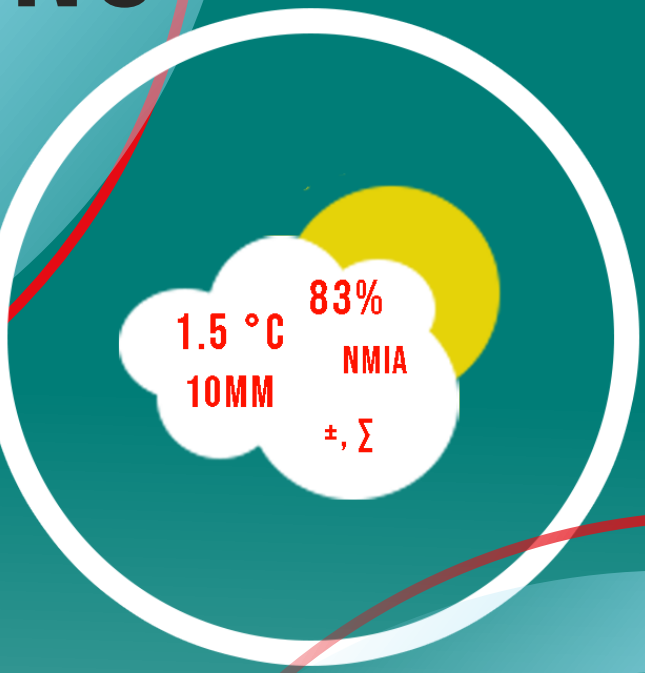
CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

NOVEL INSIGHTS BRIEF

1.5°C WARMING



More than one billion people live in deltas, semi-arid lands, and glacier-dependent basins in Africa and Asia, hotspot regions that are the most vulnerable to climate change.

Over 7 years, the CARIAA program supported collaborative research to strengthen resilience in these hotspots by informing policy and practice. CARIAA brought together more than 450 researchers across 15 countries through four consortia, with selected study areas based on geographic and social similarities—with the aim of sharing knowledge and experiences across disciplines, sectors and geographies.

The CARIAA Novel Insights series provides a snapshot of the key insights that emerged from this work, on the most pertinent topics for climate adaptation.

GLOBAL TEMPERATURE INCREASE OF 1.5°C EXPECTED IN LESS THAN A DECADE, WITH HIGHER WARMING ANTICIPATED IN HOTSPOTS.

An increase in global temperatures by an average of 1.5°C above pre-industrial levels is fast approaching within the next decade, with temperatures in the Himalayan Mountains and the African semi-arid lands projected to increase more than this global threshold. What does this mean for the global population, and the ecosystems at risk?

- With 1.5°C warming, at least a quarter of the ice on the Himalayan mountains today will be lost, affecting 13% of the world's population.
- Semi-arid lands will also experience high variations in precipitation, with significant impacts on power production, agriculture and health.
- The impact in low-lying deltas will not be measurable until around the 2040s, when the area of land under inundation is expected to be about 2.5 times larger.

BACKGROUND

RESPONDING TO THE CALL FOR EVIDENCE ON THE IMPACTS OF A 1.5°C WARMER WORLD

A huge policy challenge emerged when the Paris Agreement called for a special report from the Intergovernmental Panel on Climate Change (IPCC) on the impacts of global warming of 1.5°C above pre-industrial levels, due to a lack of existing sound scientific analysis. Not only was the literature on 1.5°C warming impacts sparse (Hulme 2016), but the literature published at the time also lacked a regional or hotspot focus. Similarly, although we know the difference between 1.5°C and 2.0°C global warming is significant, we do not know how this manifests at the regional and hotspot scales, as different places will experience different levels of impacts at these temperature intervals. This gap in knowledge is what triggered CARIAA scientists to investigate the ways in which warming of 2.0°C over 1.5°C would be significant in each of three hotspots—low-lying deltas, snow-melt and glacier-fed river basins, and semi-arid lands.

NEW INSIGHTS

BOTH 1.5°C AND 2.0°C WARMER WORLDS ARE RAPIDLY APPROACHING

Our model studies revealed that the 1.5°C global warming limit is being approached very quickly, and is expected to be reached within a decade in the studied hotspots. The median expected timing of global warming of 1.5 and 2.0°C is 2025 (2008–2043) and 2039 (2022–2058), respectively (Zaroug et al. 2018—submitted). Observed concentrations of CO2 have been largely tracking the IPCC's RCP 8.5 scenario and divergence from this scenario will be slow, even with ambitious policy interventions. These timing ranges are hence considered reasonably likely. Therefore, both 1.5 and 2.0°C increases are expected to arrive rapidly, pointing to challenges for adaptation at local scales (Zaroug et al. 2018—submitted).

WARMING IN HOTSPOTS WILL BE VARIED AND SIGNIFICANTLY HIGHER THAN THE GLOBAL AVERAGE

In the Indus, Ganges and Brahmaputra (IGB) river basins in South Asia, a global average warming of 1.5°C results in a much higher warming of 2.1°C (1.4–2.6) while a 2.0°C global warming leads to 2.7°C (2.0–3.4) (Lutz et al. 2018—submitted; Kraaijenbrink et al. 2017). The higher the altitude in the IGB, the greater the difference between global and hotspot warming levels. In the semi-arid regions (SARs), at least 44 African countries will warm more than the global warming mean of 1.5°C, with 11 of them warming by over 25% more than the global mean change. In all cases, national temperatures under both 1.5°C and 2°C of global warming will be climatologically different. Countries with arid and semi-arid climates and those with more continental locations will warm more than those with predominantly humid and maritime conditions. For each increment of global warming, temperature extremes between countries are statistically different, indicating markedly different regional climates at different levels of global warming (Nkemelang et al. 2018).

29–43% OF THE ICE MASS IN THE INDUS-GANGES-BRAHMAPUTRA MOUNTAINS WILL BE LOST BY THE END OF THE CENTURY

Under a global 1.5°C temperature increase scenario, 29–43% of the present-day ice mass in the high mountains of Asia would be lost by the end of the 21st century (Kraaijenbrink et al. 2017). These changes will lead to seasonal shifts in water availability and may have serious consequences for mountain and river basin communities—about 910 million people who depend on the glacier and snow-melt water as a key water source for livelihood-related activities. Global warming of 1.5°C will also lead to increased precipitation extremes and floods, heat stress, and droughts in this region. All of these phenomena will increase linearly to 2.0°C, affecting agricultural production, hydropower production, and human health at both limits of global warming.

NO IMPACT WILL BE DISCERNIBLE IN LARGE DELTAS UNTIL THE 2040S

In the world's largest and most highly populated deltas—the Ganges-Brahmaputra-Meghna (GBM), Volta and Mahanadi deltas—the differential effects (both sea level rise and increased river flows) of a 1.5°C warmer world compared to 2.0°C may not be discernible until at least the 2040s due to annual variability. At that point in time, monsoonal flooding in the GBM delta will become more frequent and widespread under climate change, increasing in a 3°C world. The average depth of flooding is expected

Photo credit, from left to right: Jennifer Leavy, Anju Pandit

to double, while the average area of land under inundation would be about 2.5 times larger. The greatest number of people affected by flooding in the GBM delta are projected to be in Khulna and Barisal.

AFRICAN SEMI-ARID LANDS TO EXPERIENCE HIGH WARMING AND RAINFALL VARIATIONS

In general, coastal countries in West Africa and most countries in East Africa show lower relative warming, while Sahelian, North African and southern African countries show greater relative warming. About 30 other countries are projected to experience reductions in rainfall, largely in southern Africa, western West Africa and western North Africa. On the other hand, countries in East Africa, eastern West Africa and eastern North Africa will have increased rainfall. Decreases in mean rainfall and increases in dry-spell length are also projected at each increment of global temperature increase in already water-stressed Botswana. These impacts will lead to more frequent water shortages in today's urban and agricultural supply systems. At global warming of 1.5°C, 14.3 million livestock holder families in East Africa will be affected by the 30°C cattle production threshold, above which cattle productivity falls. In Kenya alone, 1.7 million heads of cattle will be lost due to these conditions, an equivalent of US$680 million today. Even higher cattle losses are expected at 2°C of global warming.

LOOKING FORWARD

IT WILL BE NEARLY IMPOSSIBLE TO STAY BELOW THE 1.5°/2°C THRESHOLDS

To meet the 1.5°C or even the 2°C global warming target will be a difficult task. There is a need to slow the pace of warming and to invest in resilience to the unavoidable warming already locked into the climate system. Consequently, formulation of robust climate change adaptation policies and actions needs to be based on the full range of climate change projections and not just 1.5°C, while being cognizant of regional differences and circumstances.

FURTHER READING

- Hulme M (2016) **1.5 °C and climate research after the Paris Agreement**. *Nature Climate Change* 6, 222–224. (doi:10.1038/nclimate2939)

CARIAA PAPERS ALREADY PUBLISHED AS OPEN ACCESS:

- Nkemelang T et al. (2018) **Temperature and precipitation extremes under current, 1.5°C and 2.0°C global warming above pre-industrial levels over Botswana, and implications for climate change vulnerability**. *Environ. Res. Lett.* 13: 065016, 1–11.
- Kraaijenbrink PDA et al. (2017) **Impact of a global temperature rise of 1.5 degrees Celsius on Asia's glaciers**. *Nature* 549, 257–260.
- Nicholls RJ et al. (2018) **Stabilization of global temperature at 1.5°C and 2.0°C: implications for coastal areas**. *Phil. Trans. R. Soc. A* 376: 20160448. http://dx.doi.org/10.1098/rsta.2016.0448

FURTHER READING, CONTINUED

PUBLICATIONS UNDER REVIEW FOR PUBLICATION IN DIFFERENT JOURNALS:

- **SARs:** National Climate Change at 1.5°C and 2.0 °C Global Warming over Africa
- **Basins:** Regional Environmental Change South Asian river basins in a 1.5°C warmer world
- **Deltas:** What are the Implications of sea-level rise for a 1.5°C and 3.0°C rise in global mean temperatures in vulnerable deltas?

A FINAL SYNTHESIS PAPER LED BY CARIAA'S CLIMATE SCIENCE WORKING GROUP IS IN PREPARATION FOR PUBLICATION IN THE 6TH ASSESSMENT REPORT OF THE IPCC (AR6):

- Characterising climate signals in complex climate hotspot systems in the developing world

OTHER TOPICS IN THE SERIES

MIGRATION

RESEARCH FOR IMPACT

EFFECTIVE ADAPTATION

GENDER AND SOCIAL EQUITY

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