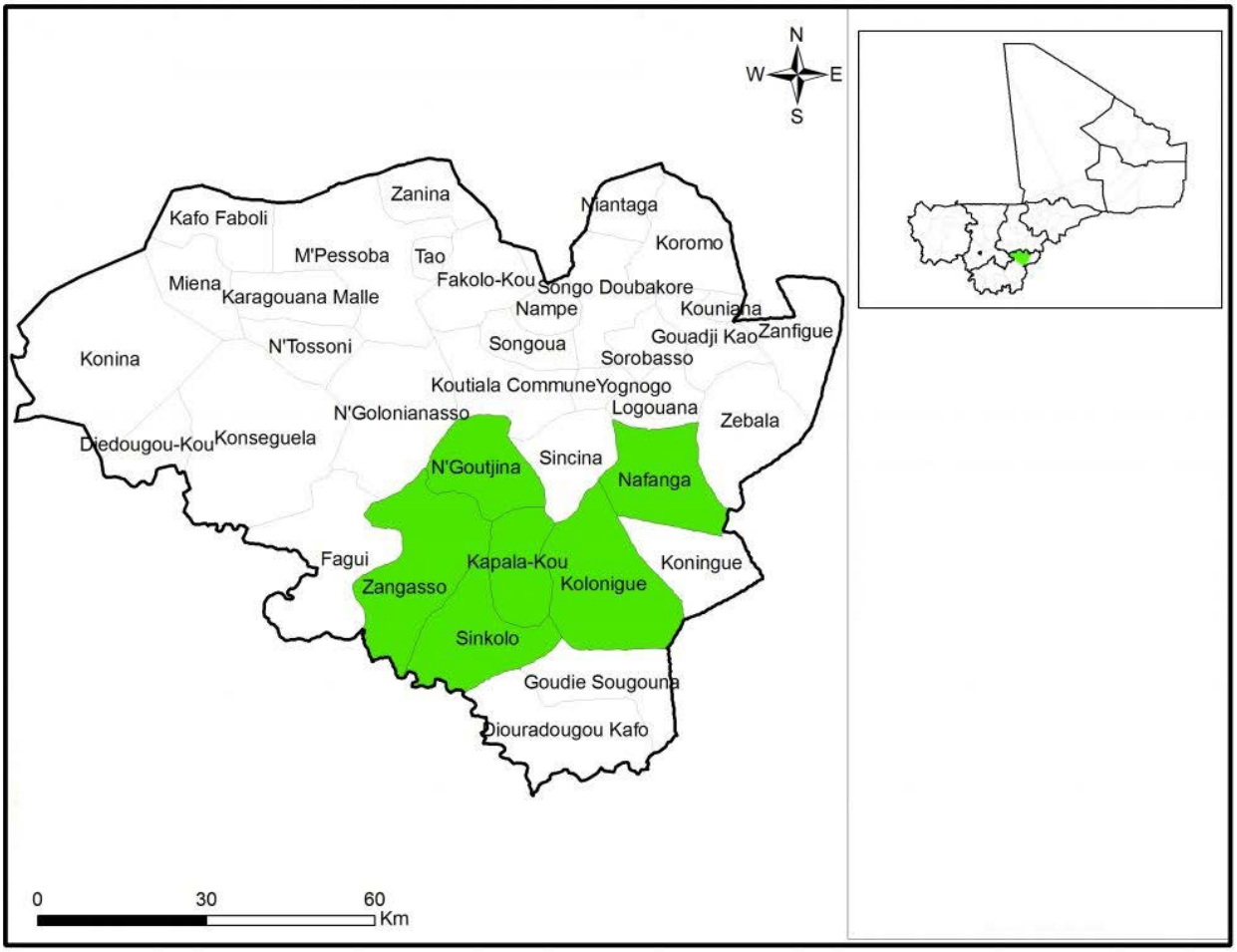
Our work in Mali prioritised agriculture, food security and livelihoods. This was done, from the start, in the context of projections that show agriculture in West Africa undergoing intensification over upcoming decades. This intensification is seen as necessary for meeting national food security needs, and could be enabled by public and private sector investments. We closely examined these priority areas and their links to adaptation with regard to factors such as access to resources (e.g., credit, services, inputs, markets, equipment, infrastructure) and governance (management of different sectors and natural resources, and social and environmental tradeoffs of different policies and actions). This was in line with ASSAR's overarching theme of adaptation under dynamic systems change.

ASSAR investigated how combined climatic and non-climatic stressors affect vulnerabilities and adaptation options among and within different groups of people in Koutiala, Mali. We also investigated barriers and enablers to adaptation relating to:

- Governance of cotton cooperatives
- Migration
- Governance of seed systems
- Gender and traditional household structures
- Transformative Scenario Planning (TSP) as a means to adaptation

Case study sites

We focused on the Sikasso portion of the dry sub-humid band that extends from the Upper West Region of northern Ghana through southern Mali, referred to as the Wa-Bobo-Sikasso transect. The region experiences high exposure to dry spells and has medium-high to high drought risk and strong multi-decadal fluctuations in climate. This transect is also an action site of the CGIAR's Dryland Systems Collaborative Research Programme (CRP) and is home to several projects with the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS).



In the Sikasso region, the district of Koutiala was our main research site. Rainfed cotton production is the core of the agriculture system in this area. Government subsidies for cotton inputs are an essential means for farmers to also obtain inputs for other cereal crops, therefore making this system central to food security. In addition to challenges with obtaining farm inputs, those living in this area also face issues with a lack of social safety nets, high instances of gender inequality, high levels of poverty, degraded natural resources, herder-farmer conflict, and poorly functioning governance structures. Climate change is exacerbating these challenges through impacts including flooding, drought, and extreme temperatures. As governance is a key part of our research, the scale of our stakeholder interactions extended beyond the district level to the national level as well.

Approach

Our research in Mali contributed to answering the consortium-wide ASSAR question: "*What are the barriers and enablers for effective medium-term (2030 and beyond) adaptation, and what responses enable more widespread, sustained adaptation?*". We began by gaining a deeper understanding of current dimensions of risks, vulnerabilities and adaptation responses across and within different groups of people in the study sites and through cross-referencing at the national level. This process started during the Regional Diagnostic Study (RDS) phase of ASSAR. The RDS included a national expert meeting in Mali's capital city Bamako with national policy and decision makers; three focus group discussions in Koutiala with representatives from farmers' associations, women's groups, extension officers, and locally operating NGOs; and finally a set of key informant interviews (KIIs) in Koutiala. The engagements at the district level helped us gain a better understanding of how people at the local level understood and were responding to climate change, and explore the extent to which information from the national level was feeding into actions on the ground. The national level engagement enabled us to better understand the scale of adaptation planning in Mali, and to get a more holistic picture of how national-level policies are intended to play out at subnational levels.

The information gained during that first phase of the project helped us shape the way our research questions were contextualised and approached in the first round of studies conducted by master's and PhD students, and through research done by the senior researchers and MSU partners. Further, recognising the need to make research more participatory, inclusive, and representative of stakeholder needs, especially of the people living in the areas where we worked, we made efforts to develop a collaborative relationship with these groups and incorporate their knowledge and views in the design and analysis of the research process. This is what we called Research-into-Use (RiU). The team provided research evidence that fed into the central dimension of our RiU process, the Transformative Scenario Planning workshops held in Koutiala in the second half of 2016. These workshops aimed to bring diverse groups of stakeholders together in an open setting where they could talk openly and honestly about key challenges for the future of agriculture and food security in Koutiala, and could identify ways to work together to better prepare for those challenges.

Insights gathered during the TSP process continually informed the ongoing student and team research that formed the second phase of our Regional Research Program, which more closely examined how different types of governance, formal and informal structures, instruments, and social norms influence vulnerabilities and responses in different ways. Throughout all stages of the research, special attention was given to recognising how gender and other intersecting categories of social difference shape the vulnerabilities, capacities, and responses of different people.

The knowledge generated in the TSP along with the second phase of research also informed targeted activities at the end of the project that focused on building capacities of local and district stakeholders and strengthening the sustainability and legacy of ASSAR's work in Mali over the preceding five years.

FINDINGS AND RECOMMENDATIONS

TRADITIONAL GENDER AND SOCIAL ROLES CAN RESTRICT ADAPTATION OPTIONS FOR CERTAIN HOUSEHOLD MEMBERS IN TIMES OF STRESS

Cultural norms and traditions can shape the adaptive capacities of different household members in different ways. In Koutiala, climatic and non-climatic stressors intersect with traditional roles based on age and gender to increase the vulnerability of young women, despite their importance to household food security.

In Koutiala, social norms and traditions (a form of intra-household governance) can enable or constrain the way different household members navigate environmental, technological, and food-related challenges. Elder men are responsible for decisions concerning crop production, food allocation, and income generation. The decisions they make in this regard directly influence other family members. For example, they make decisions about what type and quantity of crops will be grown, and what type of inputs (fertiliser) and farming equipment will be used. However, young men and women provide the labour to implement these decisions. Overall, households with higher numbers of productive members are more likely to withstand challenges. At the individual level, however, in times of stress, whether climatic or not, elder men can better overcome many challenges, often by shifting greater responsibility to other family members for whom they make decisions. Stressors such as poor soil or sporadic rain can pose significant environmental challenges to young men working their own land; however, they are still able to work on other farms, or migrate to urban areas to provide remittances for food to the family if the need is great enough.

Elder women are responsible for most decisions concerning food consumption (setting menus, planning the preparation and distribution of food to other family members). However, young women provide most of the labour for these tasks and are primarily responsible for fetching water and pounding millet, two key aspects of food consumption in this system. Young women are also responsible for a great deal of field labour and firewood collection, and in this way are key to food security in the rural Mali farming system. But their control over their own decisions regarding their responsibilities is severely limited by adherence to traditional gender and age roles.

Under times of stress, such as those brought about by climate-change-related drought or extreme temperatures, they have fewer adaptation options than other household members.

In certain parts of Koutiala, especially the village of Koumbri, vegetable production has become a popular alternative to migration, and an important source of diversification along with cotton farming. However, married and young women who are responsible for many household duties are excluded from large-scale vegetable farming, due to the burdens encountered when attempting to carry out both activities. This exclusion is also supported by men in the village who prefer to see their wives in the household instead of in the vegetable fields. Further, people who are not originally from Koumbri are also excluded from large-scale vegetable production because they lack access to sufficient land (which is usually passed on through inheritance).

Recommendations

- Adaptation policies can benefit immensely from the integration of nuanced data that indicate how farmers—differentiated across multiple axes of social, demographic, political, and ecological factors—make decisions on how to adapt to both climatic and non-climatic risks.

- Those working on adaptation policies and planning that target households need to consider the ways in which multiple factors impacting different household members' adaptive capacities interact. This requires looking at how dimensions like environmental risks, capacity to mobilise labour (particularly household productive labour), power relationships, exposure to climate impacts, and sensitivity to those impacts all come together to mean different things for different people. Such information can be used to design plans that increase adaptive capacities of as many family members as possible, but especially the most vulnerable.

- It is critical to integrate both biophysical and socio-cultural issues when addressing food security, and challenge the social norms and patriarchal customs that discriminate against women.

BUILDING FLEXIBILITY, COMMUNICATION AND LEARNING INTO GOVERNANCE STRUCTURES ACROSS SCALES CAN HELP AVOID MALADAPTATION

Disconnects between governance actors and across scales of governance structures are a barrier to adaptation in Koutiala. These disconnects are highlighted through instances of conflict between those in charge of governing natural resources or agricultural systems, and instances where local and district level needs are not being sufficiently recognised and addressed in top-down policies.

In Koutiala, population growth combined with the depletion of pastoral resources shared by several villages is exacerbating the pressure on natural resources. This issue is compounded by multiple layers of governance that involve locally-elected, village and district administrative authorities. Lack of communication and collaboration between these overlapping decision makers is causing the governance of pastoral resources to become more complex. This leads to high-level regulations conflicting with norms and rules at the local level. Part of this complexity is related to the devolution of decision making over natural resources to local authorities, as part of the decentralisation policy, which has made locally agreed bylaws the major tools for management of pastoral resources.

However, social norms are hindering the fair enforcement of these bylaws. For example, one provision states that the stay of transhumant pastoralists in local pastoral areas cannot exceed five days (if the stay is not prohibited, as can be the case in certain bylaws). But some local people hosting these transhumant pastoralists would like them to stay longer to maximise the benefits of the organic manure produced by their animals and to benefit from associated milk production and business opportunities, such us buying or selling oxen at good prices for the next rainy season.

Rules and regulations cannot be effective when designed at one scale while ignoring the conditions at other levels. This can be seen when looking at institutional arrangements in Koutiala's agriculture and food security sector. Here, the Cooperative Law (which governs cotton cooperatives) as well as the Seed Law (which governs seed certification and access) were both designed at national level and have yielded mixed results with regard to anticipated outcomes. The Cooperative Law is believed to degrade social cohesion and the mutual support on which vulnerable farmers rely when facing climatic and non-climatic risks. Similarly, the new seed system is found onerous and prohibitively expensive for farmers. In some ways, the local convention for the management of natural resources established as part of the ongoing decentralised governance policy seems to resonate with local culture but it remains challenged by other stakeholders who do not benefit.

Recommendations

- Mechanisms should be put in place to ensure that user perspectives are incorporated into policies from the early planning stages, and that user feedback on implemented policies is recognised, monitored, and responded to in a timely way.
- Policies need longer-term perspectives to consider potential unintended consequences, who may win or lose as a result of their implementation, and what this means for long-term adaptation to climate change.
- Extension services, together with farmer organisations, need to design social support structures for those who lose out as a result of policies that result in unintended outcomes, such as the new cotton cooperative law.
- Early-maturing, high-yield crop varieties are needed to maintain options for secure food sources. But for the seed system to work, the certification process needs to be affordable and accessible. Similarly, the Ministry of Agriculture needs to create enabling conditions to support smallholder farmers to certify seeds themselves, for example, by developing smaller and closer certification labs.
- Locally agreed bylaws on pastoral resource management should be enforced equally for all pastoralists and farmers by local law enforcement officials and traditional authorities.

ADAPTATION STRATEGIES APART FROM MIGRATION SHOULD BE EXPLORED TO AVOID RISKS TO THE HEALTH AND WELLBEING OF MIGRANTS AND THOSE WHO STAY AT HOME

Though migration is often viewed as a valuable adaptation strategy, in Mali the risks that accompany migration and the burdens placed on those who stay behind are often greater than the rewards. Some villages have found alternatives to migration, such as focusing on vegetable production. These alternatives should be looked at more widely in Koutiala and beyond.

In the village of M'Pessoba, migration is perceived as an adaptation strategy. The village is known for having high pressure on its natural resources and limited income-generating activities because of its geographic position. Migration to traditional mining sites has been gaining in popularity here. Young people who decide to migrate refer to the success stories of migrants who are able to establish their own trade businesses in the village upon return from the mining areas. Successful migrants are able to support their families with inputs and equipment during the farming season. These stories influence young people from the village to look for opportunities in traditional mining areas. However, the harsh working conditions in the mining settlements are a source of disease for many migrants. Many village heads in the area reported that they had to use common resources to treat these cases of disease, mostly to no avail. One village head said, "*the person ends up dying but the resources that they haven't contributed have been used to treat them*." Further, for some young people, what was initially intended to be a seasonal migration turns out to be a permanent move. This can create an increased burden for those who did not migrate, such as elder family members, spouses, and children. Those groups have to take on the responsibilities normally carried out by young men and women.

In the village of Koumbri, small-scale vegetable farming introduced to help people cope with severe drought in the 1980s has now flourished into large-scale production and is well grounded as an adaptation strategy. It is perceived as an alternative to migration to mining sites. Known as a female activity in the beginning, all social groups including older and young men, are now involved in vegetable production. Young men call their vegetable plots ''*Machogo*'' (meaning mine site), in reference to these plots constituting "*gold mines*." One young man we interviewed noted, ''*we don't rent rooms to sleep or expose ourselves to challenging living conditions, such as bad food and dirty water, as is the case in the traditional mining sites*." However, this alternative livelihood is not always accessible to everyone, as women are often excluded from the large-scale production (as explained above) as are migrants to Koumbri.

Recommendations

- Migration can be a valuable adaptation option, but it should not be seen by policy makers or those working on adaptation as an *a priori* solution as it can come with many risks.

- Extension officers and local planners should seek to learn about smallholder vegetable production and conservation of produce in other villages in Koutiala to see if this could be promoted to increase adaptive capacities and food security and as an alternative to migration, which can bring about new sets of risks.

ADAPTATION TO CLIMATIC STRESSORS IS IMPORTANT, BUT IT IS EQUALLY IMPORTANT NOT TO OVERLOOK NON-CLIMATIC FACTORS THAT AFFECT PEOPLE'S LIVES AND ABILITY TO ADAPT

Climatic changes are not the only stressors that factor into adaptation needs in Koutiala. Urbanisation, changing social structures, and governance of resources are also impacting the abilities of different people to adapt. Moreover, sometimes adaptation strategies can bring about unanticipated non-climatic changes that can create new challenges that people must also cope with.

In the village of Zangasso, climatic changes (e.g., declining rainfall) are negatively affecting fishing resources. However, a number of combined non-climatic changes are also having a large impact on the fishery and the ability of people to build their livelihoods around it. Changes in who is using the fishery are complicating its management. For example, beyond the traditional ethnic groups known to be fishers by profession and through generations, fishing is now practiced by all ethnic groups in the village including Bambara and Minianka, who are traditionally known to be farmers. With this shift, the division of labour along ethnic lines is becoming blurred. At the same time, climatic changes are combining with other factors that are degrading the fishery, including the obstruction of water sources resulting from erosion and the construction of new urban infrastructure (e.g., roads and bridges). This is also contributing to traditional fishers, the Bozo and Somono, converting to farming.

The entry of new groups of fishermen, who are introducing prohibited fishing tools and techniques, is contributing to overfishing. These changes are also making it challenging to enforce the traditional governance of water resources that involve the prohibition of fishing during the reproductive periods of fish. Combined, these factors are affecting the viability of fishing as an alternative income-generating activity, and form of adaptation, for local people.

In another area of Koutiala, farmers have been engaging in lowland farming where small-scale irrigation can be used as a way to adapt to climatic changes impacting their farms. Along with this adaptation strategy, though, have come new and unforeseen challenges. For example, an invasive weed species has emerged in areas where new irrigation facilities are built for repetitive rice production.

This has created a situation where an adaptation strategy aimed at coping with climatic changes has produced a non-climatic stressor that now also needs to be dealt with.

Additional insights on agricultural intensification and ecosystem services were gained through documenting the contribution and importance of agro-biodiversity to climate change adaptation in Koutiala. This work assessed (including through farmers' perceptions) the impact of climate change and variability on agro-biodiversity and its services in rural Mali, and modelled the impact of harnessing agro-biodiversity on household vulnerability in its semi-arid areas. This work found that thinking of agrobiodiversity-based (or ecosystem-based) versus other adaptation practices/strategies as mutually exclusive might be misleading and not tell the full story on the ground. Agrobiodiversity-based adaptation practices always occur in combination with other practices. Further, both climatic and non-climatic risks drive adoption of agrobiodiversity-based practices.

Recommendations

- Policy makers and other decision makers need to take a systems view when thinking of adaptation, as pursuing adaptation in one area may create unforeseen challenges in another. Continuous learning and adjustment of adaptation planning is required.

- Climatic changes are combining with changing social traditions and urbanisation in unpredictable ways. This should be recognised when designing new policies or programmes aimed at natural resource governance or adaptation.

- While introducing new and more climate-resilient crop varieties is an important step toward sustained adaptation, the importance of traditional varieties for maintaining biodiversity and providing broader adaptation options should not be ignored.

- A holistic approach is crucial for taking stock of the synergies created through integrating multiple practices/strategies (agrobiodiversity/ecosystem-based) across scales. The effectiveness of these synergies in reducing vulnerability to risks or improving adaptive capacity needs further investigation.

TRANSFORMATIVE SCENARIO PLANNING IS A USEFUL TOOL FOR BUILDING RELATIONSHIPS AND LEARNING, BUT NEEDS TO BE PART OF BROADER STAKEHOLDER ENGAGEMENT TO STIMULATE LONG- TERM CHANGES

TSP is a participatory process of stakeholder engagement that creates unique opportunities for bringing diverse, sometimes conflicting, stakeholders together around serious shared challenges. It helps people imagine the ways in which the future can be changed, and to identify leverage points to facilitate that change. TSP provides a valuable space for learning, and building networks and relationships, but in order to bring about meaningful adaptation changes it needs to be part of a larger engagement effort.

We convened TSP workshops in Koutiala that brought together 27 stakeholders from Koutiala and Bamako. Participants included district officials, village leaders, NGO staff, public servants (extension officers, planning officers, forest agents and meteorological agents), farmers, researchers, and the media. Discussions centered on three key questions: What is the desired future for agriculture and food security in the district of Koutiala? What can and/or must the participants do individually and collectively to achieve the desired future? How could ASSAR's research help to achieve the desired future?

ASSAR researchers and stakeholders approached these questions together by building scenario stories to imagine what might plausibly happen to Koutiala's agriculture, natural resources, and food security in the future (up to 2035). More importantly, scenario team members were able to critically reflect on what needs to happen in the present to better prepare for that possible future.

Scenario team members identified access to agricultural land and access to water for irrigation as the main drivers of food and agricultural security in Koutiala. These drivers were then used to build four scenarios of the future. These scenarios informed the second TSP workshop where the participants developed "Vision 2035," a shared outlook on what challenges need to be targeted and key actions that could improve them. The Vision 2035 statement reads, "By 2035, strategic investments will target agriculture and natural resource conservation to ensure food security and improve household income in the Koutiala district. New, updated training sessions will allow communities to make better use of the scarce water resources and variable rainfall in the region. This will be combined with improved rainwater and soil management and the promotion of improved seeds." Actions that participants felt would help achieve this vision included developing partnerships, training farmers on sustainable rainwater management, piloting new rainwater management techniques, and diagnosing barriers to adoption of improved seeds. These identified actions later informed follow-up RiU and capacity building activities in Koutiala.

After the close of the workshops, further analysis found that while scenario workshops provide a valuable and unique interaction space for learning and building networks and relationships, scenario processes alone may not be enough to stimulate transformation around key adaptation challenges. The actions identified for helping to achieve Vision 2035, though important for improving adaptive capacities of those in Koutiala, were incremental and will likely not be a sufficient long-term solution for ensuring future agriculture and food security. These long-term solutions need a broader stakeholder engagement effort that targets the root causes of key challenges.

Recommendations

- Inclusive and participatory methods can help more comprehensively identify sources of risk and their socially differentiated impacts, compared to traditional "expert-driven" models. Such methods are a valuable addition to methodologies for analysing climate risk. Scientists and policy makers would do well to consider dynamic interactions between drivers of risk when assessing the resilience of agricultural systems to climate change.
- Scenario planning exercises, and consultative processes generally, need to be incorporated as one component of broader and deliberate stakeholder engagement, learning, and evaluation processes. Such processes need to focus on targeted actions that aim to change and improve root causes for key challenges such as governance, market systems, and cultural traditions.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

The TSP workshops in Koutiala were central to our RiU and capacity building work in Mali. They built a strong foundation of communication and collective visioning that helped identify more relevant and legitimate actions aimed at building stakeholders' adaptive capacities. In order to build on the development of Vision 2035, a cross-border exchange visit was organized for TSP participants to a neighbouring area of Burkina Faso where the villagers have extensive experience in these practices, especially in the construction and use of runoff basins for water conservation.

This work was facilitated by the ASSAR Scenario Based Capacity Building (SBCB) grants and by Oxfam. The exchange visit allowed community members to learn from their peers by being exposed to new experiential knowledge from Burkina Faso. The replication in Koutiala of what was learned in Burkina Faso is expected to create room for capacity development around the practical needs on soil and water management in the district. Beyond the 10 participants who took part in the cross-exchange visit, all the TSP participants were trained on the practices of soil and water management as a follow-up to the visit to Burkina Faso. After learning about the criteria for selecting appropriate sites to construct runoff basins for supplemental irrigation, participants identified two suitable sites to construct pilot basins in Koutiala. Though the construction of these basins in Koutiala, and the capacities built with the exchange, are not sufficient for meeting overall long-term adaptation needs, some short-term ones have been addressed. The process helped to build skills, relationships, and knowledge, and therefore boosted adaptive capacities.

Based on the research on household-level adaptive capacities highlighted above, and discussions in our TSP workshops, we also recognised a need for strengthening the adaptive capacity of young women, who are the most vulnerable to climate change because of their limited access to education, financial services, and assets.

The team used an ASSAR Grant for Local Adaptation Support (GLAS) to identify windows of opportunity for young women's businesses to expand their access to resources. The project team proposed that creating reliable market opportunities for young women could inject much-needed income into some of the poorest food-insecure rural households and increase their resilience. A group of 14 women were selected from seven villages in Koutiala for a workshop on exploring ways to improve their living conditions through the increase of business revenue across the agricultural value chain. The workshop discussions identified vegetable production and the conservation of produce to improve access to markets as cross-cutting issues among the seven villages. The meeting was followed by an exploratory trip to the seven villages to meet with young women together with the village councils and heads of villages. The aim was to assess the level of organisation, cohesion, and other criteria for eligibility to host a test strategy for promoting vegetable production and conservation of produce. This strategy involves partnership building, extension services, and exploring broader funding options with financial institutions.

We will continue working with the Association of Awakening to Sustainable Development (AMEDD), Oxfam, and other partners to ensure that progress made through the activities initiated with the SBCB and GLAS grants will not be lost, and that instead these groups can continue working with those in Koutiala and beyond to build on lessons learned and extend successful dimensions of this work to other areas.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

The findings outlined above are important for the future of adaptation in Mali because they identify important challenges that will have to be overcome in order to attain food and livelihood security in the face of a changing climate.

Rapid climatic changes, ongoing attempts at decentralised governance, and entrenched cultural norms are combining in ways that will make adaptation difficult without substantial and meaningful changes – especially for groups with limited power and agency to determine their own decisions and livelihoods. Such changes are especially necessary for more inclusive and participatory policy design processes and for increasing the rights and decision-making power of women and marginalised groups. ASSAR's research, and its RiU and capacity building dimensions, have built on the work of others to continue sowing seeds for change aimed at overcoming barriers to adaptation, but this progress needs to be sustained through continued research, practice, and policy actions.

Our findings provide certain concrete (though not simple) recommendations for ways that these challenges can be addressed. Overall, we emphasise the need for a shift away from conventional top-down and expert driven policy making approaches toward flexible approaches that are built on continuous communication and learning across scales and actors, with specific focus on making these processes more representative. Current decentralisation efforts are not going far enough. There should be renewed energy put toward inclusion of previously marginalised voices, especially those of young women. Participatory processes can be used for capturing diverse perspectives and needs, and building new and sustainable relationships across organisations and institutions for testing, monitoring, and expanding promising adaptation solutions.

In the short term, certain concrete actions, such as building affordable seed certification facilities near to farmers, promoting small-scale vegetable production in cotton-dominated villages, and supporting water harvesting practices, can contribute to strengthening adaptive capacities in the face of sometimes unpredictable climatic changes.

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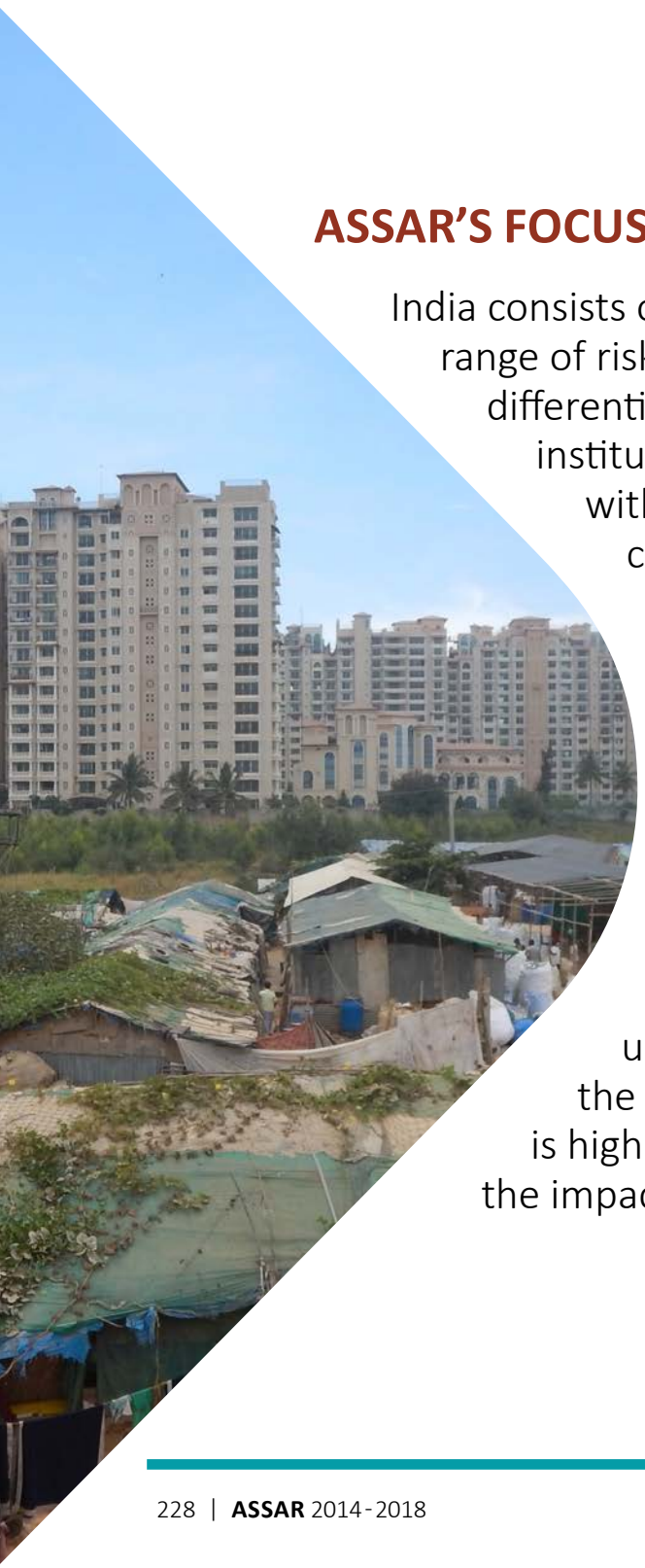
KARNATAKA, INDIA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID KARNATAKA, INDIA



ASSAR'S FOCUS IN KARNATAKA, INDIA

India consists of a diverse set of ecosystems with a range of risks, climatic and non-climatic exposures, differential vulnerability profiles, and various institutional regimes. The country is complex, with multi-hazard environments and climate-change hotspots. Negative impacts on key rural production systems like agriculture and forestry are already evident, and a range of losses and impacts across agricultural, water, and forest-based systems is projected for the future. Major livelihood transitions are expected to take place along the rural-urban continuum, coupled with increasing urbanisation. A significant proportion of the population lives in extreme poverty and is highly vulnerable to both everyday risks and the impacts of extreme events.

The country also faces serious institutional and governance challenges, compounded by contested growth dynamics, rural-urban migration, and fluxes in the historically-established formal and informal sectors. These dynamics will combine to create pockets of risk where concentrations of historical and emergent challenges are amplified by climatic variability.

From 2014-2018, ASSAR's Indian Institute for Human Settlements (IIHS) team worked in urban, rural and peri-urban study sites in the Bengaluru district, and rural sites in Gulbarga (north Karnataka) and Kolar (in close proximity to Bengaluru) to better understand their existing climate and development challenges. Made up of a team of senior researchers, early career researchers, and post doctoral fellows from IIHS, and scientists from the Indian Institute of Tropical Meteorology (IITM), Pune, we worked with stakeholders across all levels: state, non-state, household, and community to understand what makes people vulnerable to climate change, what the barriers to adaptation are, and what could enable more effective, sustained and widespread adaptation to climate change.

Key insights

- To deal with differential vulnerability across the rural-urban continuum, development policies and climate change adaptation interventions need to respond to the needs and dynamic aspirations of the most vulnerable. Urban development policies require a deeper understanding of informal settlements, including dimensions of differential vulnerability, particularly across the multitude of social categories present, the various actors involved, and the roles of social networks, local associations, and social cohesion. Additionally, viable employment options in rural areas should be developed through the strengthening of rural livelihoods and/or the natural resource base upon which these livelihoods depend.

- Migration drivers, processes, and outcomes are complex, differentiated, and span the rural-urban continuum. Migration does not necessarily lead to improved wellbeing, and might have trade-offs for some members of the household. The increasing volumes of migration mean that policy makers need to reimagine adaptation as beyond-local, and develop strategies that can, on one end, make agriculture more viable, and on the other end, provide safer and more inclusive conditions for migrants in urban areas.

- Urban and regional governance in India is fragmented and weak, and there is little engagement with climate policy. Local governments lack personnel and technical capacity, and have not sufficiently leveraged the presence of a range of domestic and international non-state actors. The relationship between state and city government remains top-down, with decision-making occurring at the state level, and local agencies responsible for implementation. The largest challenge, however, is to build support for climate action within state and local government officials.

- For decision makers and practitioners in semi-arid regions to make robust and informed decisions it is imperative that they take into account the available, legitimate and reliable knowledge that supports fine-scaled, contextualised, and robust adaptation responses. To facilitate knowledge transfer and local-level adaptation, knowledge brokers should be recognised and formally supported, and the effectiveness of extension services should be improved.

- Preserving functioning ecosystem services within the urban fabric is crucial for climate resilience planning. However in Bengaluru, these ecosystem services are being challenged by unplanned, haphazard urbanisation. Promoting ecosystem-service-based stormwater-management practices, and exploring alternative strategies that can enable stormwater attenuation or retention are necessary.

ABOUT THE RESEARCH

Research priorities

Our research priorities were guided by an evolving national and sub-national context that is characterised by incremental and unplanned urbanisation, skewed structural transformation, and stressed rural production systems. These characteristics are compounded by huge dependency, particularly in semi-arid regions, on the Indian summer monsoon. Our research was further guided by ASSAR's overarching research framework that was designed to examine climate adaptation challenges through research streams of social differentiation and gender, governance, dynamics of ecosystem services, and knowledge systems.

Our research for the Karnataka semi-arid region focused on: (1) understanding the drivers of differential vulnerability to better address its root causes; (2) understanding current and future climate variability, non-climatic risks, and their interactive impacts; (3) understanding the local and sub-regional institutional imbalances that intensify existing inequity in accessing public services, natural resources, knowledge and power; and (4) understanding the dynamics of livelihoods, and migration as an adaptive strategy along the rural-urban continuum. Our broader aim was to influence balanced regional development, and mainstream climate change into development planning.

Case study sites

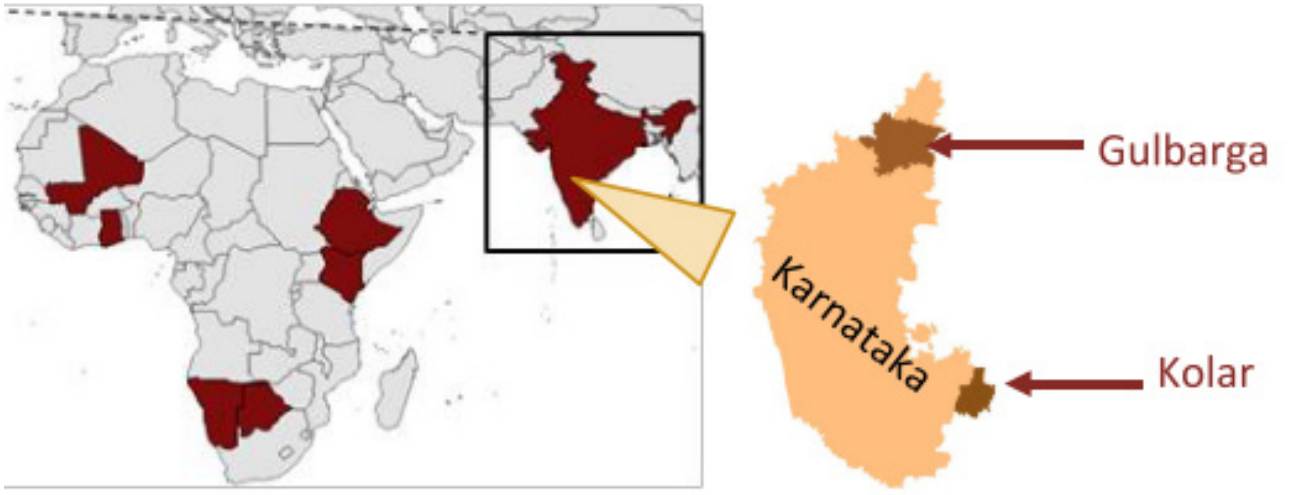
Karnataka is a predominantly semi-arid state in South India. Within Karnataka, we studied two districts – Kolar and Gulbarga – which are among the least developed districts in the state, and face severe water scarcity, recurrent droughts, and increasing natural resource degradation. Kolar falls in the southern part of the state and is relatively more developed on account of its proximity to the state capital, Bengaluru, while Gulbarga, part of North Karnataka, is recognised as a 'backward district', and performs poorly on most human-development indicators.

We also studied distinct urban, rural, and peri-urban areas in the Bengaluru region, which is characterised by rapid urbanisation and unplanned growth. We observe increasing population trends here due to in-migration, since Bengaluru acts as a magnet for livelihood opportunities for people in surrounding areas and regions. In addition, large-scale infrastructure and development projects are shaping the spatial, economic, and cultural landscape of Bengaluru. We also find an increasing trend in informal settlements in the city; these settlements are particularly vulnerable due to their location, and lack of access to basic services such as water supply and sanitation. There is also an increased dependency on marginal work within the informal economy. The natural resource base is limited and fast depleting, and structural gender-based inequalities exist. A multiplicity of city planning agencies, and fragmented governance processes complicate development and climate response, and skewed public policy (inadequate structural transformation) does not adequately address multidimensional poverty and both climate and non-climate induced vulnerabilities.

The ASSAR India study areas at IIHS are regionally spread across the Bengaluru sub-region in Karnataka (which includes Kolar and Gulbarga districts in Karnataka).

Approach

Our research in Karnataka was guided by ASSAR's overarching research framework (that enabled comparative regional and cross-regional research). Within that, we used a mixed methods approach to collect data, which included a structured household survey, participatory focus group discussions (FGDs), multi-stakeholder key informant interviews, and in-depth life histories. The main driver of our research was to have a meaningful impact in the realm of climate policy and practice in the region, particularly in the context of the most marginalised population. It was, therefore, imperative for us to get buy-in from all key stakeholders (state, non-state, and the most marginalised population) regarding key challenges in the region, so as to orient our research agenda towards those challenges. The methods helped us explore risk and response portfolios at three scales: settlement-level, household-scale, and intra-household scale.



Our mixed method, multi-scalar approach allowed us to deliberate on the circumstantial drivers of vulnerability at the local scale, going beyond the immediate, observable impacts to more structural drivers of vulnerability. We also emphasised a gendered approach to the planning and practice of data collection and analysis, and paid special attention to issues of marginalisation, intersectionality, and the many forms of social differentiation. We supplemented our research methods with detailed literature reviews, and analysis of relevant grey and policy literature.

We constantly endeavoured to orient our research to the needs of the policy makers and the vulnerable communities, as guided by ASSAR's Theory of Change. To do this, while formulating our research design and setting up relevant research processes, we did numerous scoping visits to sites of relevance, and conducted interviews and held dialogues with key informants. We subsequently held iterative processes to get thematic and location-specific feedback from peers and experts. We also gave regular research updates to policy makers through our structured, theme-based IIHS policy dialogues, and – where appropriate – adjusted our work plans in response to their feedback. We also consciously engaged with grassroots organisation (MYRADA Gulbarga and MYRADA Kolar) to be co-participants in our research in the rural sites of Karnataka, in order to facilitate local research, and leverage on long-standing regional relationships.

We also used participatory processes such as Transformative Scenario Planning (TSP) to bring together diverse stakeholders such as government officials, lake-citizen groups, and NGO representatives to facilitate initial dialogue and enable further collaborations. As an offshoot of this process, we investigated if TSP can be used as a precursor for developing adaptation pathways.

Capacity building was an important element in IIHS ASSAR research. We focused on building interdisciplinary research capacity amongst early-career researchers (within IIHS) coming from varied disciplines through participation in several short courses on gender, and climate information for adaptation, and by using various opportunities within ASSAR (e.g., Small Opportunities Grants). We were also able to build external capacities through multiple platforms, channels and engagement processes (e.g., ASSAR's Grants for Local Adaptation Support, TSP, IIHS institutional engagement processes, project stakeholder consultations, and strategic partnerships). We were also able to use our research process and findings to build capacity to mainstream climate concerns in development planning, either through training courses (e.g., IIHS course on vulnerability assessments), or through dialogues with strategic partners like IITM, to integrate climate science with vulnerability and adaptation planning. While internal capacity building processes enabled rigour in our research, these external processes were a constant source of validation of our research, and presented opportunities to influence policy processes.

Finally, we also produced and disseminated multiple research products such as information and policy briefs, and used our partnerships with key policy and science-based stakeholders like IITM to help us engage closely with the science-based policy process in India.

FINDINGS AND RECOMMENDATIONS

ADAPTATION INTERVENTIONS NEED TO RESPOND TO THE NEEDS AND DYNAMIC ASPIRATIONS OF THE MOST VULNERABLE

a. In the rural context of the semi-arid regions of Karnataka, risks from environmental change, climate change, and increased climate variability are crucial but are mediated through existing structural conditions such as poor market linkages, inadequate credit, low asset bases, and caste- and gender-based differences.

Vulnerability in semi-arid regions is characterised by a range of interacting social, economic, political, and environmental changes, which impact agricultural and non-agricultural livelihoods. This vulnerability is exacerbated by inherently low agricultural productivity, rapid and increasing natural resource degradation, inadequate governance responses to aid livelihood diversification and adaptation processes, and an overall poor performance on development indicators due to economic marginalisation. Climate change is projected to exacerbate these problems, pushing semi-arid systems to cross biophysical thresholds, with long-term implications on local livelihoods and agricultural sustainability. Extant vulnerability and adaptation research has typically focussed on a static, location-specific understanding of risk and response; yet risk management strategies traverse multiple locations through, for example, higher human mobility and changing social norms.

In this context, we attempted to understand the dynamic reality of risks and responses in the context of climate change, by examining livelihood responses and their outcomes at household, community, and sub-national scales in rural Karnataka. We aimed to unpack household risk portfolios and assess their long-term implications on household wellbeing and systemic sustainability.

We found that people are responding to multiple risks, of which environmental changes are a significant part. However, these responses are not necessarily climate change adaptation strategies. Further, although many interventions are helping build generic capacity to deal with non-climatic risks and alleviate development deficits, they may not be building specific adaptive capacity to climate change. In some cases, in fact, interventions can be maladaptive in nature.

Furthermore, risk accumulates over time with recurrent drought, natural resource degradation, and deteriorating common pool resources being significant drivers of biophysical vulnerability. The nature of risks also changes over time with increasing reports of drought incidence and dry spells. When seen through a livelihoods lens, these environmental risks interact with institutional risks (e.g., pervasive agricultural policies favouring irrigation-based farming), financial risks (e.g., reliance on moneylenders in the absence of adequate credit facilities), and social risks (e.g., women unable to travel long distances for work) to shape household vulnerability.

Responses to risks are also multi-scalar in nature: policy shifts such as diesel subsidies or promotion of organic farming at the state level, percolate into household response strategies, with negative or positive outcomes. Across time, some responses (e.g., digging farm ponds, shifting to water-intensive cash crops) are highlighted as having potentially maladaptive outcomes. This calls for growing awareness about trade-offs that a particular intervention entails, and a careful pre-project exploration of potential maladaptive outcomes becomes necessary and desirable.

Some responses are changing either in type (shifting away from farm livelihoods) or in nature (migrating farther away, into non-agriculture wage labour), demonstrating how livelihood portfolios are increasingly dynamic and complex. Critically, these changes in responses also signal changing aspirations, especially among rural youth.

b. Climate action and priorities in Indian cities is a function of city development trajectories, their governance and political contexts (at city, state, and national levels), and their emerging patterns of socioeconomic inequality. A better understanding of how structural vulnerability and climatic impacts intersect would lead to better responses and climate-resilient outcomes.

The impacts associated with climate change differ significantly among different social groups, falling disproportionately on the working classes and the marginalised, and reflecting highly nonlinear relationships between climate change and its outcomes. Understanding the causality and structure of vulnerability helps to focus on the larger social, political-economic, and structural variables that shape capacity and underpin livelihood security. Within cities, the processes of urbanisation produce several forms of social, political and economic inequality, and contribute to creating multiple forms of vulnerability.

It has been argued that climate change is not just impacting the city but is produced through the city, exacerbating uneven patterns of development and urban inequality.

We found that the drivers of vulnerability are different in rural, urban and peri-urban areas, and moving away from rural areas does not necessarily make people less vulnerable. In fact, people enter new risks in urban settings. These risks are usually different for inter- and intra-state migrants, and climate-related vulnerability directly impacts their material and subjective wellbeing. For example, in urban areas, localised flooding, poor access to basic services, and insecure livelihoods are key risks. In addition to climate drivers, structural drivers of vulnerability directly impact people's wellbeing. These drivers are partly driven by historical marginalisation, the political economy of development pathways, and poor planning.

Recommendations

- Strengthening institutions to support household-level autonomous responses such as crop diversification, or using water-saving technologies, is critical. We see some examples of early successes such as subsidising drip irrigation in Kolar, or providing drought-tolerant seed varieties. However, these interventions need to be sustained, inclusive, and focused on building upon local, tested solutions instead of replacing them.

- While climatic risks are important, and increasingly perceived as crucial for rural livelihoods, they are experienced in conjunction with non-climatic risks. Thus, a focus on perceived risks (e.g., increasingly-erratic rainfall, higher daytime temperatures), is a critical starting point for adaptation interventions.

- Additionally, risks change over time and space. Current vulnerability assessments – the basis on which adaptation interventions are built – and adaptation interventions, tend to overlook or inadequately account for this dynamic nature of risk. Therefore, we need assessments that acknowledge and incorporate the messy, dynamic nature of vulnerability, tracking risks and responses over time, to understand how they shape household and system-level pathways. In our work, we use life history interviews and participatory timeline mapping in gender-differentiated groups as ways to capture this temporality.

- Building both generic and climate-specific capacities and considering spatio-temporal scales can result in better risk management. Interventions to build specific capacity would involve: forward-looking actions such as using climate information to shape appropriate cropping regimes; incentivising mixed crop-livestock systems to spread risk (as opposed to mono-cultivation of cash crops); institutional reform where local governance structures are flexible in the face of increasing climate vulnerability; and the provision of safety nets for responses spanning the rural and urban, such as migration.

MIGRATION DRIVERS, PROCESSES AND OUTCOMES ARE COMPLEX, DIFFERENTIATED, AND SPAN THE RURAL-URBAN CONTINUUM

Migration does not necessarily lead to improved wellbeing, and might have trade-offs for some members of the household. The increasing volumes of migrants mean that policy makers need to reimagine adaptation as beyond-local, and develop strategies that can, on one end, make agriculture more viable, and on the other end, provide safer and more inclusive conditions for migrants in urban areas.

Our study of migrants in multiple contexts — urban, rural and peri-urban — offered a unique opportunity to understand different forms and patterns of human mobility, as well as the drivers and outcomes of migration across different contexts and different social groups. By considering migration into urban Bengaluru, land-use change and migration patterns in peri-urban Bengaluru, and migration and commuting from rural Kolar and Gulbarga, we were able to explore how migration shapes adaptive capacity at household and intra-household levels across the rural-urban continuum.

Within Karnataka, migration is a key livelihood and response strategy. Its drivers are primarily economic, but reinforced by climatic risks that have disrupted traditional farm-based livelihoods. The prospect of better livelihoods, driven partly by aspirational changes and partly by a lack of opportunity in rural areas, is the major driver to outward migration from the rural areas. The nature of migration depends on the social location of gender, land-holding size,

caste, religion, and accessibility of villages to urban centres. Short-term, seasonal, and long-term migration patterns differ across gender and social groups. Women's mobility for work is restricted, while members of disadvantaged groups are more likely to migrate out due to their lower endowment of landholding.

Although the wellbeing and adaptation outcomes of migration vary due to specific circumstances, permanent migrants with an endowment of human and social capital are able to attain a better standard of living over the long run. However, in the short term, migrants face considerable challenges in urban areas, primarily due to the difficulty of accessing critical infrastructure and public services. Due to the precarious nature of their habitations and settlements, migrants are also prone to various environmental hazards.

Migrant households fare worse in terms of asset ownership. They are therefore likely to report lower quality of life and poorer adaptive capacity to deal with disruptions to their livelihoods. However, there is no significant difference between the income of migrants and non-migrants. The differences in wellbeing outcomes are primarily due to migrants' inability to access infrastructure services at the destination.

Due to the lack of recognition of their domicile status, migrants often lack access to critical social security services and entitlement, most significantly, the Public Distribution System that offers access to food grains at subsidised prices. Migrants also score low on indicators of subjective wellbeing. Migrant wellbeing can vary from surviving, erosive coping, positive coping, and possibly adaptive.

Recommendations

- When considering response strategies for climate-induced risks, a continuum approach allows for a systems perspective that connects rural, peri-urban and urban areas. In rural areas, key issues to address are changing aspirations and climatic stressors interacting with social marginalisation, while in urban areas it is poor planning and inadequate safety nets for the most vulnerable. In the peri-urban, overlapping and unclear jurisdiction, and rapid land-use-change interactions are critical. Overall, actions on these aspects must be taken simultaneously to enable sustainable and just adaptation. In some cases, however (e.g., in peri-urban Bengaluru) we see examples of changing gender norms demonstrating how moving along the continuum can change norms and, consequently, change household response strategies.

- In addition to focusing on structural drivers of vulnerability such as caste or gender-based differences, and their related outcomes, climate-induced risks and their interactions with non-climatic risks must be addressed. For urban development policies to be effective and inclusive, they require a deeper understanding of the nature of informal settlements — dimensions of differential vulnerability, particularly across a multitude of social categories, the various actors involved, and the roles of social networks, local associations and social cohesion.

- Migration remains a key livelihood strategy in semi-arid regions, either due to intensification of climate signals or through changing aspirations, and this must be recognised within state policies. It appears that strengthening of adjacent city public services and improving accessibility to social security services and their entitlement would be able to improve wellbeing outcomes for all kinds of migrants.

BUILDING CLIMATE RESILIENCE AND ENHANCING ADAPTIVE CAPACITIES REQUIRES GOVERNANCE COORDINATION AT MULTIPLE LEVELS

Urban and regional governance in India is fragmented and weak, and there is little engagement with climate policy. Local governments lack personnel and technical capacity, and have not sufficiently leveraged the presence of a range of domestic and international non-state actors. The relationship between state and city government remains top-down, with decision-making occurring at the state level, and local agencies responsible for implementation. The largest challenge, however, is to build support for climate action within state and local government officials.

Urban regions across the world are emerging as critical actors in dealing with climate change. As India prepares for a large-scale urban transition, with the urban population projected to almost double by 2030 as compared to 2010, current and future urban populations will become increasingly vulnerable to climate change. While growing interest in climate policy and its resulting initiatives are welcome, the larger challenge in the Indian context is perhaps the creation of an institutional architecture to enable the adoption and implementation of the adaptation and mitigation strategies that are being developed at the national scale. Focusing on Bengaluru, and Chennai — and using institutional mapping, stakeholder interviews, and literature reviews — we were particularly interested in understanding how a variety of urban stakeholders (state and non-state) participate in, and influence, climate governance across scales and sectors in India.

While there are a range of efforts across multiple scales and sectors underway to tackle climate and other environmental challenges, these are often piecemeal and not coordinated. Regional governance is fragmented, as institutional structures do not translate/replicate across government levels (national to sub-national, state/regional), with sub-optimal outcomes. The governance challenge is more acute in the context of climate-specific governance, as climate is a subsidiary of existing structures, processes and mechanisms, and does not get the attention needed to allow it to be mainstreamed or respond efficiently. Furthermore, potential opportunities for multi-level governance across state/non-state actors, and different levels of government do exist, but these are not leveraged.

There is also no systematic approach at the urban or regional scale to specifically address questions of adaptation or mitigation. Instead most environmental policy is broadly framed and addresses questions of sustainable development rather than focusing specifically on climate change. In the absence of an adequate institutional governance framework, the long-term sustainability of climate action in the Indian context is called into question.

Recommendations

- There remains a perception within state and city agencies that climate change is beyond their mandate. This is an issue that needs to be resolved by national governments. However — in the absence of city or state government agencies taking on a coordinating role for climate action across different scales of government and different sectors — this role is increasingly being taken on by non-state actors such as donor agencies or community-based groups. The challenge with this is that their influence is limited, and often very focused on a particular problem or sector. We recommend a stronger coordinating agency within the sub-regional administrative structures which could help coordinate climate action and provide convergence across multiple sectors and actions. Needless to indicate, such an agency should have a political, financial, and legislative mandate.

- Urban governments and their agencies have the potential to play an important role in mobilising climate action at the city-scale. There are isolated examples of Indian cities and individual champions that are beginning to take action on climate-related issues (e.g., Surat), but these remain few and far between. There are also opportunities to engage with several non-state actors such as local academics, community organisations, and private sector entities to help fill the technical and knowledge deficit within government, and to help mobilise effective climate governance.

EFFECTIVE ADAPTATION IS UNDERPINNED BY THE EFFICIENT PRODUCTION, INTEGRATION, TRANSFER, AND USE OF RELEVANT KNOWLEDGE

For decision makers and practitioners in semi-arid regions to make robust and informed decisions it is imperative that they take into account the available, legitimate, and reliable knowledge that supports fine-scaled, contextualised, and robust adaptation responses. To facilitate knowledge transfer and local-level adaptation, knowledge brokers should be recognised and formally supported, and the effectiveness of extension services should be improved.

A key barrier to managing current and future climate risks relates to the availability of accessible, reliable and relevant weather and climate information. Despite advances in science, and the increasing availability of climate information, examples of long-term climate information being used in decision making are hard to find. While weather advisories and seasonal forecasts are used to plan for and manage short-term risks, long-term information predominantly serves only a steering function. The difficulty of integrating long-term climate information into decision-making and policy processes is largely due to the uncertainty of the information, the mismatch of fine-scale information needs and coarse-scale climate projections, mistrust in the mode of information delivery, and a lack of institutional capacity to deal with long-term climate risks. However, not considering long-term climate information in present actions can have long-term and potentially maladaptive implications.

One way of better integrating available climate information into local-level practice is through knowledge brokers. Through our research on four knowledge brokers (Tarun Bharat Sangh in Alwar, Rajasthan; North East Network in Phek, Nagaland; Timbaktu Collective in Anantapur, Andhra Pradesh; and Foundation for Ecological Security in Anand, Gujarat) we found that by transferring knowledge horizontally (among locals) and vertically (among research institutions and extension offices), knowledge brokers (be they individuals, groups or organisations) can help address weak links that persist between local and supra-national levels. They can promote local practices that are culturally and socially relevant, and can help to integrate these practices with modern/formal knowledge. They can also facilitate interactions and engagement among varied stakeholders, including local communities, scientific institutions, and extension offices, and can use these networks to foster social learning, and advocate for appropriate policy changes. In doing so they can also facilitate the evolution of decentralised institutions, and the inclusion of local actors in local resource governance. Finally, they can create local awareness about entitlements, and help to regulate access to available state schemes and benefits.

Agricultural extension services are also a crucial means of transferring knowledge to local levels, particularly small and marginal farmers. However, in rural Karnataka we found low or inadequate visibility of extension institutions, and the devolution of extension services at the village level. Even though the institutional landscape of extension services has undergone a drastic change from a more top-down to a group-based approach that employs information and communication technology (ICT), the penetration of public extension remains poor. It is beset by differential access based on socio-economic status, with upper and dominant landed castes, villages close to district headquarters, and farmers with higher education levels having far better accessibility to services than marginalised communities.

Women have far more limited access to extension services than men due to their not traditionally being seen as a beneficiary group for technical information, and their non-ownership of mobile phones. There are also structural challenges with extension services, including staff shortages, lack of village-level deployment of functionaries, regional disparities, and operational inconsistencies within the extension programme. As a result, the current extension framework does not address the objectives of knowledge transfer and effective decentralisation, especially in remote villages.

Recommendations

- Combining short- and long-term climate information can aid decision making across spatial and temporal scales, and can help systems to become more resilient to both current and future climate risks. Setting up processes, institutions, and infrastructure that align short-term and long-term action, coupled with improvements in knowledge, will help improve the utility of climate information for decision making.

- Tailored climate products and information (agro-advisory services provided by the Watershed Organization Trust (WOTR), in coordination with the India Meteorology Department) – that are scaled to local contexts and realities, and delivered in appropriate formats at appropriate times – are being increasingly recognised as important for enabling climate-resilient decision making in different sectors. Achieving this requires a collaborative effort between multi-level institutions in order to develop forecast systems, maintain and strengthen observation networks, and engage with different communities to co-develop relevant information.

- The important role played by knowledge brokers should be recognised by formal governance structures and better supported. For example, knowledge brokers could be used to help integrate local practices with state development policies and programs, and subsequently these processes could be institutionalised.

- Dealing with the layered inadequacies of extension services, particularly in the context of small and marginal farmers, requires using a mix of approaches, and state and non-state interventions. More specifically this means:

    - Having the right mix of face-to-face engagement and ICT for outreach. Further, in areas where mobile ownership is still exclusively male-dominated, continued efforts should be made to tap into women's networking potential by holding separate training sessions by dedicated state institutions.

    - Incorporating a systemic reform of extension services, including additional fiscal support and investment in manpower, and considering the active involvement of non-state actors or processes to help bridge information gaps, particularly in areas where the reach of public extension is limited by structural and other barriers.

FUNCTIONING ECOSYSTEM SERVICES CAN ENHANCE CLIMATE RESILIENCE IN CITIES

Preserving functioning ecosystem services within the urban fabric is crucial for climate resilience planning. However in Bengaluru, these ecosystem services are being challenged by unplanned, haphazard urbanisation. Promoting ecosystem-service-based stormwater-management practices, and exploring alternative strategies that can enable stormwater attenuation or retention is necessary.

Urbanisation, especially in developing countries, is often accompanied by degradation of the surrounding environment and overall loss of biodiversity. When urbanisation is rapid (due to increased economic activity), institutional capacities are often found lacking, and unplanned development occurs. The result is the degradation and loss of crucial ecosystem services such as water provision, disaster protection, water treatment, and healthy environments. A changing climate will exacerbate and compound these urbanisation issues while the decline in ecosystem services is likely to make cities less resilient in the future.

Bengaluru is the fastest growing city in India. This growth is fueled by a sharp rise in economic activity, which inadvertently has had a major impact on ecosystems and biodiversity. While historically, the city attracted people for its pleasant climate provided by the large expanses of green cover and water bodies, the subsequent influx of growth has led to a reduction in green cover due to the disproportionate increase in impervious surfaces, along with the encroachment and degradation of water bodies.

Furthermore, due to weak governance and haphazard planning, the city has grown in an inequitable fashion where the peripheries have seen rapid urbanisation along with a high degree of fragmentation of processes and services.

Peri-urban growth in Bengaluru has had implications on the integrity of the watersheds that define the northern edge of the city. The management of water in a city, both for anthropocentric uses, and for those that cater to the health of the environment, should be critical components of planning practices. It is with this lens that we conducted geospatial analyses on a sub-watershed which is a part of the larger Yale Mallappa Shetty Kere (YMSK) watershed.

We found that changing rainfall regimes are increasing water extraction patterns. In addition, changes in land use and land cover, and reduced infiltration caused by rapid urbanisation, have led to a decline in groundwater levels. Encroachment of previously green and open spaces coincides with regions that have reported floods in the last few monsoon seasons. Land-use changes – typically in the form of an increase in impervious area, reduction in local water retention in lakes, a decrease in vegetation cover, and alteration in drainage patterns – have led to enhanced threats of flooding, and water shortages in the city. Stormwater, often mixed with sewage flowing through the urban landscape, has also led to widespread contamination of water bodies, causing degradation of ecosystem services attached to these water bodies.

Recommendations

- Ecosystem-service-based stormwater-management practices should be promoted to better conserve stormwater as a resource, while in the process providing additional ecosystem service benefits including hydrological services, climate regulation, and flood mitigation.

- There is a need for exploring alternative strategies that enable stormwater attenuation or retention within urban environments. Low Impact Development (LID) is one such suggested approach. Green Infrastructure-based development (such as LID) is intended to mimic the pre-urbanisation hydrology of the location or city, thereby providing a valuable ecological service. It is possible to identify potentially viable spaces within urban catchments and to map them at a high resolution with the intention of rejuvenating hydrological flows in cities. This is technically feasible for Bengaluru, but the social implications of doing so need to be extensively studied first.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

IIHS has been involved in various processes of climate policy discussions at the local, national and international levels. We were significantly present in the IPCC process with Aromar Revi being the Coordinating Lead Author on the IPCC Special Report on 1.5 degrees. Chandni Singh and Amir Bazaz were Contributing Authors to this report. Aromar Revi is also a Coordinating Lead Author in the next cycle of IPCC's Assessment Report 6 on Chapter 18 "Climate resilient development pathways", and Chandni Singh is a Lead Author (Working Group II, AR6) on Chapter 10 "Asia". We have and will continue to influence climate policy through the IPCC engagement, with the bulk of our policy influencing work being guided by ASSAR research. We were also able to present research findings from ASSAR, especially on 'Assessing Sensitivity and Vulnerability to Climate Change', at a UNFCCC process: Nairobi Work Programme called the 11th Focal Point Forum. We will continue to engage with this forum and other related ones so as to influence climate policy processes.

At the national level, IIHS, along with representatives from DECCMA and HI-AWARE created a Country Engagement Group and produced three national level policy briefs: on Hotspots, Migration, and Adaptation Policy. These were launched in an event attended by national level policy makers, and disseminated widely to policy and decision makers. We hope that the findings presented will build significant external decision-making capacities. We will continue, through this network, to engage with policy process at multiple levels.

ASSAR's findings were frequently discussed during the flagship IIHS annual event, Urban Policy Dialogues (UPD), with a range of audiences including policy makers, practitioners and researchers. Through UPD and the National Consultations on Climate Change (which were a regular feature during ASSAR), IIHS has been able to create a network of governmental and non-governmental professionals, and has been continuously building their capacities while also benefiting from their experience in and knowledge of other contexts and sectors.

Our Transformative Scenario Planning (TSP) process on water security in Bengaluru was an imaginative exercise that helped bring together multiple stakeholders. While the objectives of the process were to engage stakeholders in a scenario planning exercise, it also enabled the creation of a cohort of institutions and actors that regularly engaged on other issues in the city. The trust, mutual respect, understanding of alternate language, and knowledge exchange mechanisms developed through this process have enabled IIHS to maintain a sustained dialogue within the group, which has been leveraged to create responses to multiple other challenges facing Bengaluru.

Responding to the needs identified on the ground, IIHS co-organised a Capacity Development Workshop on Integrating Climate in Development Projects funded through ASSAR's Grants for Local Adaptation Support (GLAS). This was aimed to build frontline capacities of local NGOs, especially from Mysore Resettlement and Development Agency (MYRADA) in both Kolar and Gulbarga. MYRADA was our local partner through multiple phases of our research, and we consciously aimed to ensure that they benefited from this partnership.

We also aimed to build capacities of organisations like MYRADA in order to encourage reflexive and critical thinking about their work at the interface of development and climate change/variability, which in turn will directly impact vulnerable communities that they work with on the ground. Finally, we used these collaborations as opportunities to influence MYRADA's research methods and to facilitate knowledge exchange for bringing in climate concerns into development planning efforts.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Climate change and its impacts are being progressively, albeit at a slow place, recognised as an important challenge in the Indian context. Most of the state responses have been largely project-driven or in mission mode, with no systematic understanding of how climate change intersects with social and economic development trajectories in various regions. Governance structures, processes, and mechanisms are also inappropriate for managing climate stresses, with extreme discontinuities across administrative and policy boundaries. These challenges could be addressed in the following ways:

- Sustained external capacity building efforts are desirable and these should be institutionalised. Research evidence, across multiple scales and contexts, needs to be organised into appropriate learning material for policy makers. For example, IIHS has been actively engaged, using various institutional avenues, in offering electives such as Sustainable Cities and Climate Change and Human Settlements as part of the institutional Urban Fellowship Program, a nine month urban fellowship. In addition, IIHS is also involved in developing a MOOC on Cities and Climate Change that uses ASSAR research as teaching cases and is aimed at practitioners, policy makers, researchers, and citizens across the world.

- It is important that a clear, unambiguous message goes to policy makers that current adaptation is largely autonomous, and short-term and multiple barriers (technical, institutional, social, economic, cultural) interact to shape effectiveness and sustainability of local adaptation. There is an urgent need to build climate-specific capacities, and to carefully analyse the long-term impacts of climate on people and systems. Adaptation planning and implementation should be expanded from a narrow, reactive perspective, towards a regional agenda that incorporates longer-term changes.

- Current planning based on five-year-plans is unable to address entrenched structural vulnerabilities (determined by who you are, and where you live). Climate change is not explicitly considered in planning because the focus tends to remain on immediate risk management or poverty reduction. Although this focus has yielded reasonable results in the short-term, it is unable to prepare vulnerable groups for future climate risks. Deeper, sustained transformation would require an imagination that merges structural vulnerability concerns with proximate and long-term climate risks, and articulates a policy pathway that is regionally designed (across the dynamics of the rural-urban continuum), with wellbeing of the most vulnerable at the core. Transformational actions that include deep, systemic changes are thus essential to deal with structural vulnerabilities as well as projected climatic risks.

- Inter- and transdisciplinary research is necessary for identifying appropriate policy interventions, for which structured engagements across the science, policy and practice community is essential. For example, climate projections need to be integrated with adaptation prospects and local vulnerability assessments to be able to inform policy makers about the limits of adaptation planning.

- Systematic assessment, recognition, and institutionalisation of varied sources of knowledge systems is necessary. It appears that local knowledge is helping build resilient communities but needs to be recognised and used for large-scale, long-term systemic change. It also appears that access to knowledge, and knowledge translation would be critical in managing climate-induced risks, but access mechanisms need to be carefully structured.

- Serious inconsistencies exist between national and regional development pathways. Largely motivated by political economy concerns, there are huge disparities across development pathways at scale and with incoherent objectives and aims. These are largely due to unclear incentives and accountability mechanisms which themselves are outcomes of rigid institutional structures, discontinuities across governance regimes, and unclear responses to emerging stresses like climate change.

- There is a need for new institutions and governance structures. Many of the climate commitments remain as plans, and with insufficient and inappropriate implementation. Incumbent institutions and governance structures are inadequately equipped to manage climate-induced transitions, which are happening simultaneously with complex structural transformations. There is a need to re-imagine new institutional regimes to manage this complex structural transformation, with climate action and development concerns going hand-in-hand.

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MAHARASHTRA, INDIA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID MAHARASHTRA, INDIA

ASSAR'S FOCUS IN MAHARASHTRA, INDIA

India consists of a diverse set of ecosystems with a range of risks, climatic and non-climatic exposures, differential vulnerability profiles, and various institutional regimes. The country is complex, with multi-hazard environments and climate change hotspots. Negative impacts on key rural production systems like agriculture and forestry are already evident, and a range of losses and impacts across agricultural, water and forest-based systems are projected for the future. Major livelihood transitions are expected to take place along the rural-urban continuum, coupled with increasing urbanisation. A significant proportion of the population lives in extreme poverty and is highly vulnerable to both everyday risks and the impacts of extreme events.

The country also faces serious institutional and governance challenges, compounded by contested growth dynamics, rural-urban migration, and fluxes in the historically-established formal and informal sectors. These dynamics will combine to create pockets of risk where concentrations of historical and emergent challenges are amplified by climatic variability.

Maharashtra State is vulnerable to many of the risks detailed above, not least because of its challenges related to groundwater availability and management. The state is mostly semi-arid (73% of its geographic area is classified as such), and houses about a quarter of India's drought-prone districts. More than 30% of the state falls within a rain shadow, which suffers from scanty and erratic precipitation. In addition, continued overexploitation of groundwater has led to depleting aquifer stocks and falling water levels, which threaten the sustainability of agricultural economies built on the basis of groundwater irrigation. Groundwater is not uniformly available across the region and a disaggregated typology of groundwater, derived on the basis of aquifer settings, is an important consideration for groundwater management strategies.

The Maharashtra Groundwater Development and Management Bill of 2009 is the Maharashtra state government's initiative to regulate groundwater. It prohibits the drilling of deep wells, places restrictions on withdrawal of water from existing deep wells, and contains provisions for levying cess. It also requires that tubewell owners and drilling contractors are registered, and that contractors obtain permission before drilling a tubewell. However, implementation of the regulations has been a challenge.

The Watershed Organisation Trust (WOTR), a non-governmental organisation that has been actively working with communities in Maharashtra for the past 25 years, engages in developmental activities in the areas of natural resources management, watershed development, and climate change adaptation. From 2014 to 2018, as part of ASSAR, WOTR's team of researchers and practitioners worked with multiple stakeholders, including farmers, local village-level elected representatives, government functionaries (state and district level), and other research organisations, to develop strategies to bolster the resilience of farmers and rural households to climate risks, while strengthening local-level water management initiatives, including groundwater management.

Key insights

- Agricultural growth in semi-arid regions is largely dependent on groundwater. Depleting groundwater levels put the agrarian economy of the entire semi-arid region at serious risk. Raising farmer awareness about water management through effective communication, especially about groundwater use, is a crucial step towards implementing rules and regulations for groundwater management.

- Building people's adaptive capacities in Maharashtra requires understanding differential vulnerabilities to climate risks and capacities among the different social (castes) and farmer (based on land ownership) categories. This understanding can be used to inform and develop local-level livelihood adaptation strategies. At the same time, the needs and aspirations of people in these different social and demographic categories need to be taken into account when preparing local adaptation and development plans.

- Heat stress in the peak summer months is increasingly affecting people's health and livelihoods. Many factors influence vulnerability to heat stress, including age, pre-existing health conditions, occupation, and housing type. State- and local-level heat action plans that address the needs of rural and urban populations, are vital. Communities should also be made more aware of heat stress so that people can take adequate precautions.

- Despite there being a number of government and private Information Communication Technology initiatives in India aimed at supporting farmers, farmer access to usable information on weather and climate risks, and agro-advisories remains a challenge. There is also ambiguity around whether the available information meets famer requirements. A dynamic and responsive agro-met advisory system, that provides demand-driven, and location- and crop-specific information, can help to better manage climate risks and support adaptation.

ABOUT THE RESEARCH

Research priorities

To better understand how people in Maharashtra are exposed to climate risk, and what capacity they have to respond, we explored the biophysical and socially-differentiated vulnerabilities at play in the region, as well as the barriers and enablers to wellbeing of the communities we worked with. Our research examined the vulnerabilities and adaptation strategies of farmers in a dynamic context of increasing rainfall variability, land use/land cover (LULC) changes, reductions in groundwater levels and overexploitation of this resource, and long-term climate changes.

Heat stress emerged as an important issue, especially during the peak summer months when heatwave-related deaths were recorded across the country. Yet we found no comprehensive heat action plan for Maharashtra. In order to better explain the impacts of heat stress on rural populations, we focused on understanding differential vulnerabilities to heat stress among rural communities as well as the factors that influence these vulnerabilities.

To understand how global warming of 1.5°C and higher will affect India, we assessed the projected local impacts of increasing global warming scenarios on regional rainfall and temperature extremes across the country. This work can be used to inform local-level adaptation planning.

We also conducted micro-level studies to gain an understanding of: 1) farmer behaviour towards groundwater use; 2) the role of the agro-advisory system and farmer responses to climate risks; 3) the needs and aspirations of local communities; and 4) barriers and enablers to adaptation in local governance mechanisms.

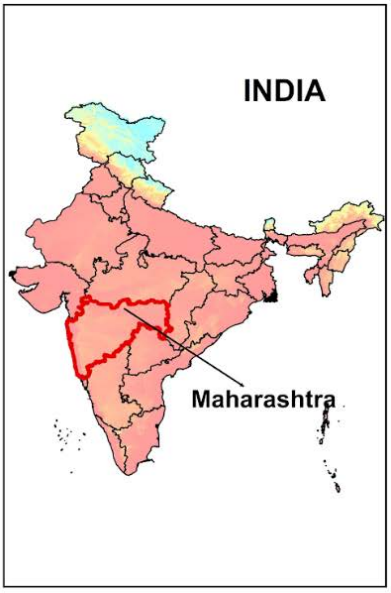
Case study sites

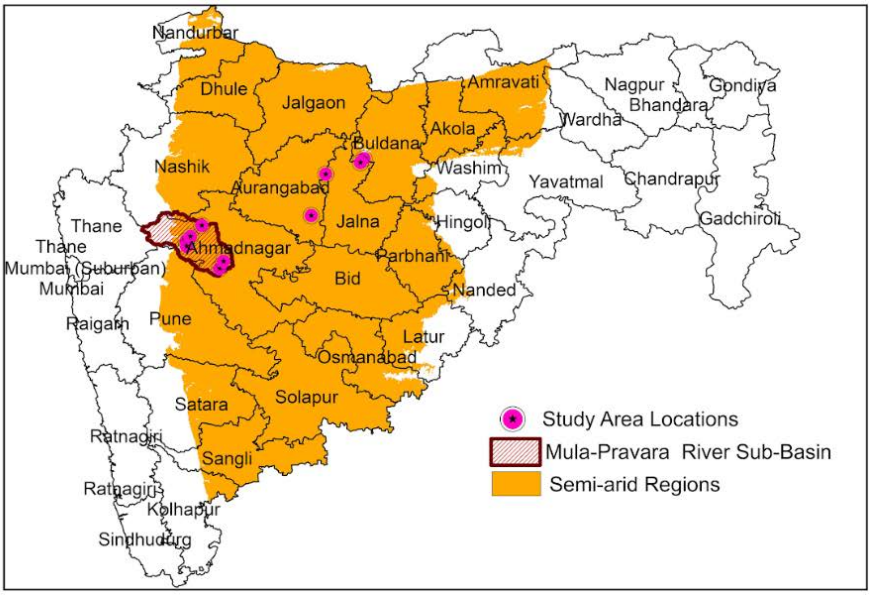
We worked across four districts in Maharashtra. Our main study site was the semi-arid Mula-Pravara region (part of Godavari basin) in Ahmednagar district. This district is centrally located in the state of Maharashtra and covers 17,114 km$^{2.}$ It has a population of 4,543,159 (2011 census) with a density of 226 people per km2; about 80% of the population is rural.

Ahmednagar district falls largely within the hot, semi-arid agro-ecological subzone of the Deccan Plateau, and has black soil. The district's position in the rain shadow area of the Western Ghats makes it susceptible to droughts, which occur every three years. The latest national groundwater assessment categorises the central part of the basin in the Sangamner administrative block as an "overexploited" groundwater zone.

Average annual rainfall in Ahmednagar district is 565 mm, with 94% of this falling from June to October. There has been a modest increase in annual average rainfall since the early 1990s, but there was also high variability in the contribution of sparse and moderate rain events. Projections indicate that there will be an increase in extreme rainfall and a decrease in the number of rainy days in the region in future. This is a matter of concern for agriculture. In recent years, Mula-Pravara's LULC has experienced dramatic changes. There has been a noticeable expansion in the agricultural area, along with shifts towards commercial crops, such as soybeans, sugarcane and pomegranates, with large dependence on groundwater for irrigation.

The increase in area irrigated through groundwater has led to a significant rise in groundwater draft, leading to overexploitation in many parts of the district. Between 2004 and 2011, groundwater draft in the Ahmednagar district increased from 74% to 82% of net annual availability, and groundwater depletion has become an important focus area.





APPROACH

Our team comprised 15 researchers from varied research backgrounds, including geo-hydrology, natural resource economics, climate science, sociology, agriculture and agricultural engineering, coupled with teams of practitioners working at the grassroots level. Our main objective was to produce comprehensive transdisciplinary research with high application value that could make an impact on critical challenges in Maharashtra State.

Our Regional Diagnostic Study (RDS) helped us to identify key research gaps and critical barriers to effective, widespread and sustained adaptation in Sangamner sub-region. Detailed analyses of existing literature helped us delineate emerging themes and issues that exacerbate the impacts of climate change on natural, physical and social systems. Through multiple stakeholder engagements during the RDS phase we identified specific problems in the region that subsequently link to ASSAR's overarching research themes. At the local level, we identified key research themes that included the assessment of biophysical (LULC changes) and socio-economic vulnerabilities to climate change, water governance (focused on groundwater management), and agro-meteorology. We conducted a down-scaled assessment of groundwater vulnerability in selected villages in the Mula-Pravara sub-basin. As part of our Research-into-Use (RIU) efforts, especially with regard to water governance, we initiated steps to engage with various stakeholders so as to share information and identify topics for further research.

As a first step, we organised a stakeholder engagement event, where farmers, government functionaries, researchers and practitioners came together to discuss and identify key problems, which helped us to prioritise our research topics and questions. Groundwater use and its management emerged as key issues needing immediate attention. Next, we assessed the regional geo-hydrology and analysed the long-term LULC changes in order to identify areas of groundwater vulnerability and hotspots of land use change.

As part of our stakeholder engagement, we initiated a Transformative Scenario Planning (TSP) process in the drought-prone Jalna district. The TSP brought together 40 stakeholder representatives, including landless women, farmers from different landholding categories and farmer movements, members of the gram panchayat (village governing body), government officials, academic institutions, college students, non-governmental organisations (NGOs), media, and a scientist from the water sector. The TSP created new partnerships around a common burning issue: how can we identify equitable and transformative adaptation pathways to ensure water for domestic and livelihood needs in the medium-term future (2015-2030)? Participants agreed that the implementation of government policies and programmes, and collective action to manage water resources, were vital for helping Jalna district address its future water situation.

Our heat stress research provided an opportunity to link with Wageningen University, a partner in the Himalayan Adaptation, Water and Resilience (HI-AWARE) consortium (part of CARIAA). Through this partnership, we undertook a pilot study that monitored temperatures during peak summer in the houses of rural communities, giving us an improved understanding of their vulnerability to indoor and outdoor heat exposure.

FINDINGS AND RECOMMENDATIONS

CLIMATE CHANGE, LAND USE/LAND COVER CHANGES, AND OVEREXPLOITATION OF GROUNDWATER EXACERBATE VULNERABILITIES

In Maharashtra, increased access to groundwater has caused the area of land used for agriculture and horticulture to mushroom over the past 25 years. A major part of the Sangamner transect is now classified as groundwater 'overexploited.' Global warming of 1.5°C and higher is expected to add further challenges to existing groundwater vulnerability here, and exacerbate the impacts of recurrent droughts and heat stress.

Between 1991 and 2016, the Mula-Pravara river basin, located in the semi-arid region of Maharashtra state, has seen the area of land used for agriculture and horticulture increase by about 98% and 1601%, respectively. At the same time, unculturable and culturable wasteland (UCW) declined by 34.6%, and fallow lands declined by 60.5%. These changes can be majorly attributed to increased access to groundwater, irrigation projects, and watershed development programmes.

In the Sangamner sub-region, an assessment of precipitation trends indicated a modest increase in annual average rainfall since the early 1990s. It also recorded high variability in the contribution of sparse rain and moderate rain events. Due to increased groundwater dependence in the Sangamner transect, the major part of the block is now groundwater 'overexploited.'

We found that almost 87% of the area in the study villages is classified as having 'high' to 'extreme' groundwater vulnerability. These zones have very low hydraulic yields, with low capacities for groundwater storage in the hard rock basaltic aquifers. This makes it all the more important to use the groundwater resource judiciously. Vastly different vulnerabilities and current trends of groundwater use exist in the region that can shift areas of 'low' vulnerability to 'high' and 'extreme' vulnerability in the coming years. Current practices of groundwater exploration and use (pumping excessively; storing groundwater in farm ponds; drilling new and deeper wells) can impact base water flows, and dramatically reduce water availability.

Amongst various schemes, farm ponds are being encouraged at a large scale by the government in order to drought-proof the region. In principle, farm ponds are traditional rainwater harvesting structures that are supposed to have an inlet to allow runoff to ingress in the pond, and an outlet to let out excess water. Their purpose is to help farmers adapt to the vagaries of the monsoon by harvesting rainwater. But these farm ponds have changed from their intended design and are now widely used as storage tanks to hold groundwater, which is extracted indiscriminately from the multi-layered aquifer system.

We found that the benefit-cost ratios were higher in the case of smaller farm ponds as compared to large farm ponds. When considering externalities of pumping out groundwater and storing it in surface water structures (e.g., value of evaporation losses, and opportunity costs of land lost to farm pond structure) as costs, then the Net Present Values (NPV) decreased for all sizes of farm ponds. Only the smaller farm ponds were found to be viable with a positive NPV and benefit-cost ratio.

Global warming of 1.5°C and higher is expected to result in local temperatures in much of India rising more than the global average. This will likely usher in further climate challenges that exacerbate current community vulnerabilities to land use/land cover change, and groundwater overexploitation.

Recommendations

- It is essential for India's current national and state action plans on climate change and adaptation to consider the local implications of global warming of 1.5°C and 2°C in India and make informed policy decisions around these.

- Overdependence on groundwater could have serious implications for regional agricultural sustainability. State government needs to prioritise groundwater management by formulating strategies to operationalise the recently-enacted Maharashtra Groundwater (Development and Management) Act, 2009 to regulate groundwater. This is a first step towards addressing groundwater governance issues, and will require the reductions of the conflicting development programmes and subsidies that sometimes inadvertently lead to groundwater overexploitation.

- In zones identified as being 'highly' or 'extremely' vulnerable to groundwater scarcity, the use of inefficient and unsustainable irrigation practices, like flood irrigation, should be reduced. Farming of water-intensive crops, such as sugarcane and sweet lime, should be avoided.

- A better, more fine-scale/local-level understanding of underground common-pool, multi-layered aquifers, and groundwater flow patterns, can guide the regulation of borehole drilling, determine the best placement of water-saving measures, and assist communities with their water-management efforts in lieu of changing rainfall regimes.

- Farm ponds converted to groundwater storage structures should be closely managed to minimise and prevent misuse. For this to happen, the gram panchayat needs to proactively engage in monitoring and regulating the extraction of groundwater for storage in farm ponds, as well as farm pond size.

- It is important to generate knowledge and evidence about groundwater status at the local level, create awareness among different stakeholders (farmers, concerned government authorities, researchers), and create a platform for dialogue for local solutions at the community level. Such a platform could help to bridge knowledge gaps pertaining to hydrogeological information at the community level, and contribute to making more robust groundwater management plans at the village and aquifer levels.

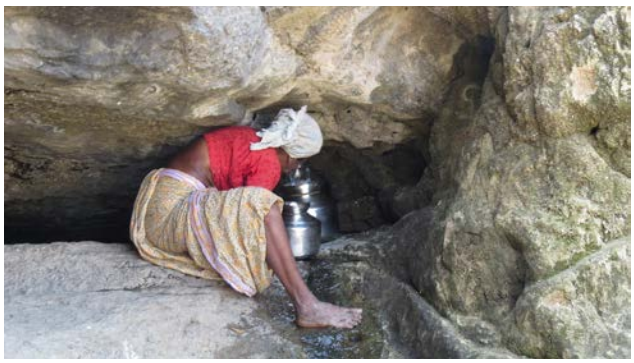
ADAPTATION PLANS NEED TO FACTOR IN THE DIFFERENTIATED VULNERABILITIES, NEEDS AND ASPIRATIONS OF DIFFERENT SOCIAL GROUPS IN RURAL COMMUNITIES

Building people's adaptive capacities in Maharashtra requires understanding differential vulnerabilities to climate risks and capacities among the different social (castes) and farmer (based on land ownership) categories. This understanding can be used to inform and develop local-level livelihood adaptation strategies. At the same time, the needs and aspirations of people in these different social and demographic categories need to be taken into account when preparing local adaptation and development plans.

In rural Maharashtra communities identified both climate risks (associated with changes in temperature and rainfall) and non-climatic risks, that combine to significantly influence their crop management decisions. For our research, we categorised farmers according to gender, land ownership (large, medium, and small and marginal), and whether or not they were landless. All farmers demonstrated a high sensitivity to both climate and non-climatic risks; however we found differential vulnerabilities across farmer categories, as we detail below.

Sometimes access to, and investments in, irrigation do not necessarily reduce vulnerability, and conducting rainfed farming does not necessarily increase vulnerability. For example, despite the small and marginal Mali community farmers having access to irrigation – as they practice groundwater-dependent, high-profit commercial crops such as pomegranate – their lands and crops are at a higher risk from future climate impacts and declining groundwater resources. Conversely, the *Banjara* community farmers, who have no access to irrigation sources, successfully manage their agriculture and semi-intensive livestock rearing in rainfed conditions.

Caste and social standing also majorly impact whether farmers can access resources and subsidies, leading to further differentiated vulnerabilities. For example, lower caste groups are unable to access subsidies and government programs. Furthermore, the knowledge and skills of different castes or social groups can be culture-specific, and can inherently affect resilience to climate change.



Vulnerabilities are also reflected through people's needs, and the satisfaction they get from different areas of their lives. Identifying the differential needs and aspirations of the diverse demographic (adults, young adults – both men and women) and socio-economic groups (based on social categories, land ownership, and economic criteria) in rural communities is an important step not only towards understanding specific vulnerabilities, but also towards achieving the Sustainable Development Goals. For example, all socio-economic groups were dissatisfied with food, health care and sanitation, but there were relatively higher levels of satisfaction among some socio-economic groups regarding credit and agricultural inputs.

Climate change impacts existing vulnerabilities by creating stressors and shocks. Such shocks magnify the impacts of existing social fissures, either harming or benefiting people's adaptive capabilities. For example, the forward communities have more land holding, and are primarily engaged in agriculture. They face higher risks from rainfall variability. Scheduled tribes and scheduled caste communities have lower land holdings, and depend on wage labour as their major livelihood source. They are also prioritising education in attempts to secure regular employment in the government sector (due to reservations and other enabling environments). Given expected climate change impacts, these backward communities could thus potentially become more resilient due to their diversification into alternate livelihoods.

Community priorities (needs and satisfaction) are influenced by village resource endowments, awareness of government programmes and schemes, and literacy. Our assessments of these priorities brought into focus the extent to which local governance mechanisms sufficiently support local communities, especially in the context of village-level development plans (Gram Panchayat Development Plans), and helped us to identify the functional constraints of village-level institutions. For example,we found that health care, sanitation, education, and employment opportunities were the most commonly identified priorities of the communities. In most cases, the Gram Panchayat Development Plans reflected these community priorities, even though community members from different villages varied in terms of how satisfied they were about the way the plans were executed on the ground.

Recommendations

- Caste and social standing play a major role in determining access to resources, land ownership, and livelihood choices, thus differentially impacting people's vulnerability to climate change. Accordingly, any local-level adaptation plans by local governance institutions (panchayats) have to correspond to the specific vulnerabilities (to climatic and non-climatic risks) of community groups. These vulnerabilities should be assessed using cluster-based, holistic and participatory approaches, with assessments conducted at fine scales (rather than treating districts as a single category) to account for the way that climate risks vary across and within village clusters.

- Efforts need to be directed toward addressing the structural and institutional barriers of local-level governance. Improved engagement with communities can foster more inclusive village-planning processes. For example, sometimes the large size of gram panchayats becomes an impediment when reaching out to all the villages or hamlets within the panchayat. It is therefore important to increase the number of community social workers (gram sevaks), thereby reducing the risks of overburdening them, or having to reorganise large panchayats into smaller panchayats.

- Illiteracy, and a lack of knowledge about leadership roles and responsibilities of elected representatives, are barriers to active participation in local governance, especially for women. Focused training and capacity building of elected representatives (whether women or men) to build their managerial skills, and inform them about the legal or constitutional powers vested in their respective positions, could be done using various multimedia tools.

HEAT STRESS POSES SERIOUS AND DIFFERENTIAL RISKS TO PEOPLE'S HEALTH AND LIVELIHOODS

Heat stress in the peak summer months is increasingly affecting people's health and livelihoods. Many factors influence vulnerability to heat stress, including age, pre-existing health conditions, occupation, and housing type. State- and local-level heat action plans that address the needs of rural and urban populations, are vital. Communities should also be made more aware of heat stress so that people can take adequate precautions.

People in the region are also at risk of heat stress, with some groups being more vulnerable than others. The major heat-related symptoms reported include headaches, heavy sweating and fatigue, which were mild or moderate in nature. We found that differentiated vulnerabilities to heat stress are based on type of livelihood, type of housing, wealth, age, gender, and pre-existing health conditions.

For example, working men and women (31-59 years old) were found to be most vulnerable when compared to all other age groups, given that they frequently work outdoors during the middle of the day. In addition, homes in Yavatmal district with tin roofs and poor indoor ventilation had higher indoor afternoon temperatures than houses with other roofing types, increasing the heat stress risks of those inside at that time of day (the elderly, children and women).

Recommendations

- There is an urgent need for pre-emptive strategies to reduce the vulnerability of people in heat-stress prone areas. Early detection is crucial, and communities should be made more aware of heat stress so that people can take adequate precautionary measures.

- Rural health infrastructure should be upgraded to handle heat stress-related incidences, such as having cooling rooms in primary health centers (PHC) in the villages.

- Effective planning by Maharashtra State's Public Health Department and Rural Development Department could help to mitigate and avoid heat-related illnesses and deaths, through development of surveillance mechanisms to monitor heat-related mortalities and morbidity.

- At present there are heat action plans for only some states and few cities in India. Developing a state-level heat action plan for Maharashtra, which addresses urban and rural communities, should be a priority.

COLLABORATIVE KNOWLEDGE SYSTEMS SUPPORT FARMERS TO BETTER MANAGE CLIMATE RISKS

Despite there being a number of government and private Information Communication Technology initiatives in India aimed at supporting farmers, farmer access to usable information on weather and climate risks, and agro-advisories remains a challenge. There is also ambiguity around whether the available information meets famer requirements. A dynamic and responsive agro-met advisory system, that provides demand-driven, and location- and crop-specific information, can help to better manage climate risks and support adaptation.

Farmers and other rural actors can benefit from numerous types of advisory services. There have been many initiatives (from both government and private sector) to provide weather-based crop advisories for India's farming community, based on location-specific, medium-range weather forecast for the districts under different agro-climatic zones. The success of an advisory system depends upon the quality of its inputs, and the interactions between the different organisations and subject-matter specialists involved.

For example, WOTR provides knowledge-embedded services to farmers in our study region. Farmers receive crop and locale-specific agro-advisories, based on weather forecasts and the particular crop growth stage, in order to reduce their risks and improve their agricultural productivity. Our advisory system is based on a collaborative partnership with key developmental, scientific, and academic institutions (government, private and farmers), which makes it possible to pool and share valuable resources and expertise across domains and institutional boundaries. This collaboration facilitates mutual learning, co-generation of practical knowledge, and technology transfer.

Advisory systems need to be responsive to farmer needs. Thus, it is equally important to understand farmers' responses (adoption or non-adoption) to different types of agro-met advisories. In this context, we found that there were differences in uptake depending on the type of crop grown. In general, farmers tended more often to follow advisories for commercial crops (e.g., onions) than food crops (e.g., pearl millet). Not all farmers followed up on all the advisories, with some crop advisories being more readily adopted than others. Weather advisories had good uptake irrespective of crop type (food or commercial).

Recommendations

- To develop a dynamic farmer-responsive agro-advisory system, it is important for diverse stakeholders (farmers, NGOs, research institutions, government institutions, private organisations) to collaborate, and pool their respective strengths. For example, the Indian Meteorological Department (IMD) – with its expertise in providing short-term weather forecasts – could coordinate more closely with the state agriculture department, state and central government, academic and research institutions (such as State Agricultural Universities and the Central Research Institute for Dryland Agriculture), and with NGOs such as WOTR that can facilitate interactions with farmers on the ground.

- To enable IMD to better calibrate their weather models (given the diversity of topographies and agro-climatic ecologies in the region), the government needs to generate high-quality data points by increasing the number and density of Automated Weather Stations.

- Advisory systems need to be demand-driven and should provide information that is locally relevant and crop-specific. The systems can also be continually improved by ensuring that there are communication flows and feedback mechanisms between the users and generators of information.

WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

In 2013, the Government of Maharashtra activated the previously dormant Groundwater Act of 2009. However, the application of this act remains a challenge. According to the Act, villages in clusters (along aquifers) need to work together to manage their water resources judiciously. Based on an awareness of how much water is available, villagers are required to draw up prospective crop plans (agriculture and water-use plans) and follow those diligently. The proper application of the Act requires that people be motivated and mobilised to work together as a community, and are incentivised for positive action.

To support action on groundwater management, we initiated a stakeholder engagement process to bring together concerned agencies, farmers, and other practitioners to work on operationalising the Groundwater Act. We disseminated the findings from our study on groundwater vulnerability, and the vulnerability assessment study, through stakeholder engagement workshops in Sangamner's Ahmednagar district. This contributed to a better understanding by the community members of the regional groundwater characteristics and the differential vulnerabilities of farmer categories in the village.

Through experiential learning games (such as the Common Bucket Game), participants realised and appreciated the finite nature of groundwater resources, and the need for each generation to use water sustainably. Another method we used to help farmers understand the common pool nature of groundwater resource (shared aquifer) was the application of a tool called "Community Driven Vulnerability Evaluation – Visual Integrator (CDVI)." This involves producing a 3D model of the hydro-morphology of the village(s) together with participating villagers.

Transformative Scenario Planning (TSP) is an approach that brings together stakeholders who often have conflicting perspectives and who then work together towards a shared outcome. In our TSP process in Jalna district we explored the "Water situation in rural Jalna in 2030: for domestic and livelihoods needs." As a result of the TSP workshops, participants identified two concrete needs: (i) to capacitate and train people on how to prepare 'water budgets'; (ii) to use TSP in other parts of the district to motivate people in those areas to prepare similar water-management plans. To help address these needs, we conducted three further workshop events, with support from Oxfam, taking the TSP experiences to a wider audience in Jalna. Through these events we engaged with farmers from 38 villages.

For many years, WOTR has been working on the issue of groundwater management, and has trained local youth to use tools, such as water budgeting, to more effectively manage water resources. We used an ASSAR Grant for Local Adaptation Support to train and motivate leaders from the gram panchayat to prepare village water budgets. We also linked up with WOTR's Water Stewardship Initiative where villagers are motivated to manage groundwater and develop crop plans based on the annual availability of water. All these efforts helped in generating momentum on the ground to operationalise the Groundwater Act.

In order to further understand heat stress vulnerability, we convened meetings with subject-matter specialists (national and international). We generated awareness about heat stress among communities and local health authorities through a research survey, and disseminated pamphlets and posters on heat stress management (in English, Hindi, Telugu, and Marathi). We also produced a heat stress film: 'Under the blazing sun.'

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Our findings point toward the need for systemic and immediate changes to adaptation planning that take into account state- and local-level realities. For example, groundwater levels have declined due to the government policies and development activities that promoted groundwater abstraction, while at the local level, farmers need support in coping with various climatic and non-climatic risks, and managing natural resources effectively.

An important aspect of this systemic change is the need to include research in the design of adaptation projects, which can help to minimise maladaptation. Furthermore, a transdisciplinary approach that involves different stakeholder groups in 'action research' will play an important role in reducing the research-action-research feedback loop.

As part of future strategies, and in order to strengthen farmers' capacities to adapt, it is important to: (1) generate increased awareness among farmers about short-term and long-term climate change risks and adaptation measures; and (2) improve information flow and feedback mechanisms between research agencies, practitioners, and farming communities.

As the depletion of groundwater resources is a critical concern for semi-arid regions, it is imperative to develop village-level water management plans. To this end, local people should be trained to become water stewards, and should be equipped with the skills and knowledge that enables them to better manage groundwater and surface water.

AUTHORS

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Photographs in this section: Lucia Scodanibbio, Tali Hoffman, Renie Thomas, Watershed Organisation Trust

TAMIL NADU, INDIA

ASSAR
Adaptation at Scale in Semi-Arid Regions

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SEMI-ARID TAMIL NADU, INDIA

ASSAR'S FOCUS IN TAMIL NADU, INDIA

India consists of a diverse set of ecosystems with a range of risks, climatic and non-climatic exposures, differential vulnerability profiles, and various institutional regimes. The country is complex, with multi-hazard environments and climate change hotspots. Negative impacts on key rural production systems like agriculture and forestry are already evident, and a range of losses and impacts across agricultural, water and forest-based systems is projected for the future. Major livelihood transitions are expected to take place along the rural-urban continuum, coupled with increasing urbanisation. A significant proportion of the population lives in extreme poverty and is highly vulnerable to both everyday risks and the impacts of extreme events.

The country also faces serious institutional and governance challenges, compounded by contested growth dynamics, rural-urban migration, and fluxes in the historically-established formal and informal sectors. These dynamics will combine to create pockets of risk where concentrations of historical and emergent challenges are amplified by climatic variability.

India's Moyar-Bhavani sub-region comprises a diverse landscape with abundant natural resources, complex systems of governance, and a multitude of actors with varying degrees of influence and levels of interaction within the system. Along with diverse wildlife and physiographic features, the landscape has very high human density, and a long history of human use. The area is inhabited by diverse indigenous tribal communities, as well as a large population of scheduled castes (socially-marginalised groups). Major livelihood activities include agriculture, fisheries, pastoralism, and collection of non-timber forest products (NTFP). The forest-agricultural socio-ecological system is a key aspect here.

There are existing stressors within the agricultural system including groundwater dependency, decreasing labour, low productivity, and low levels of mechanisation. Risks caused by the occurrence of droughts, increasing temperature profile, declining crop yields and livestock mortality are some of the sub-region's key challenges. With ongoing deforestation, the proliferation of invasive alien species, landscape fragmentation and local extinction impacts, natural ecosystems suffer from rapid land use changes. Considering the essential role that native ecosystems play in ensuring tribal livelihoods, climate change is projected to intensify existing vulnerabilities and amplify risks.

Key insights

- Climate change and climate variability have resulted in increased temperatures and unpredictable monsoons. Despite observed declines in rainfall and recurrent drought, some agricultural areas are greening due to a growing dependence on groundwater, and unauthorised lift irrigation from perennial rivers.

- An increase in agricultural water use, driven by government policy (e.g., free electricity), has enabled a shift from dryland agriculture to intensively-irrigated agriculture that may not be sustainable under future climates.

- The agrarian transition driven by changing aspirations has increased household incomes, especially of large and medium farmers. However, this increase has had little impact on women's capacity as they often cannot access these incomes for their own investments. The increased movement of men into non-agricultural livelihoods has opened up space for women in agriculture, but they remain constrained by a lack of asset ownership and consequent inabilities to increase land productivity.

- Although food security has improved in the region through the targeted Public Distribution System, undernourishment persists and may worsen with increasing urbanisation, shifts to high-value commercial farming (despite the risks), and water scarcity.

- Invasive alien species are adversely impacting native biodiversity and communities. Yet a lack of tenure, and the extensive network of protected areas in the region, complicate the use of these species by forest-dependent communities to supplement agricultural incomes.

- Poor access to services, and lack of knowledge and support constrain women, while men continue to maintain hegemony over technology-related, and indeed, more remunerative tasks. Education, however, remains one of the biggest assets to women, which allows them to diversify their livelihoods out of agriculture.

ABOUT THE RESEARCH

Research priorities

The Moyar Bhavani sub-region consists of two distinct landscapes of which one is an agricultural socio-ecological system (SES), and the other a forest-agricultural SES. In this landscape, ATREE's research focused on understanding socially-differentiated vulnerability, and the barriers to and enablers of adaptation. Our research priorities were informed through stakeholder engagement and scoping studies. Ecosystem services and the gendered impacts of resource use, were two important areas of questioning that were addended to our research agenda based on these engagements.

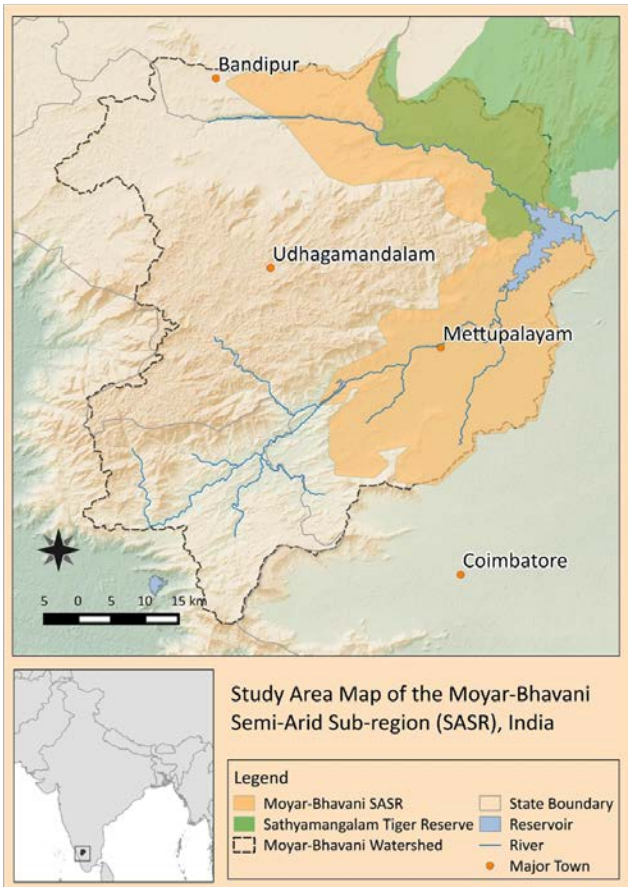
Our research priorities were formulated after an in-depth review of literature on the state of water, forest and agriculture sectors in Tamil Nadu. We then distilled research themes from the larger narrative emerging in the semi-arid regions of India that are characterised by depleting forest and water resources, increased vulnerability of natural resource-dependent communities, and our current inability to disentangle climatic and non-climatic causes of this vulnerability.

Insights from preliminary field visits, stakeholder workshops and interviews with key informants were integrated in the broad set of research questions. Our research was an iterative process where emerging insights were used to inform and calibrate existing research questions.

Specifically, we sought to understand: (1) non-climatic drivers of differential vulnerability; (2) current and future climate variability, non-climatic risks, and their interactive impacts; and (3) local and sub-regional institutional mechanisms of natural resource governance. We focused on key ecosystem services (agricultural productivity, biomass, water, non-timber forest products (NTFP)) and biodiversity, and how these are impacted by ongoing climate change, and the proliferation of invasive species.

CASE STUDY SITES

The combined catchment area of the Bhavani and Moyar rivers is located at the confluence of the Eastern and Western Ghats, and bounded to the north by the state of Karnataka, to the west by Kerala, to the east by the Bhavanisagar reservoir, and to the south by the Coimbatore plateau. The topography is undulating in the lower plateau and uplands, and rugged in the western parts. Vegetation is a mosaic of grassland, scrub, deciduous and evergreen forests, plantations of exotic tree species, and crops. Along with diverse wildlife and physiographic features, the sub-region has a very high human density and a long history of human use.



The sub-region is characterised by a diverse composition of ecological and human communities, and consists of two distinct landscapes. The Bhavani landscape is predominantly agrarian, and supports rural communities that are heterogeneous and made up of various castes. The forested Moyar landscape, on the other hand, supports a relatively homogeneous group of tribal communities that lives in close proximity to, or within, the protected area network. Livelihood profiles in both landscapes are dependent on agriculture, although agricultural practices differ. In the Bhavani landscape, agriculture is typically irrigated and more lucrative than the traditional rainfed farming system of the Moyar landscape.

APPROACH

Semi-arid regions are typically described as climatically stressed with high annual temperatures, and highly seasonal but low rainfall. Our first stakeholder engagement through key informant interviews suggested, however, that the Moyar-Bhavani sub-region had undergone substantial recent change. In order to disentangle climatic and non-climatic drivers of change here, we used a time-series of remotely-sensed vegetation data to detect sites where substantial change had occurred, and compared these with sites where relatively little change had occurred.

In the Bhavani landscape, we selected four villages and conducted a detailed vulnerability and wellbeing assessment by sampling 415 households across these villages. We used a stratified proportional sampling approach to ensure weighted representation across landholding size (large, medium and small landholders) and caste. We supplemented the survey with information from a gender-disaggregated survey in 200 of the 400 households, a nutritional survey conducted in 100 households, 20 focus group discussions (FGD) and 25 in-depth interviews conducted with women in the study area in the years 2016-2017.

The Moyar landscape is characterised by extensive areas under the protected area network and communities dependent on these native ecosystems. Here we conducted two stakeholder engagement events, to gain insights on the changes in governance regimes, communities, climate and ecosystems, and the impacts of these on livelihoods. We then sampled 400 households across 11 hamlets in the landscape to conduct a detailed assessment of the vulnerability and wellbeing of these communities, with an emphasis on the use and role of ecosystem services in community livelihoods.

Our key informant interviews suggested that invasive alien species (IAS) were a major challenge in the Moyar landscape, and we established and measured a series of vegetation plots and transects to understand the impacts of IAS (particularly *Prosopis juliflora*) on native species and the non-timber forest produce that the communities depend on.

Across the two landscapes, we sought to understand how communities manage risk in response to environmental and development stressors and the key vulnerabilities that impact their adaptive capacities. Using both primary (household interviews, FGDs and vegetation plots) and secondary (satellite imagery and weather stations) data, we identified and investigated changes in the quality, quantity and distribution of key ecosystem services (biomass, agricultural productivity, water and NTFP) over the last few decades. Finally, we examined national and sub-national priorities that shape legal, jurisdictional, economic and environmental implications of multi-layered governance in our sub-region.

FINDINGS AND RECOMMENDATIONS

EFFECTIVE ADAPTATION TO, AND MANAGEMENT OF, INVASIVE ALIEN SPECIES REQUIRES BOTH TOP-DOWN AND LOCAL PARTICIPATORY APPROACHES

Forests in the semi-arid tropics play a key role through provisioning services to tribal communities, which are strategically used to buffer risks. In the Moyar Bhavani, IAS are negatively impacting native biodiversity and ecosystem services. The ability of local forest-dependent communities to develop management practices and adaptation strategies to the emerging novel ecosystems is constrained by lack of land tenure due to the delayed implementation of the Forest Rights Act (2006) in Tamil Nadu, and confounded by the protected area status of a large part of the landscape. Meanwhile, the capacity of the Forest Department, NGOs and local communities in understanding the temporal and spatial dynamics, and magnitude of the problem, is constrained. Potential short- and long-term management strategies remain reactive, and are uninformed by scientific studies.

Prosopis (*Prosopis juliflora*) was introduced to the landscape in the 1960s and was expected to contribute to provisioning services through fuel and animal feed, thus increasing the productivity of grasslands. The expansion of *Prosopis* is driving a significant greening of vegetation along the Moyar valley. *Prosopis* in the region is now impacting biodiversity (blackbuck in the region prefer native species, and avoid *Prosopis*-dominated landscapes) and community livelihoods (crop raiding on farm lands from herbivores is linked to increases in *Prosopis* growth). The impacts of *Prosopis* may also worsen in the near future as the consumption of pods by wild herbivores is augmenting the dispersal of this species by blackbuck and elephants.

At higher elevations, the expansion of Lantana (*Lantana camara*), another IAS, has impacted local livelihoods significantly. Livestock pasturing areas have reduced, and NTFP productivity in the region has been impacted by the spread of IAS.

Resistance from state agencies (especially the Forest Department) to implement the Forest Rights Act, and the pertinacious focus on physical solutions for IAS spread in the region has neglected the potential of community-led solutions. Furthermore, the spatial and temporal dimensions of the spread of IAS, and their impacts on NTFP, livestock grazing, and wild herbivores, is not adequately acknowledged and more research is needed on the factors that drive their occupancy and persistence.

Recommendations

- The Forest Department invests significant effort in the control of IAS in protected areas, albeit sporadically. An ecological monitoring effort is needed to assess the effectiveness of current strategies.
- Information on IAS is patchy and restricted to protected areas, and the potential of technological advances (e.g., smartphones and tablets) to map and monitor the spread of IAS frugally and efficiently remains underused.
- The management of IAS needs to move from the rhetoric of state-funded extraction alone to community-led solutions that take into consideration the potential for livelihood generation through the removal of IAS by communities. A novel ecosystem framework is needed to assess the potential of IAS for livelihoods, biodiversity and ecosystem services.

CLIMATE CHANGE AND VARIABILITY ARE DISCORDANT WITH OBSERVED CHANGES IN LAND USE AND LAND COVER

Large parts of Tamil Nadu receive the bulk of their annual rainfall during the northeast monsoon (Oct-Dec), but our analysis reveals a shift in the monsoon, with less rain falling during the winter months. The winter rains are crucial for agriculture, and this reduction in moisture, combined with warming, is likely to pose a challenge to the resilience of these socio-ecological systems. These shifts in rainfall regimes are, however, being currently buffered by increasing dependence on groundwater, which is driving greening in cultivated areas. Farmers are reducing risks by opting for non-agrarian livelihoods, and increasing – and likely unsustainable – dependence on groundwater. Future climate is likely to reduce moisture availability and elevate temperature, but SWAT (Soil and Water Assessment Tool) hydrological models are not adequate to capture changes in evapotranspiration under different land-cover change scenarios.

We noted a significant decline in the southwest (Jun-Sep) monsoon in the semi-arid regions of north-west and central India from 1951-2007. Although these declines are not observed in Tamil Nadu, large parts of the state are witnessing declining contributions from the northeast (NE) monsoon in areas historically adapted to receiving the bulk of their annual rainfall in these (Oct-Dec) months. This shift in monsoonal regime is also accompanied by delays in the onset and amount of rainfall received through the NE monsoon, driving changes in cropping patterns. Our analysis also revealed significant increases in mean annual temperature, and summers are now reported to be hotter and starting earlier.

Despite the declines in precipitation we observed, we noted significant greening in the Moyar-Bhavani semi-arid region (from 2001-2015), with rapid change occurring from 2006-2015. In the agrarian socio-ecological systems along the Bhavani River, this reflects an increasing dependence on lift irrigation from the river, and groundwater extraction for crop irrigation. The current risk-management strategies of farmers, which include non-agrarian livelihood diversification, groundwater dependence and shifting of cropping patterns, have adverse implications for household wellbeing and gender relations within the household, which may not be sustainable.

We also conducted an assessment of the impacts of future climate and potential land-use change on hydrology in the Moyar-Bhavani by combining statistically-downscaled climate variables with a SWAT hydrological model. Our assessments reveal a projected decline in precipitation, and an increase in minimum temperatures by 2100 under the conservative RCP2.6 (Representative Concentration Pathway 2.6) with respect to the baseline (1970-2000). Currently, evapotranspiration is observed to be more than half of the incident precipitation, followed by soil moisture, runoff and deep recharge. This is expected to change dramatically under future climate scenarios with nearly 90% being consumed by evapotranspiration at the cost of contributions to soil moisture and runoff. Changes in landuse and landcover were explored using a scenario-based approach that incorporated (10%, 25%, and 50%) changes in the extent of forest cover, agriculture, plantations and barren land, but these results were inconclusive. Evapotranspiration under future climate is likely to be a key driver of water stress.

Recommendations

- More effort needs to be invested in studying the NE monsoon, as monsoon research tends to be focused on studying the southwest monsoon. This will help in the development of appropriate adaptation options for communities that depend on these rains.
- Shifts in monsoonal regimes need to be investigated under ongoing and future climate change as these are expected to impact regional ecology, agriculture and adaptation options.
- Further work is needed to assess the hydrological response of changing land cover (e.g., by using different hydrological models) under future climates, by choosing physical hydrologic models or combinations of models that are able to mimic the key hydrologic fluxes in a particular basin (e.g., evapotranspiration in semi-arid regions).
- Adaptive management of groundwater under a changing climate is a key ingredient of adaptation.

PROTECTED AREAS IN INDIA RESPOND DIFFERENTLY TO GLOBAL CLIMATE DRIVERS COMPARED TO SIMILAR AREAS IN AFRICA AND INDIA

Natural and human-dominated semi-arid ecosystems show clear signals of CO_2 fertilisation effects across protected areas and their buffers in India and Africa. Although the amplitude of the annual seasonal cycle is increasing over time in all regions, there are clear differences in the response of protected areas and their agro-pastoral buffers in India and the three African regions. In India, the protected areas have a smaller amplitude of annual seasonal change compared to the buffer which we attribute to their relatively greater moisture-storage regimes; these trends are reversed in the African semi-arid regions where protected areas and buffer zones respond similarly.

The amplitude of annual seasonal phenology is increasing over time; some of this is due to decreases in dry-season vegetation, and some to greater greening at the peak of the growing season. A comparison of protected areas with agro-pastoral buffers (20 km) around them, indicated that semi-arid protected areas in India have a relatively lower amplitude of annual seasonal change, which we attribute to the higher elevations, and the protected watersheds in which these protected areas tend to be located.

Greening and browning had very different impacts on key ecosystem services in the region. In some cases greening was associated with increased productivity and improved ecosystem services, while in other cases it was driven by a proliferation of detrimental invasive species. These vegetation changes impact communities, households and individuals through changes in the availability of ecosystem services such as biomass, water and food, which are mediated by social differentiation and governance regimes. We found clear evidence for CO_2 fertilisation causing higher greening trends, particularly across sites in the 350-800 mm rainfall gradient, supporting the hypothesis that this effect would find its highest expression in moisture-stressed sites.

Recommendations:

- Better communication of global and local drivers of ecosystem change and emerging trends amongst policy makers and communities may result in more robust adaptation practices. For example, a better understanding of the effects of CO_2 fertilisation and sequestration can help understand a few of the positive impacts that IAS have on global change.

- The connectivity in ecological and hydrological processes between protected areas and their buffer areas should be reflected in land-use policies in the buffer zones. Specifically, recharge areas for groundwater inside protected areas should be recognised for their role in sustaining agriculture outside.

- The capacity of multi-disciplinary teams of practitioners, land managers, and scientists needs to be built to: improve their understanding of the ongoing changes in socio-ecological systems, including the dominant local, regional and global drivers of ecosystem change (and their feedback mechanisms); and enhance their abilities to generate future scenarios of change.

- The overall implications of greening linked to bushy encroachment of invasive tree species should be considered when designing adaptation options under near-future and multi-decadal time-scales.

RURAL RISK-MANAGEMENT STRATEGIES ARE SHAPED BY CONTEMPORARY NON-AGRARIAN ASPIRATIONS

The Bhavani basin exemplifies the dynamic nature of rural livelihoods in India. The region has shifted from a feudal land system, to a textile hotbed, and back to an agrarian landscape. The type of agriculture here has also undergone profound change, shifting from dryland agriculture to intensively-irrigated agriculture. Enabling government policy has played an essential role in these shifts; free electricity coupled with a lack of regulation on groundwater has allowed farmers to shift to resource-intensive irrigated crops. Although lucrative in the short run it has resulted in the overexploitation of groundwater in the region, bringing into question the sustainability of these modes of agriculture.

Government policy in the Bhavani basin is determined largely by a populist agenda. Although profitable to communities in the short run, the lack of long-term considerations, particularly considering additional stressors from climate change, has resulted in unsustainable resource use regimes. Communities dependent on these resources are now impacted by their decline, and these impacts are differentiated by age, caste and gender.

Aspirations are an important variable – as can be witnessed in the rise of loans taken for educational purposes – that policy makers fail to consider. Farmers in the region, frustrated by increasing risks to their livelihoods, prefer that their children move out of agriculture, using resources and investments accordingly, and often prioritise short-term gains over longer-term sustainable practices.

To enhance overall wellbeing, the priorities and aspirations of both older and younger generations should be addressed by development and land-use policies.

Recommendations

- Growing precarity of groundwater resources in the region must be regulated through policy. Additional emphasis on the development, maintenance, and management of alternative and traditional irrigation sources, such as traditional tanks, is required to diversify irrigation sources.
- Policy makers must consider the non-agricultural aspirations of contemporary farming communities to understand how farmers view their own wellbeing, and manage risks.
- Recognising how aspirations change is key, and can be used to inform investments by the state and private actors into sectors such as commerce, health, education (including vocational training), and industry. It can also help with effective implementation of agricultural policies, and other programmes targeted at improving rural wellbeing, particularly in supporting youth with skillbuilding programmes, and beyond-farm livelihood opportunities.

CLIMATE- AND MARKET-DRIVEN CROPPING PATTERNS IMPACT HOUSEHOLD FOOD AND NUTRITIONAL SECURITY

Food and nutritional security is the foremost development challenge in India, with ~15% of the total population described as undernourished despite food security having recently improved. Over the last few decades, increasing urbanisation, amplified variations in rainfall and temperature, and intense use of land and water resources, have altered cropping patterns. Food security, and more specifically nutritional security, has been severely affecting the overall wellbeing of the vulnerable due to stagnating and declining agricultural productivity. The threats of climate change, water scarcity, potentially increasing population size and higher food demand, further complicate the challenge of achieving food, water and nutritional security.

Agriculture plays a pivotal role in Tamil Nadu with more than 40% of the population of Tamil Nadu dependent on this sector for their livelihood. Although the state reports one of the highest agricultural productivity rates, this performance is not consistent, and the frequency of drought has increased over time. Two consecutive years, 2014-15 and 2015-16, have seen rainfall deficits, which have enhanced the drought conditions. Agriculture in many semi-arid parts of the state is dependent on groundwater or rain, and increasingly common droughts threaten farmers' livelihoods. In the lower Bhavani, multiple endogenous and exogenous factors have resulted in shifting cropping patterns, and implications on rural household nutrition. Dietary patterns in the region have shifted due to various developmental policies, such as the White Revolution, and targeted Public Distribution System.

There has been a significant change in dietary composition: primary cereals have shifted from millets to rice, and dairy products have been added to the diet. Cropping pattern has a weighted influence on household nutritional status. Farmers have shifted from subsistence farming to high-value commercial farming in the hope for a 'bumper crop', which would offer a solution to all their problems. Given India's focus on nutrition security, it has become imperative to understand the impacts of the agricultural transition on household diets. These insights provide empirical evidence to suggest nutrition is being compromised as a result of commercial farming, though food security itself may have improved at the household level.

Recommendations

- To improve food and nutritional security, the Public Distribution System needs to supplement staples with an assortment of pulses and traditional millets, which should be customised to seasonal produce.
- Agricultural policies in the region should provide incentives to produce non-staples which are less resource-intensive and rich in nutrition. Adequate market support ensuring commercial viability of these products should be provided to farmers for enhancing income, including mainstreaming distribution of these supplements in the existing Public Distribution System.
- Households in the region are highly dependent on livestock for consumption of dairy products as well as income generation. Policies should be targeted towards enhancing milk productivity and linking farmers to the dairy value chain.
- Only a handful of villages are currently benefiting from existing nutritional schemes; institutional arrangements should be made to reach out to the areas with limited accessibility.

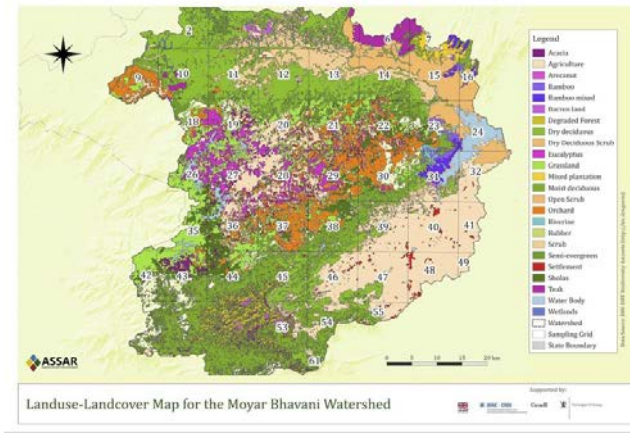
WORKING WITH STAKEHOLDERS TO IMPROVE ADAPTATION AT MULTIPLE SCALES

ATREE has contributed to discussions regarding the impacts of land-use-land-cover, and climate change and variability on ecosystems and communities at regional, national and international fora. Jagdish Krishnaswamy was appointed as a coordinating lead author for the IPCC Climate Change and Land special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

ATREE's association with regional stakeholders began early and continued throughout ASSAR's duration. Our target groups were: decision makers/policy circles; technical staff of various state agencies; and the wider public, including civil society organisations. The objective was to raise awareness around issues of environmental governance, including forests, agriculture, water and rural livelihoods. Advised by key informant interviews with researchers from Tamil Nadu Agricultural University, we have been working with researchers from the Foundation for Ecological Research Advocacy and Learning to assess changes in the NE monsoon, which provides significant amounts of rainfall to the region.

Although IAS have adversely impacted ecosystems and communities in the region for decades now, the issue has come to the forefront in the last few years through ongoing litigation in the regional (state) High Court. The Tamil Nadu Forest Department (TNFD) also invests significant effort in the control of IAS, yet little is known about (i) the extent of some of these invasive species (esp. *Prosopis juliflora*), and (ii) the success of TNFD's current removal strategies. Recognising the dearth of spatial information on the extent of *Prosopis*, and building on data on other IAS that WWF-India had provided, we set about collecting data to create a *Prosopis* map for TNFD. By working with the Forest College and Research Institute, Mettupalayam, we were able to improve our assessments of the impacts of IAS in the Moyar landscape.

Even as we set about to achieve the above, our conversations with WWF-India and Keystone Foundation suggested that there was no systematic baseline information on IAS occurrence, especially outside of the protected area network.



Landuse-Landcover Map for the Moyar Bhavani Watershed

Responding to this need, ATREE formed a collaborative network of researchers and practitioners called 'PARDESI' (Participatory Assessment of the Regional Distribution of Exotic Species in India) to collect data on IAS through researchers, practitioners, Forest Department officials, schoolchildren, college students and citizen volunteers, using a citizen science approach. For this, ATREE used the Open Data Kit platform available on Android devices to map invasive species, and conducted a series of skill-building workshops on the use of this digital platform. Our partners have taken this initiative forward, working with schools and higher-education institutions in the region to map IAS in the region. By using the camera and GPS that smartphones are equipped with, users can provide spatially explicit, verifiable information on the location of these invasive alien plants in the landscape.

At the state level, the past few years have seen a number of court cases before the Madurai Bench of the Hon'ble Madras High Court that have examined the critical state of grassland ecosystems and IAS across Tamil Nadu. Through PARDESI and other ASSAR work, Jagdish Krishnaswamy and Milind Bunyan, together with other colleagues at ATREE, are providing scientific support to legal teams petitioning for the removal of IAS and grassland conservation, and contributed to a workshop co-organised by ATREE and the Kalakkad-Mundanthurai Tiger Conservation Foundation (KMTCF) in Kalakkad-Mundanthurai Tiger Reserve (KMTR) on 30 April 2018.

Our engagement with state agencies has also been informed by larger environmental and livelihood threats in semi-arid regions outside of Tamil Nadu. In Karnataka, ATREE has long been engaged in the water reform process, and Shrinivas Badiger and other experts were invited to be on the state task force instituted to advise the Karnataka Knowledge Commission in November 2017. The Knowledge Commission was established by the state government to reformulate guidelines and policies in the agriculture and water sector. A final report was submitted by the task force, which was informed by the sub-committees with active involvement of ATREE researchers.

In October 2018, ATREE researchers working in the agriculture and water sector, led by Shrinivas Badiger, organised a 10-day training workshop titled "Management Development Programme on Integrated Water Resources Management for Karnataka State Water Resource Engineers and Managers", with support from the Karnataka State Government's Advanced Centre for Integrated Water Resources Management (ACIWRM) and the Asian Development Bank (ADB). The goal of the training workshop was to enhance the capacities of engineers and managers in water-related departments of government to understand, analyse and address water-resource management in an integrated and holistic manner. ATREE will be organising a series of such capacity assessments and training programmes for the Karnataka State Water Resources Department officials in the coming years, and continues to support the state's effort in reforming the agricultural and water sectors.

NEXT STEPS FOR RESEARCH, POLICY AND PRACTICE

Our research in the Bhavani has highlighted the need for policy to take into consideration the how and why of risk management, recognising the role of individual and household aspirations and perceptions of risk. For policy to comprehensively promote sustainable rural livelihoods it is important to integrate agricultural and non-agricultural interventions. Our study on groundwater use in the region has emphasised the importance of policy to consider long-term impacts, particularly in climate-vulnerable semi-arid regions that face multiple stressors. Furthermore our study underscored the insidious role of policy in reinforcing gender inequality in the region.

Considering the regional variability of climate risks (e.g., shifting monsoons, erratic rainfall), differential resource availability and socioeconomic capacities, generic welfare and development programs alone are insufficient to address specific adaptation needs of communities in the region. This is especially pertinent for semi-arid regions that have unique and diverse socio-ecological characteristics which make them more vulnerable to the impacts of climate change; explicit and regionally-specific policy focusing on adaptation is required. Research programmes targeting climate resilience and improving adaptive capacity should link to – or be embedded in – rural development processes that address water scarcity, food insecurity, social welfare, and poverty alleviation. Climate advisories, including crop advisories, should be customised to assist rainfed farming practices since these are most vulnerable to climate change.

Patterns of historical marginalisation manifesting as asymmetrical capabilities have severely impeded the adaptive capacities of scheduled castes and tribes in the region. Programs are needed that focus on building their adaptive capacities through access to capital, skill building, and the strengthening of institutions to ensure equitable access to natural resources. Research that leads to impact and benefits for people should be undertaken in a collaborative manner between government, non-governmental organisations (NGOs), communities (including those most marginalised and disempowered), the private sector and academia, and integrate these diverse sources of knowledge. Long-term, targeted responses are needed, and government needs to support people's livelihoods by building adaptive capacity, making governance inclusive, providing jobs and creating markets.

With temperatures expected to rise and rainfall regimes expected to change (e.g., delayed monsoon onset, declining contributions from the NE monsoon), scientists and researchers need to direct more effort at understanding the dynamics and trends of climate variables. Special attention is required for understanding the expected changes to the NE monsoon which tends to be understudied compared to the better understood (and researched) southwest monsoon.

Insufficient IAS management and monitoring strategies, and changes in forest management regimes, have impacted the livelihoods of forest communities, increasing their vulnerability to the impacts of climate change. Although the Forest Department currently invests significant effort in managing IAS, the department and researchers need to work collaboratively in assessing the efficacy of current removal strategies, and – where needed – test new ones. IAS management by the Forest Department should focus on developing forest management plans that are sensitive to the needs of these communities, and could provide a source of income to communities by involving them in IAS removal and use.

In our engagement with the state and civil society organisations in peninsular India, we will continue to work with the Karnataka State Government on providing scientific evidence and training programmes for capacity building of the state water resources department officials. Expanding our ongoing engagement with the Forest Department in Tamil Nadu, we are initiating a series of such discussions with organisations in Tamil Nadu working on sustainable water management, and we expect similar progress with the state water resources departments and planning commissions.

AUTHORS

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Photographs in this section: Milind Bunyan, Lucia Scodanibbio, Jagdish Krishnaswamy, Prakriti Prajapati, Ashoka Trust for Ecology and the Environment

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Photograph: Mark Tebboth

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PUBLICATIONS IN PROGRESS

Alare, R. S. and Segnon, A. In prep. Landscape transformational analysis in semi-arid areas: Case study of Ghana and Mali.

Alare, R. S., Lawson, E. T., Mensah, A., Ansah, P. and Adiku, P. In prep. Social networks, gender relations, and climate change adaptation in the semi-arid region of Ghana.

Ashwathi, V. K., Badiger, S., Krishnaswamy, J. and Bunyan, M. In prep. Implications of future climate and land use/land cover change on catchment water budgets in Moyar-Bhavani sub-basin. Link to poster.

Camfield, L., Leavy, J., Endale, S. and Tefere, T. In prep. 'People who once had 40 cattle are left only with fences': Coping with Persistent Drought in Awash, Ethiopia. Link to presentation.

Degefu, M. A., Assen, M., Few, R. and Tebboth, M. G. L. In prep. Perceptions of local people on impacts and management of *Prosopis juliflora* in arid/semi-arid regions of the Middle Awash Valley, Ethiopia. Link to poster.

Degefu, M. A., Assen, M. and Satyal, P. In prep. Villagisation and water resource in the Middle Awash Valley of Ethiopia: Implications for climate change adaptation.

Duraisamy, V., Mugari, E., Segnon, A. C., Togarepi, C., Tesfaye, M., Alare, R. S. and Misra, G. In prep. Landsat-based land use / land cover mapping and cross-site analysis at South Asia and Africa.

Few, R., Satyal, P. and Tebboth, M. G. L. In prep. Using a justice/capabilities framing to understand people's vulnerability and adaptive capacity in the drylands of East Africa.

Few, R., Singh, C., Spear, D., Tebboth, M., Davies, J., Thompson-Hall, M. and Muhvich, K. In prep. The role of culture as a barrier and enabler to adaptation in semi-arid lands.

Gitonga, Z. and Visser, M. In prep. Evaluating access, use and impact of climate information on welfare and use of adaptive strategies by rural families in arid regions of northern Namibia.

Gitonga, Z. and Visser, M. In prep. Impact of migration on household social protection and wellbeing: An application of dose-response using control function approach.

Gitonga, Z., Visser, M. and de Groot, H. In prep. Leveraging improved maize technology uptake to improve welfare of farm families through market participation and food security.

Hegde, G., Sasidharan, S. and Bazaz, A. In prep. Traditional knowledge systems and the role of knowledge brokers, in India. Link to poster.

Hegga, S. and Kunamwene, I. In prep. Mapping actor influence in climate adaptation practices: The case of north-central Namibia. Link to poster.

Hegga, S., Kunamwene, I. and Ziervogel, G. In prep. Local participation in decentralised water governance: Insights from north-central Namibia. Link to presentation.

Kaur, H., Bazaz, A. and Srinivas, A. In prep. Understanding access to knowledge systems and rural perspectives from Karnataka.

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Michael, K., Deshpande, T. and Bhaskara, K. In prep. The political economy of climate change and vulnerability in a neo-liberal city: A case of Bengaluru's informal settlements. Link to summary.

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Ofoegbu, C. and New, M. In prep. Making climate information useful to adaptation decision making in the agriculture sector in Namibia.

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Poniso, A. L. and Togarepi, C. In prep. An assessment of climate variability on key forest ecosystem services and its impacts on livelihoods of communities in North Central Namibia. A case of Onesi Constituency, Omusati Region.

Rahman, A., Basu, R. and Singh C. In prep. Exploring the interface between climate change and migration: Evidence from India.

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Segnon, A. C., Totin, E., Zougmore, R. B., Achigan-Dako, E. G., Lokossou, J., Ofori, B. D., Gordon, C. In prep. Assessing household vulnerability in semi-arid areas of Mali: A multidimensional approach.

Segnon, A. C., Zougmore, R. B., Achigan-Dako, E. G., Ofori, B. D., Gordon, C. In prep. Harnessing agrobiodiversity for climate change adaptation in semi-arid areas of Mali.

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Singh, C. and Basu, R. In prep. Moving in and out of vulnerability: Interrogating migration as an adaptation strategy along a rural urban continuum in India. Link to summary.

Singh, C., Tebboth, M. G. L., Spear, D., Ansah, P. and Mensah, A. In prep. Opening up the methodological toolkit on climate change vulnerability and adaptation research: Reflections from using life history approaches.

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SK, N. In prep. Situating vulnerability in climate change adaptation research: Insights from India and Ghana.

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Solomon, D. and Badiger, S. In prep. The evolution of vulnerability: Rethinking the scope of indicator-based assessments in agrarian socio-ecological systems.

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Tebboth, M. G. L., Singh, C., Spear, D., Mensah, A. and Ansah, P. In prep. The role of mobility in changing livelihood trajectories: Implications for vulnerability and adaptation in semi-arid regions. Link to summary.

Tebboth, M. G. L., Few, R., Assen, M. and Degefu, M. In prep. Valuing *Prosopis juliflora*? Analysing ecosystem service narratives to understand environmental management dilemmas.

Thomas, R. and Mascarenhas, K. In prep. Changing groundwater regimes and geosystem services of Nagawara catchment, Bengaluru district.

Togarepi, C. and Nangolo, E. In prep. Gendered responses to climate change impacts on ecosystem services in north-central Namibia.

Togarepi, C., Nangolo, E. and Gitonga, Z. In prep. Climate change impacts on livelihood strategies and food security in north-central Namibia.

Totin, E., Sidibe, A., Thompson-Hall, M. and Olabisi, L. In prep. Achieving sustainable future objectives under uncertain conditions: Application of a reflexive framework to adaptation trajectories in rural Mali. Link to summary.

Totin, E., Sidibe, A. and Thompson-Hall, M. In prep. Governance of resources: Is there space for implementing the land policy under complex customary tenure practices? Link to presentation.

Wasonga, O., Kibet, S., Tebboth, M. G. L., Few, R. In prep. Do wildlife conservancies enhance the adaptive capacity of local communities? Perspectives from northern Kenya.

Werners, S.E., Wise, R., Butler, J., Totin, E. and Vincent, K. In prep. Learning from adaptation pathway development: key characteristics and guiding principles.

Yaduvanshi, A., Nkemelang, T., New, M. and Bendapudi, R. In prep. Impacts of 1.5 and 2 degree global temperature rise on temperature and rainfall extremes across India.

Yaduvanshi, A., Zaroug, M., Bendapudi, R. and New, M. In prep. Regional impacts of 1.5 and 2 degree global temperature rise on different states of India. Link to poster.

Ziervogel, G., Satyal, P., Basu, R., Mensah, A. and Singh, C. In prep. Vertical integration for climate change adaptation in the water sector: Lessons from decentralisation in Africa and India.

THESES

Abass, R. 2018. *Formal and informal institutions in climate change adaptation: the case of Lawra and Nandom districts in the upper west region*. Master's thesis. University of Ghana. Link. Link to poster.

Akugre, F.A. 2017. *Implications of land tenure rights on farmers' adaptive capacity to climate variability and change in semi-arid North-Western Ghana: The case of crop farmers in the Lawra district.* Master's thesis. University of Ghana. Link.

Angula, M. In prep. *A gendered and intersectional analysis for understanding vulnerability to the changing climate within socially diverse Onesi constituency.* PhD thesis. University of Cape Town. Link to poster.

Assabil, B. 2017. *Women farmers' perception to climate change/ variability and their adaptation strategy in the Lawra district.* Master's thesis. University of Ghana. Link.

Bachuri, K. 2019. *Assessing the availability, access and use of medicinal plants in the Lawra and Nandom districts of the upper west region.* Master's thesis. University of Ghana. Link.

Ballo, M. In prep. *Effet des changements climatiques et des pratiques agricoles sur la gestion durable des bas-fonds dans le Mali Sud: Cas de Sorobasso et Koumbri dans le Cercle de Koutiala, Bamadougou Bagotière dans le Cercle de Sikasso.* PhD thesis. Institut Universitaire de Développement Territorial de Bamako (IUDT).

Berthe, D. 2017. *Analyse de la dynamique des modes d'accès au foncier agricole dans les communes rurales de koloningue et de m'pessoba, Cercle de Koutiala au Mali.* Master's thesis. Institut supérieur de formation à la recherche appliquée (ISFRA). Link.

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Biney, A. 2019. *The role of remittances on adaptive capacity of smallholder farmers in Lawra district.* Master's thesis. University of Ghana. Link.

Bridges, K. 2017. *The role of climate information and advisory services in drought resiliency: A comparative case study in Tamil Nadu, India.* Master's thesis. Oxford University. Link.

Chappel, A. 2018. *Barriers and enablers to the adoption of practices to improve crop production and reduce vulnerability to climate risks in the semi-arid Omusati Region, Namibia*. Master's thesis. University of Cape Town. Link. Link to poster.

Cisse, O. 2017. *Analyse de l'évolution des pratiques de pêche dans la commune rurale de Zangasso, cercle de Koutiala au Mali*. Master's thesis. Institut supérieur de formation à la recherche appliquée (ISFRA). Link.

Dakouo, J. In prep. *Agriculture intensification pathways in Koutiala: Implications on access to agricultural natural resource base for different social groups.* Master's thesis. Université des Sciences Sociales et de Gestion de Bamako (USSGB).

Daou, J. 2019. *Effects of agriculture intensification pathways on food, nutrition and income securities of social groups in Koutiala, Mali.* Master's thesis. Institute Polytechnique Rural de Formation et de Recherche Appliquée (IPR-IFRA Katibougou, Koulikoro). Link.

Davies, J. 2016. *Exploring the factors and actors that contribute to the co-production of climate adaptation plans: A comparison of three municipalities in the Western Cape Province, South Africa.* Master's thesis. University of Cape Town. Link.

Gitonga, Z. In prep. *Leveraging climate information, improved adaptive technology and migration to build resilience and reduce vulnerability of rural communities to climate risks in arid and semi-arid lands.* PhD thesis. University of Cape Town.

Haukongo, C. 2017. *An assessment of determinants of adaptive capacity of livestock farmers to climate change in Omusati Region.* Honours thesis. University of Namibia. Link. Link to poster.

Joshi, N. In prep. *Barriers and enablers to the sale of livestock in Omusati, Namibia*. Master's thesis. University of Cape Town.

Jubase, P. In prep. *Analysis of extreme weather events over the Limpopo and Botswana region: Synoptic systems of heat wave events and extreme hot days*. Master's thesis. University of Cape Town.

Kaba-Ayamba, O. In prep. *The influence of adaptation intervention from ecosystem services and wellbeing: A comparative study in the Lawra and Nandom districts of Upper West Ghana.* PhD thesis. University of Ghana.

Koomson, E. In prep. *Enhancing the provision and management of ecosystem services in agricultural landscapes for climate change adaptation in the upper west region of Ghana*. PhD thesis. University of Ghana.

Kumadey, C. In prep. *Improving market systems for non-timber forest products as a climate change adaptation strategy: A case study of Lawra district.* Master's thesis. University of Ghana.

Kunamwene, I. In prep. *Wellbeing as a way of looking at vulnerability and response to drought in Onesi, Namibia.* PhD thesis. University of Cape Town.

Lente, I. 2017. *Vulnerability and adaptation to changes in agroecosystems and climate in semi-arid Ghana: Lessons from smallholder farmers in Nandom district*. PhD thesis. University of Ghana. Link. Link to poster.

Mosime, B. 2018. *The use of traditional weather forecasting by agro-pastoralists of different social groups in Bobirwa sub-district, Botswana*. Master's thesis. University of Cape Town. Link.

Mugari, E. In prep. *Vulnerability and responses to recent changes in the natural environment / ecosystem services of Bobirwa, Botswana.* PhD thesis. University of Botswana. Link to poster.

Mulwa, C. In prep. *Managing vulnerability to risks in smallholder farming: Essays on sustainable agricultural intensification and climate change adaptation in developing countries*. PhD thesis. University of Cape Town.

Musingarabwi, S. 2016. *Time-use and wellbeing in Onesi, Namibia*. Master's thesis. University of Cape Town. Link.

Nkemelang, T. 2018. *Temperature and precipitation extremes under current, 1.5 and 2.0 degree global warming above pre-industrial levels and implications for climate change vulnerability: Botswana case study.* Master's thesis. University of Cape Town. Link.

Omari, K. In prep. *Drought management in Botswana.* PhD thesis. University of Cape Town.

Omari, S. In prep. *Vulnerability and adaptation of farming households to climatic and non-climatic stressors in semi-arid Ghana.* PhD thesis. University of Ghana. Link to poster.

Plea, A. 2016. *Stratégie d'Adaptation des groupes sociaux face aux changements climatiques: Cas du maraîchage dans le village de Koumbri (Commune de Yognogo, Cercle de Koutiala).* Master's thesis. Institut Universitaire de Développement Territorial de Bamako (IUDT). Link.

Poniso, A. L. 2017. *An assessment of impacts of climate variability on key forest ecosystem services and livelihoods of communities in Onesi constituency, Omusati region.* Honours thesis. University of Namibia. Link.

Rathore, D. 2017. *Blackbuck occupancy in Moyar Valley, Tamil Nadu*. Master's thesis. TERI School of Advanced Studies. Link.

Sajith, S. 2017. *Changing cropping patterns and its implications on household food security and nutrition*. Master's thesis. TERI School of Advanced Studies. Link.

Salifu, A. R. 2016. *Social differentiation in livelihood vulnerability and adaptation: A study of groundnut production in the upper west region.* Master's thesis. University of Ghana. Link. Link to poster.

Sanga, U. In prep. *A resilience-based approach to modelling food security and climate change adaptation among rural farmers in southern Mali.* PhD thesis. Michigan State University.

Sanogo, T. 2017. *Changements climatiques et gouvernance des ressources pastorales dans la commune rurale de Sincina Cercle de Koutiala, Mali.* Master's thesis. Institut supérieur de formation à la recherche appliquée (ISFRA). Link.

Segnon, A. In prep. *Exploring the role of agrobiodiversity in climate change adaptation in semi-arid areas of West Africa: A case study in Mali.* PhD thesis. University of Ghana.

Selato, J. C. 2017. *Credibility and scale as barriers to uptake and use of seasonal climate forecasts in Bobirwa Sub-District, Botswana.* Master's thesis. University of Cape Town. Link. Link to presentation.

Shaibu, M. T. 2016. Climate change adaptation strategies of small livestock farmers of Nandom and Lawra. Master's thesis. University of Ghana. Link. Link to poster.

Shooya, O. 2017. *Barriers and enablers to water access and community wellbeing in the Onesi constituency of Namibia: The case of Okalonga B and Onandjandja villages.* Master's thesis. University of Cape Town. Link.

Sulemana, A. 2017. *Management and use of non-timber forest products (NTFPs) as climate change adaptation strategy in Lawra district, Ghana.* Master's thesis. University of Ghana. Link.

Traore, A. 2019. *Effect of* agriculture *intensification on the production of maize in the district of Koutiala, Mali: Case of the village of N'Goutjina.* Master's thesis. Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR-IFRA, Katibougou, Koulikoro, Mali). Link.

Traore, O. T. 2016. *Gouvernance et vulnérabilité des groupes sociaux: Analyse de la situation institutionnelle autour du coton dans le Cercle de Koutiala.* Master's thesis. Institut Universitaire de Développement Territorial de Bamako (IUDT). Link.

Yidana, A. A. 2016. *Social differentiation in the vulnerability and adaptation patterns among smallholder farmers: Evidence from north western Ghana*. Master's thesis. University of Ghana. Link.

Zulfawo, T. A. 2016. *Exploring the competing uses of water in the context of climate variability and change in the Lawra district.* Master's thesis. University of Ghana. Link.

REPORTS

Alare, R. S., Adiku, P., Ansah, P., Mensah, A., Lawson, E. T., Thompson-Hall, M. and Hoffman, T. 2017. *Using Transformative Scenario Planning to think critically about the future of agriculture and food security in the Upper West region of Ghana.* [Report]. Adaptation at Scale in Semi-Arid Regions (ASSAR). Link.

ASSAR. 2016. *ASSAR East Africa (Ethiopia) Research-into-Use and Stakeholder Engagement Event* [Report]. Adaptation at Scale in Semi-Arid Regions (ASSAR). Link.

ASSAR. 2017. *Using Transformative Scenario Planning to think critically about the future of water for productive use in Omusati, Namibia.* [Report]. Adaptation at Scale in Semi-Arid Regions (ASSAR). Link.

ASSAR. 2019. *Changing ecosystem services are increasing people's vulnerability in semi-arid regions.* [Report]. Adaptation at Scale in Semi-Arid Regions (ASSAR). Link.

ASSAR. 2019. *Collaborative research consortia are complex, but have great potential.* [Report]. Adaptation at Scale in Semi-Arid Regions (ASSAR). Link.

ASSAR. 2019. *Effective adaptation needs forward-looking inclusive governance arrangements across different levels.* [Report]. Adaptation at Scale in Semi-Arid Regions (ASSAR). Link.

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Photograph: Birgit Otterman

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Collaborative Adaptation Research Initiative in Africa and Asia

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