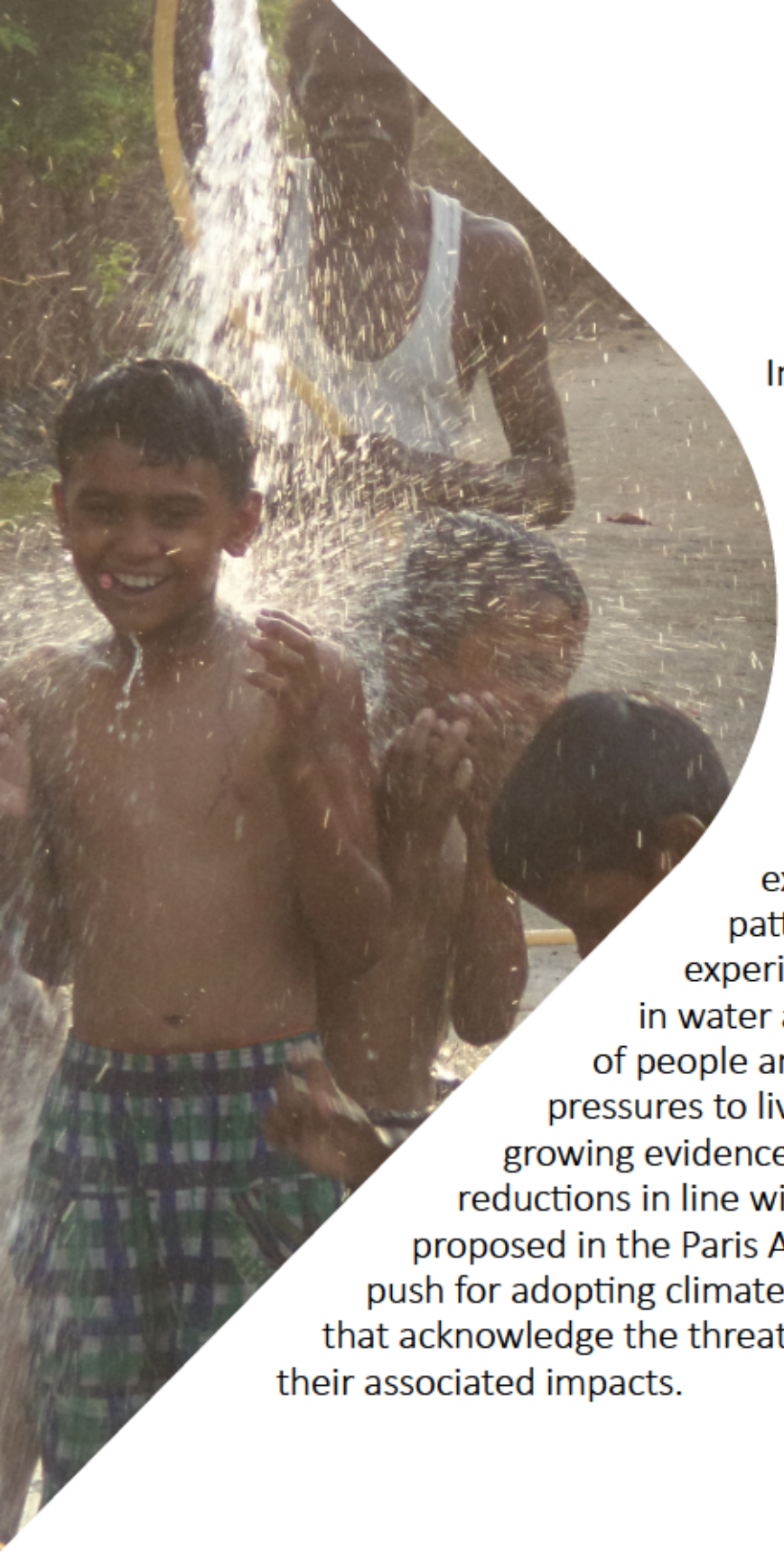
ASSAR

ADAPTATION AT SCALE IN SEMI-ARID REGIONS

2014–2018

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

AN ASSAR CROSS-REGIONAL INSIGHT



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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