Fragile Boundaries: Wetland Restoration in a Warming Zimbabwe

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Wetlands are sanctuaries in a warming world. They hold water in dry landscapes, fertility in poor soils, and coolness in rising heat. For communities facing drought or displacement, they promise life: food gardens, safe water, a place to endure. Yet this very abundance creates its own fragility. When wetlands are settled, farmed, or divided, the sanctuary begins to unravel.

That paradox is what makes wetlands so compelling, and so precarious. They store vast amounts of carbon and sustain extraordinary biodiversity. But when they are degraded, the costs are immense: carbon released back into the atmosphere, water supplies disrupted, entire landscapes destabilized.

Wetlands are places of promise, and places of risk.

In Zimbabwe, this paradox is urgent. Sites once thriving as wetlands now sustain gardens for communities displaced by drought and heat. These ecosystems, nature's own climate mitigation strategy, are fracturing under the weight of climate migration. Yet rehabilitation would mean asking families to move again, with all the disruption and trauma that entails. Before any such decision can be considered, a more basic question comes first: will the climate itself even permit these wetlands to recover? To answer, we turn to the data, to hear the story they tell – a story of rainfall that sustains and heat that threatens.

Why Wetlands Matter

Although wetlands cover less than eight percent of the Earth's surface, they provide more than forty percent of its ecosystem services (Zeleke et al. 2024) and are valued at up to $39 trillion annually in global benefits (Ramsar Convention on Wetlands 2025). They purify and store water, recharge groundwater, regulate floods, and support pollination and agriculture in fragile regions. They also secure food supplies, sustain livelihoods, protect coasts, and provide habitat for nearly half of all known species.

Healthy wetlands are among the world's most effective carbon sinks, storing carbon in soil and biomass at rates that often exceed forests per unit area. When degraded, however, they reverse course: releasing carbon, disrupting water systems, and accelerating climate change (Magure et al. 2022). Globally, more than seventy percent

of wetlands have been lost over the past century, mostly to human activity and climate stress.

These pressures are felt acutely in Sub-Saharan Africa. Rising heat, erratic rainfall, and prolonged drought directly threaten wetland resilience (UCAR 2024). Climate change also drives indirect pressures: when surrounding lands become uninhabitable, wetlands attract climate migrants. The World Bank estimates that as many as 85.7 million people in Sub-Saharan Africa could be internally displaced by climate change in coming decades (Clement et al. 2021).

Indigenous Knowledge

Statistics alone cannot capture what wetlands mean to the people who live with them. In Zimbabwe, wetlands have long been understood as sacred, life-giving places. What Western science now calls “ecosystem services” or “nature-based solutions” is, in many ways, only catching up to ancestral knowledge. Zimbabwean wetland protection activist Jimmy Mahachi describes wetlands as “very sacred places, according to our religion, the Shona culture, or the Bantu people of Zimbabwe,” where the water itself is treated as holy. But when wetlands are disturbed, he notes, “the sacredness of the wetland is no longer of effect” (Mongabay 2025).

For residents of Mabvuku, a suburb of Harare that has endured decades without reliable tap water, wetlands are not only sacred but essential sources of safe water. Mahachi warns that “continued degradation of wetlands has eroded their connection to humanity,” breaking the balance between people and the places that sustain them. His decade of advocacy reflects what global science now affirms: wetlands are indispensable, not only for biodiversity and climate mitigation, but for sustaining communities themselves (Mongabay 2025).

Zimbabwe at the Crossroads

In Zimbabwe, about sixty percent of its wetlands lie in communal and resettlement regions, placing them under continual strain. The country has already lost nearly half its wetland area since the 1980s. Yet there is also resilience: Mahachi, founder of the Cleveland Action Alliance, has spent the past decade advocating for his community’s right to water and for the preservation of the Cleveland Dam. The dam is one of Zimbabwe’s seven Ramsar wetlands (Ramsar 2024), designated under an international treaty that recognizes wetlands of global ecological importance.

Alongside such local efforts, national initiatives expanded wetland coverage from 1.8 percent of land area in 2015 to 2.0 percent in 2020 (Government of Zimbabwe 2015, 2020). More recently, Zimbabwe hosted COP15 in July 2025. The conference produced

a new ten-year Strategic Plan, increased budget commitments, and pledged to restore 250,000 hectares of degraded wetlands and designate five additional Ramsar sites (Wetlands International 2025).

The real test, however, comes at the community level. The LINCZ project is working to rehabilitate wetlands in Binga, Gwanda, and Mwenezi. Led by Zimbabwean partners and supported internationally, it responds to local advocacy and the needs of families who depend on these ecosystems for survival. But local advocacy and national plans still face a deeper uncertainty: the climate itself. Zimbabwe, like many equatorial regions, is warming faster than the global average, magnifying the risks.

Our research joins this effort at a preliminary stage. Before families are asked to move and rehabilitation begins, we must ask: will a changing climate even permit these wetlands to recover? Their viability depends on thresholds shaped by rainfall and temperature. Consistent precipitation replenishes the water table, the underground reservoir that keeps wetlands alive even through dry spells. If that cycle is broken – if rains become too scarce or too erratic – restoration may prove impossible. Yet when we turned to the climate data, the picture was not entirely bleak. The evidence on precipitation offers a surprising measure of hope.

The First Story: Signs of Hope

At the heart of our study are three wetlands: Chitongo in Binga, Simbumbumbu in Gwanda, and Chinyerenyere in Mwenezi. Once thriving ecosystems, they have become places of refuge. Families displaced by drought and heat have migrated toward them, turning parts of the wetlands into small-scale farms, community gardens, and homes. The LINCZ project now seeks to bring these wetlands back to health. Our role is to ask the question that must come first: does the climate still give them a chance?

To answer that, we began with rainfall. Historical records from 1960–2021 gave us a baseline of long-term trends. For the future, we drew on climate models that project conditions through the end of the century. These projections are reported as 20-year averages, giving us a picture of long-term shifts rather than year-to-year swings. The models consider different possible scenarios, from greener pathways with lower emissions to more extreme ones.[1]

[1] For the climate data geeks: historical monthly weather data came from CRU-TS-4.06 (Harris et al. 2020), bias-corrected with WorldClim 2.1 (Fick and Hijmans 2017). Future scenarios used CMIP6 projections (WorldClim 2025), across several Shared Socioeconomic Pathways (SSPs). Among the 14 climate models available, we focused on ACCESS-CM2, since Babaousmail et al (2023) determined that it simulates African climate conditions relatively well compared to others.

To interpret the rainfall data, we needed a benchmark. We drew this from Zimbabwe's internationally recognized Ramsar wetlands. These include, for example, the Cleveland Dam outside Harare, where activist Jimmy Mahachi has spent years campaigning for protection. From these sites we identified the rainfall levels that currently sustain healthy wetlands. We then asked whether precipitation at Chitongo, Simbumbumbu, and Chinyerenyere had already fallen below that line, or might in the decades ahead. The benchmark, in other words, is not abstract. It is grounded in the lived reality of wetlands in Zimbabwe today.

The results were encouraging. Rainfall in the LINCZ wetlands has not yet fallen below the line set by Zimbabwe's Ramsar sites. Annual totals remain within the range needed to recharge the water table and sustain wetland vegetation. In practical terms, the rains are still arriving with enough consistency to keep restoration possible.

Looking ahead, the picture remains hopeful. Climate models suggest that rainfall in these districts is likely to stay within a viable range even under different future warming scenarios. My students, who reviewed the data in detail, also found that seasonality has not changed significantly and is predicted to remain stable in the decades ahead. The rhythm of the rainy and dry seasons, which wetlands depend on to recharge and release water, is expected to hold.

This matters because wetlands depend on long-term hydrological balance. Rainfall replenishes groundwater, groundwater sustains soils and vegetation, and together they carry wetlands through the dry seasons. At Chitongo, Simbumbumbu, and Chinyerenyere, that cycle is still intact. For families who rely on wetland gardens, it means crops can grow and wells can refill. For conservationists and local leaders, it means rehabilitation is not yet foreclosed. The margins remain thin, but in a region of accelerating climate change, the persistence of viable rainfall offers something rare: a foothold for hope.

The Second Story: Sobering Limits

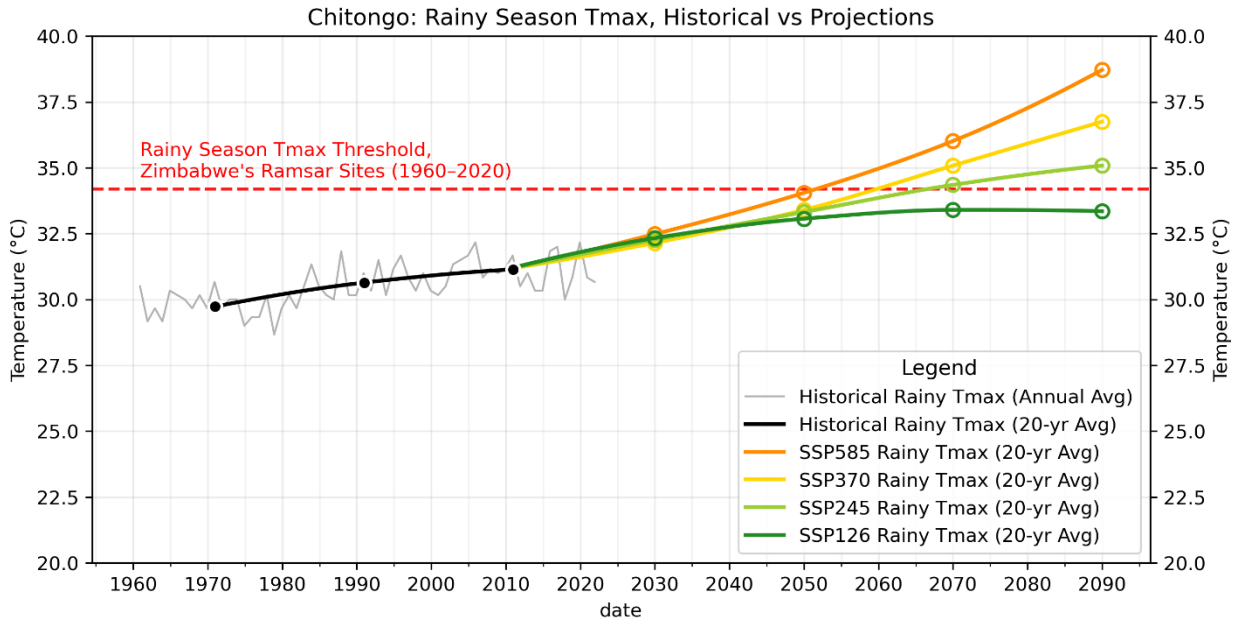
If rainfall gave us hope, temperature brings a harder truth. Wetlands depend on cooler conditions to retain soil moisture, slow evaporation, and support the plants and microbes that hold the system together. When heat rises too far, that balance can falter.

To test this, we compared site temperatures against Ramsar benchmarks. For each season since 1960, we tracked monthly minimum and maximum values (Tmin and Tmax). That shows the range within which wetlands have continued to function. For example, the monthly maximum during any rainy season at Zimbabwe's Ramsar wetlands peaked at 34.2 °C (ignoring outliers). When a site's long-term average moves outside such a range, it is not just one hot month – it means the whole climate system

has shifted higher. That shift signals a step into uncharted territory, where prospects for wetland rehabilitation become uncertain.

To explore future temperatures, we looked at four possible climate futures known as Shared Socioeconomic Pathways (SSPs). SSP126 imagines strong global action, with emissions falling quickly. SSP245 represents a middle course, with some reductions but continued growth. SSP370 assumes limited mitigation and rising emissions. SSP585 is the extreme case, a fossil-fuel–driven world where warming accelerates. By testing all four, we asked: under which futures, and how soon, might our wetlands cross the line?

The figure below shows what this looks like at Chitongo, through the lens of the maximum temperatures during the rainy season. Since climate models report 20-year averages, the smooth curves represent the typical maximum across two decades.



Chicongo Tmax. *20-year average rainy-season maximum temperatures (Tmax) at Chitongo, set against the Ramsar Rainy Season Tmax threshold (34.2 °C) to show when limits may be crossed under four climate scenarios (SSPs).*

The results are sobering. Chitongo, the northernmost site and closest to the equator, is the first to enter uncharted territory. Under the highest-emission pathway (SSP585), this happens during its dry season, as early as 2040.[2] Chinyerenyere and Simbumbumbu, further to the south, follow the same pattern. Their average temperatures exceed the Ramsar ranges later than Chitongo, but still by mid-century under high emissions. Only

[2] To be precise: Chitongo's 20-year *average* dry-season minimum temperature (mean tmin) is projected to exceed 15.2 °C by 2040 under SSP585, where 15.2 °C is the *maximum* historical monthly tmin, after outliers are removed, for any of Zimbabwe's Ramsar wetlands since 1960.

under the most ambitious pathway, SSP126, do all three wetlands remain within Ramsar ranges through the century.

Projected Exceedance. *First projected year when a 20-year average seasonal temperature crosses a Ramsar threshold, under four climate scenarios (SSPs).*

Wetland	SSP126 "Green Growth"	SSP245 "Business as Usual"	SSP370 "Fragmented World"	SSP585 "High Energy/ High Growth"
Chitongo	2091	2058	2046	2040
Simbumbumbu	–	2081	2065	2053
Chinyerenyere	–	2074	2060	2050

These projections paint a stark picture. Temperature thresholds may be breached within a single generation if emissions remain high. Heat is relentless, and local effort alone may not be enough to restore these wetlands. This is not a story of thin margins, but of a fragile boundary our climate may soon cross.

And yet the story is not all doom and gloom. The pathways we tested are not fixed destinies but scenarios shaped by human choices. Among them, SSP126 ("Green Growth") does keep Zimbabwe's wetlands within Ramsar temperature ranges through the century. Achieving it, however, will require ambitious global action – to cut emissions, build cleaner energy systems, foster more equitable societies, and shift consumption toward sustainability. Climate change sets limits, but it also leaves room for agency. What happens to Chitongo, Simbumbumbu, and Chinyerenyere depends not only on local decisions, but on the collective choices of a warming world.

A Shared Choice

What we see in Zimbabwe is part of a larger story. In Binga, Gwanda, and Mwenezi, wetlands face paradox: resilience in water, fragility in heat. Other places tell their own story. Together they raise a shared question: can we act in time to hold what remains? The science suggests there is still room to do so. But it will not happen on its own. It would require bold, collective action now, while there is still time.

The answer will not come from data alone. It will come from people. From Zimbabwean leaders, from farmers and families choosing whether to move, from activists who defend wetlands as sacred, from all of us who benefit from the carbon, water, and life these ecosystems sustain. To restore wetlands is to restore relationship: between people and

ecosystems, between local wisdom and global responsibility. That restoration remains possible. The fragile boundary has not yet been crossed. The choice is ours.

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