Unequal evidence and impacts, limits to adaptation: Extreme Weather in 2025

World Weather Attribution

Introduction

Every December we are asked the same question: *was it a bad year for extreme weather?* And each year, the answer becomes more unequivocal: yes. Fossil fuel emissions continue to rise, driving global temperatures upward and fuelling increasingly destructive climate extremes across every continent.

Although 2025 was slightly cooler than 2024 globally, it was still far hotter than almost any other year on record (Copernicus 2025) and the impacts of this hotness were unmistakable. This report reviews some of the worst extreme weather events of 2025 the WWA team has studied, documenting the severe consequences of a warming climate and revealing, once again, how unprepared we remain. Across the 22 extreme events we analysed in depth, heatwaves, floods, storms, droughts and wildfires claimed lives, destroyed communities, and wiped-out crops. Together, these events paint a stark picture of the escalating risks we face in a warming world.

At the close of 2025, this report underscores that even in a year that had weak La Niña conditions (NASA, 2025) that lead to lower sea surface temperatures, global temperatures remained very high and significant harm from human-induced climate change is very real. **It is not a future threat, but a present-day reality.**

Heatwave in London.
Image by Ackinbj.

A reindeer rests in the shade during the heatwave in Tärnaby, Sweden. In summer, reindeer normally move to higher areas to escape insects and heat, but warmer conditions on hills and mountains mean those areas now offer less relief. Photo by Amanda Nilsson.

Shymkent, Kazakhstan. Image by Raban Haaijk.

Key messages

- In 2025, extreme weather events continued to occur at concerning levels. Although the natural modes of climate variability, such as El Niño were in a cooler phase, human-driven greenhouse gas emissions meant global temperatures were exceptionally high. These elevated temperatures intensified prolonged heatwaves, worsened drought conditions and fire weather, and increased the extreme rainfall and winds associated with severe storms and floods that resulted in thousands of fatalities and displaced millions of people. **The events of 2025 demonstrate the growing risks already present at approximately 1.3°C of anthropogenic warming and reinforce the urgent necessity of accelerating the transition away from fossil fuels.**

- Since 2015, when the Paris Agreement was signed, global warming has increased by 0.3°C. This seemingly small rise has already made extreme heat significantly more frequent, adding 11 extra hot days per year on average, and is projected to dramatically escalate with further warming. If policies are fully implemented, the Paris Agreement has helped lower projected warming from 4°C to 2.6°C – a substantial decrease that would nonetheless create a dangerously hot world. Revisiting some of the recent heatwaves studied in previous years such as extreme heat in the Amazon or Burkina Faso and Mali, we found these events to have become almost ten times more likely since 2015, highlighting that **every fraction of a degree matters.**

- The impacts of 2025's extreme events are driven by local, context-specific vulnerabilities but in many cases, we find the same patterns across the world. Our study in South Sudan highlighted that women are disproportionately affected by extreme heat due to their concentration in informal, heat-exposed work such as agriculture and street vending, along with having limited resources and low literacy rates. **Globally, women carry an unequal burden**, e.g. due to their underrepresentation in leadership and unpaid caring responsibilities, often increasing their exposure to dangerously high temperatures and associated long-term health risks. Extreme heat further disrupts education, leading to school closures that reinforce gender inequalities.

- This year highlighted again, in stark terms, how unfairly the consequences of human-induced climate change are distributed, consistently hitting those who are already marginalised within their societies the hardest. But the inequity goes deeper: the scientific evidence base itself is uneven. Many of our studies in 2025 focused on heavy rainfall events in the Global South, and time and again we found that gaps in observational data and the reliance on climate models developed primarily for the Global North prevented us from drawing confident conclusions. **This unequal foundation in climate science mirrors the broader injustices of the climate crisis.**

- The events of 2025 make it clear that while we urgently need to transition away from fossil fuels, we also must invest in adaptation measures. Many deaths and other impacts could be prevented with timely action. But events like Hurricane Melissa highlight the limits of preparedness and adaptation: when an intense storm strikes small islands such as Jamaica and other Caribbean nations, even relatively high levels of preparedness cannot prevent extreme losses and damage. **This underscores that adaptation alone is not enough; rapid emission reductions remain essential to avoid the worst impacts of climate change.**

Triggered and studied events

We use a trigger methodology to guide the selection of extreme weather events to consider for rapid study.

Each hazard type – floods, storms, droughts, heatwaves, fires, and cold spells – has unique criteria specific to its distinct impacts. For example, our threshold for floods is met if any of the following criteria are met: more than 100 deaths, more than a million people affected, more than 50% of total population affected, or a declaration of state of emergency or disaster on national or state level. These thresholds ensure the methodology captures the most impactful events around the world.

The selection process has two steps. The first is identifying events that meet our thresholds. The second is narrowing the selection based on additional factors, such as data availability, previous studies in the area, team capacity, and existing regional and hazard diversity. This process ensures the selected events are impactful, relevant, and feasible for analysis, while adding to our understanding of the relationship between global climate change and local extremes.

In 2025, a total of 157 events met our trigger criteria, with triggers for floods (49) and heatwaves (49) occurring more frequently, followed by storms (38), wildfires (11), droughts (7) and cold spells (3). From these, we studied 22 events (Figure 1), comprising 3 in Africa, 7 in the Americas, 5 in Asia, 6 in Europe and 1 in Oceania. In addition, we revisited 6 heat events from previous years in a report taking stock on the state of extreme heat ten years after the signing of the Paris Agreement. For heat action day (2 June), we published a global heat report.

World Weather Attribution Studies 2025

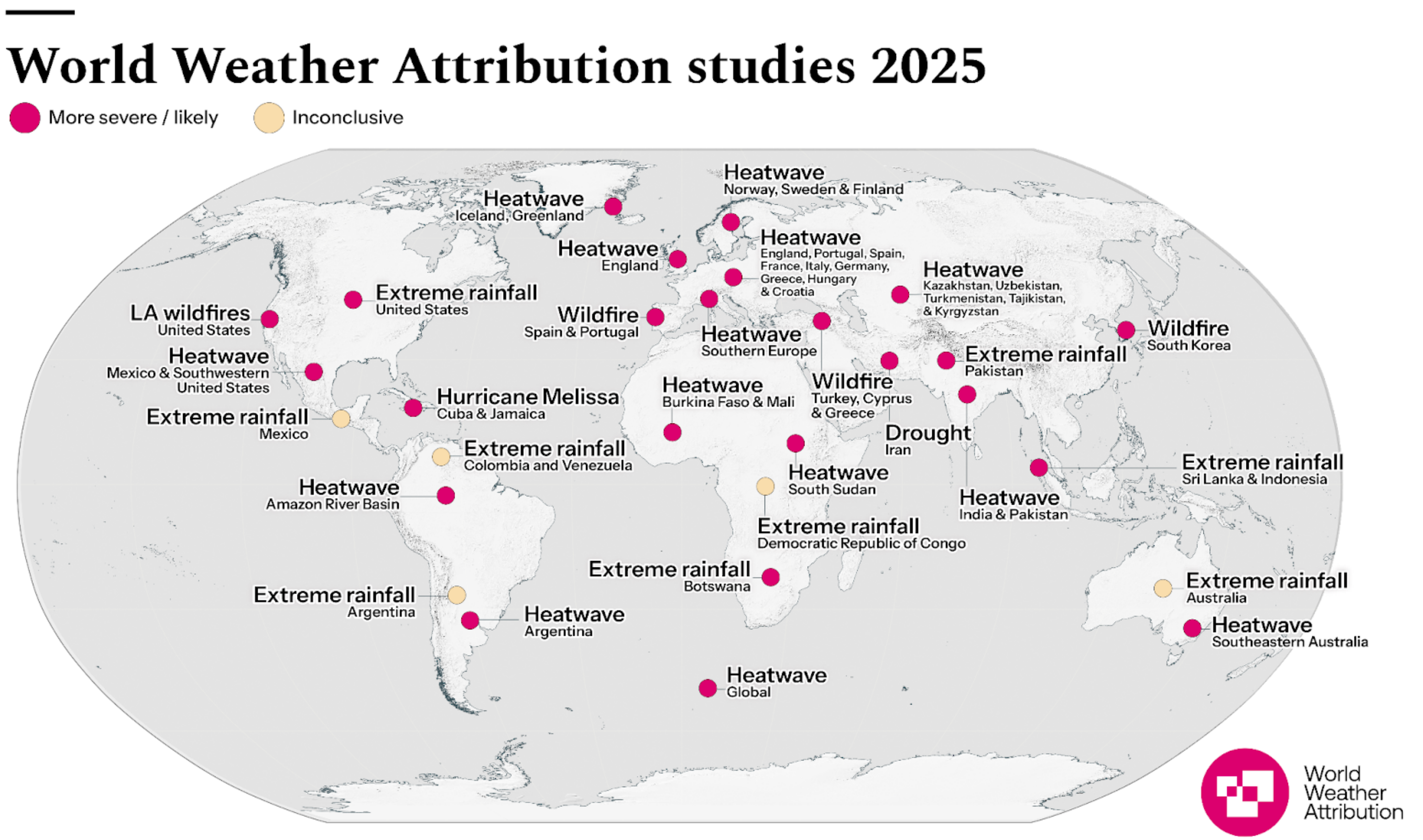

Fig. 1: In 2025 we studied 28 events. 22 of these events were triggered this year, and 6 heatwaves were revisited under the Paris report. In addition, we did a global study on extreme heat.

Heatwaves

Though 2025 will not break the global heat record set by 2024, it will still rank as one of the hottest years ever. And for the first time in history, the three-year average has crossed the 1.5°C threshold.

Being the second or third hottest year on record is not good news. Continued burning of fossil fuels means that what should have been a cooler year is now an extremely warm one, fuelling extreme weather events with devastating consequences. Amongst these, heatwaves stand out as the deadliest. Often referred to as 'silent killers', heatwaves don't leave a trail of destruction like storms or wildfires, leaving the danger of extreme temperatures to often go underreported and underappreciated. In Europe, a study estimated that across 854 cities, representing 30% of the European population, 24,400 people lost their lives in high temperatures over the summer months between June and August.

In many other parts of the world, this kind of data is not available (Longden et al., 2020), but that does not mean that people do not suffer. In 2025, for the first time, WWA undertook a rapid analysis of extreme heat that placed its impact on women and girls at the study's centre.

After dozens of children collapsed with heatstroke in Juba, the capital of South Sudan, schools were closed for two weeks nationwide starting February 20th, and the population was advised to stay indoors and keep hydrated. Both present a huge challenge for many across the country, as houses are often built with iron roofs, and lack cooling, electricity and access to clean water. In Juba, a third of the population does not have access to water and only 1% of the city offers green space and shade for people who do not have access to cooling at home.

The study found that human induced climate change made the February heatwave 4°C hotter (fig 2.a) and that burning of coal, oil and gas has transformed what used to be an exceptionally rare event into a common one, now expected to occur every other year (see fig. 2.b). In addition, we found that almost all women who are employed work in the informal sector (95%). Women predominantly work in agriculture (or another occupation with high heat exposure, such as street vending or manufacturing) and spend 60% of their time on unpaid care work, such as fetching water and cooking in extremely hot environments. This sustained heat exposure with physical exertion can have serious long-term health effects, including cardiovascular strain, kidney damage, and increased vulnerability to heat exhaustion and heat stroke.

Education is severely impacted by extreme heat. Prolonged school closures increase the likelihood of learning losses, reinforce gendered household expectations, and heighten risks of early marriage, making school return more difficult for girls. Actions such as changing the timing of school to avoid the hottest part of the day, or rearranging the academic calendar, suggested by education workers, could help avoid long-term closures. Retrofitting school buildings with passive cooling options (e.g. shade trees, painting roofs white) can also be a low-cost way of reducing risks, along with first aid education for teachers and students to recognise the signs of heat-related illness and take appropriate action.

Image taken in 2016 by Didier Revol for the International Committee of the Red Cross.

Image by Diego Torres Silvestre.

Heatwaves

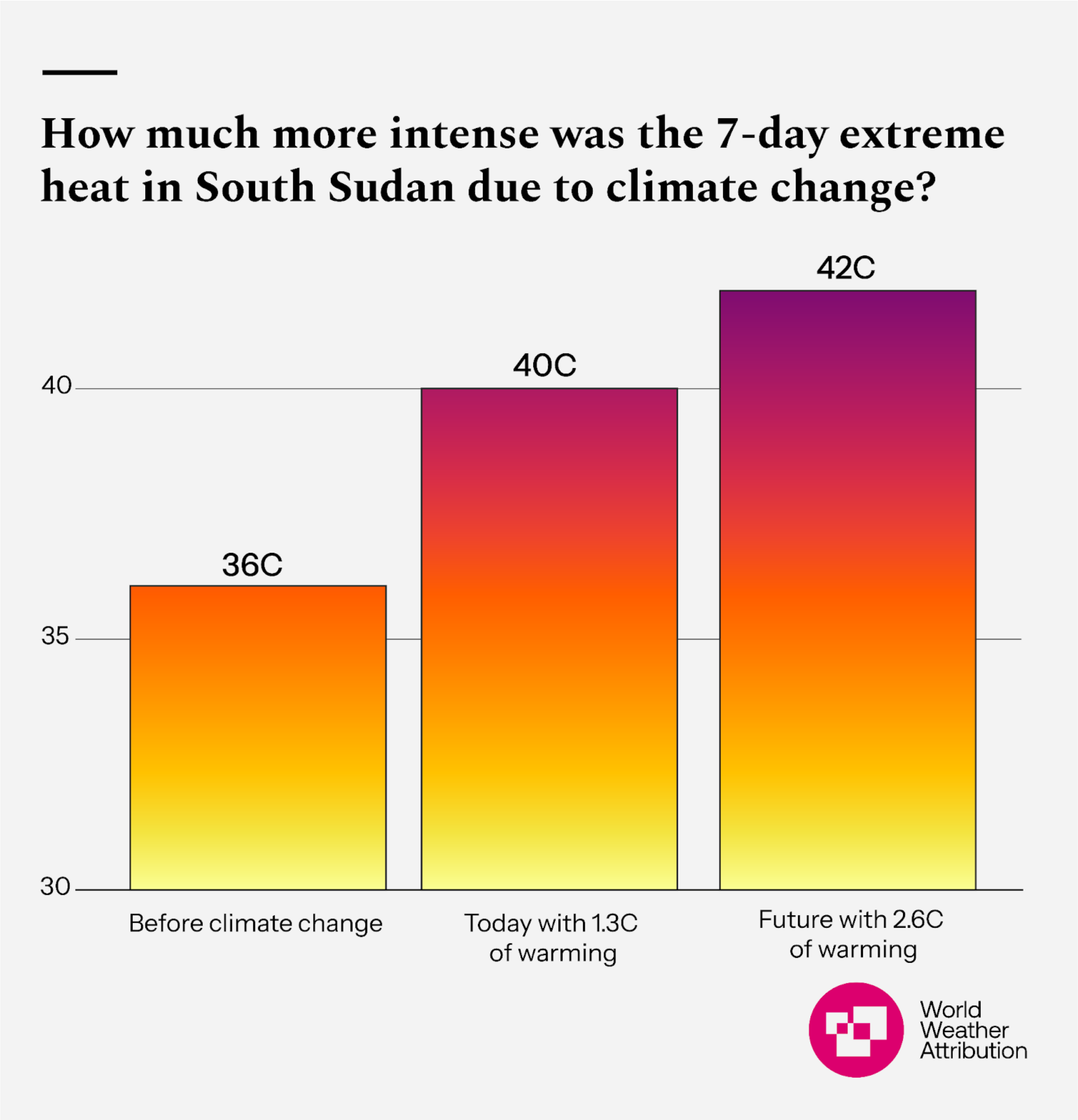

Figure 2.a: Today, at 1.3°C above preindustrial warming levels, the 1 in 2-year 7-day heat in South Sudan is 4°C hotter than before climate change.

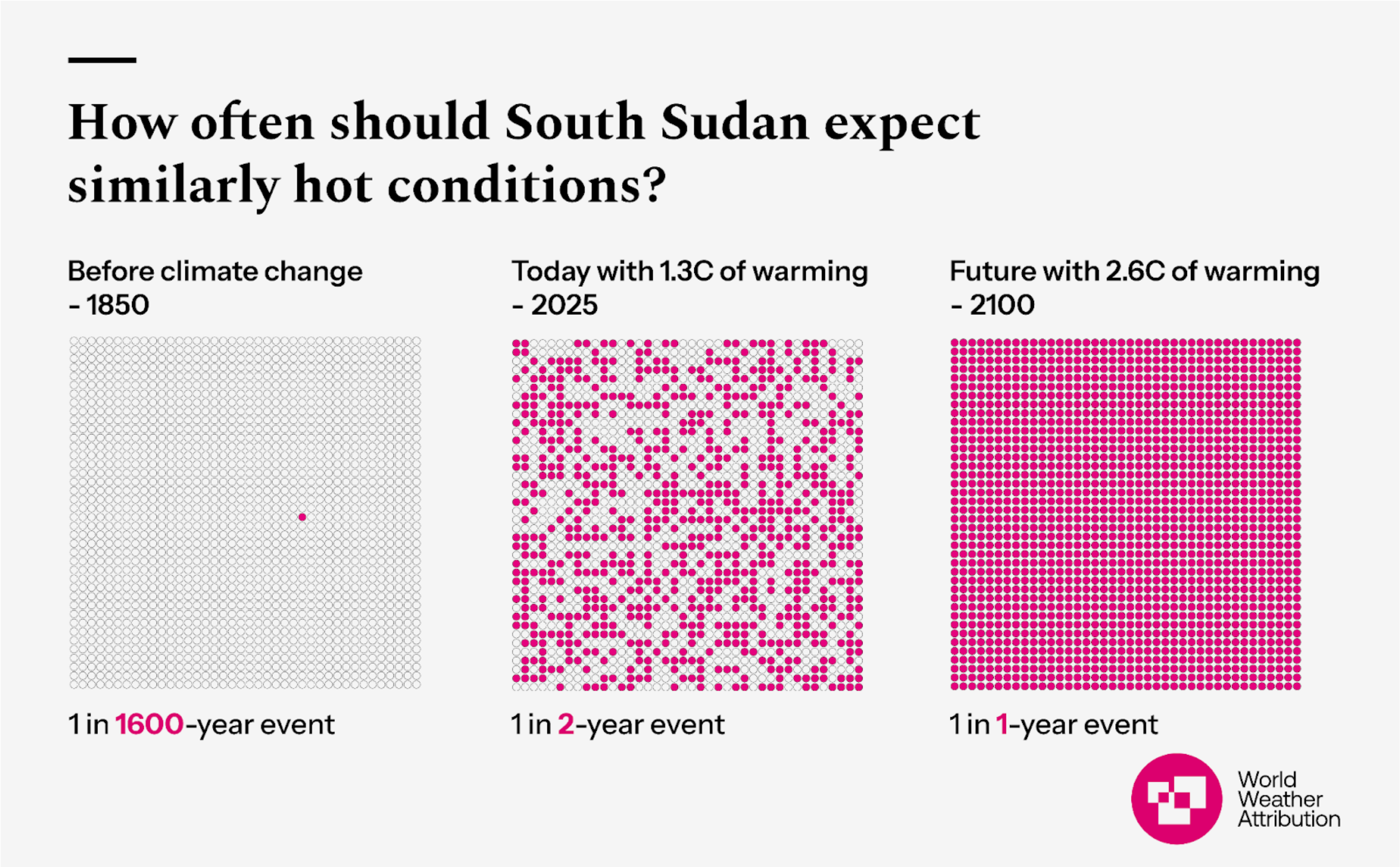

Figure 2.b: Today, at 1.3°C above preindustrial warming levels, South Sudan will experience similar heatwaves in February about once every two years, if warming increases further, February heatwaves like in 2025 would be normal events, or even cold.

Heatwaves

The year 2025 was also the year when we found the highest change in intensity due to human-induced climate change in any studies undertaken by WWA. In March 2025, Central Asia experienced an unusually intense heatwave, with temperatures reaching record highs across the region, reaching maxima of 30.8°C in Jalalabad, Kyrgyzstan, 29.4°C in Namangan and 29.1°C in Fergana, Uzbekistan, and minimum temperatures of 18.3°C in Shahdara, making it the hottest March night in Kazakhstan's history. In a 1.3°C colder climate, such temperatures would however have been extremely unlikely to occur.

Similarly, a March heat event that lasted five days with the same return period as the one observed in 2025 would have been 5 to 10°C cooler, extrapolating the observed trends back to a 1.3°C colder climate. The high change in intensity is likely related to the strong seasonal cycle. Figure 3, which shows the regions in the world that had record annual heat in 2025 (in pink), also highlights Central Asia as a particularly hot region. The same is true for Scandinavia and Greenland, which were also studied in 2025 by WWA.

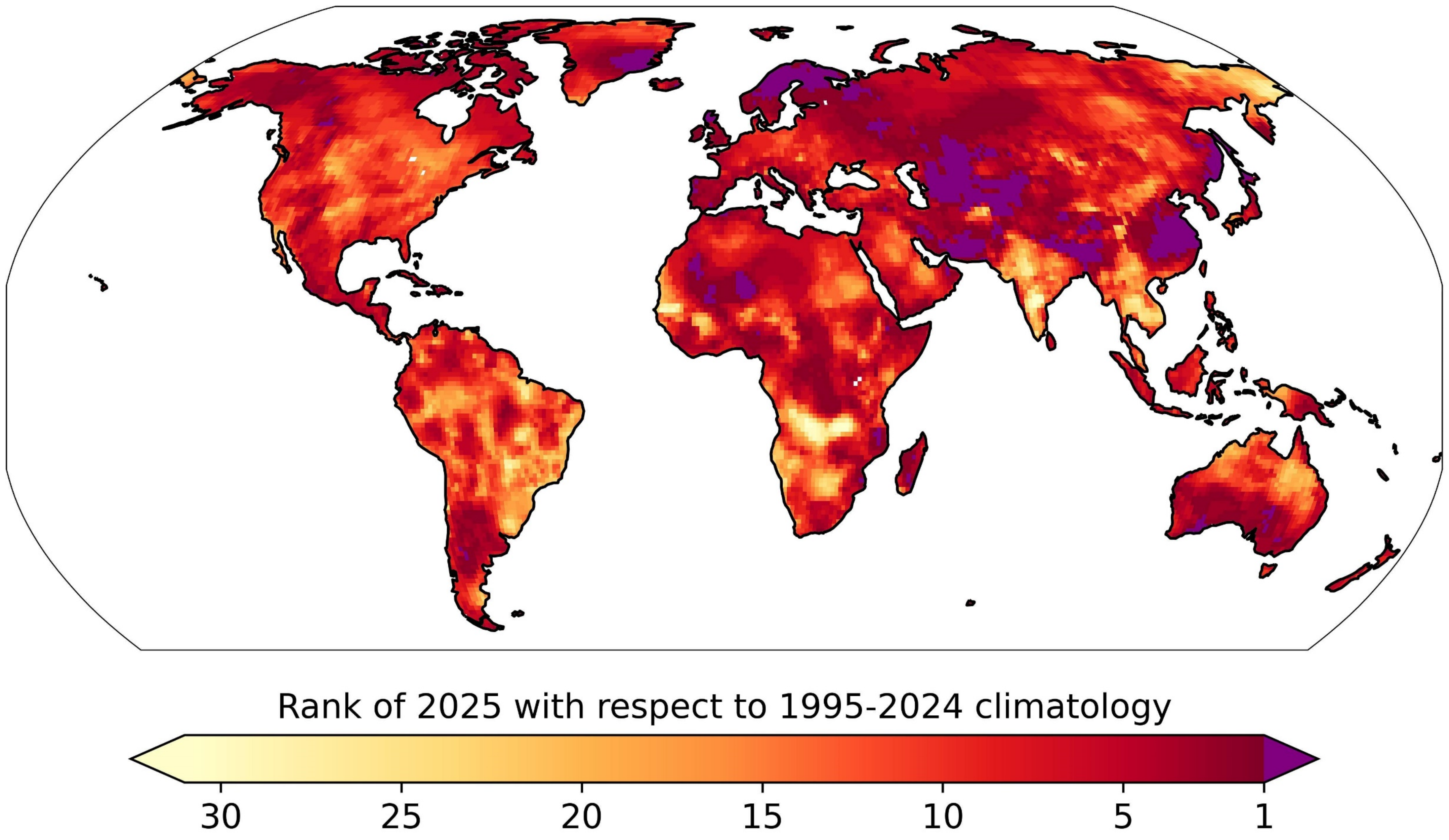

Fig. 3: Rank of 2025 with respect to the 1995-2024 climatology. Rank 1 (purple) means it was the hottest year on record, rank 31 would mean it is the coldest in the last 30 years.

Floods and heavy rainfall

In 2025, floods were the most triggered hazard for WWA, and with eight studies, they were also the hazard we studied most frequently. While a number of these studies had a very clear signal from human-induced climate change, such as the devastating floods in Pakistan, Sri Lanka and Indonesia, the Mississippi River Valley and Botswana (fig. 4), a large proportion of the studies on heavy rainfall in 2025 were inconclusive (fig. 1). In some cases, such as the heavy rainfall in New South Wales, Australia, which led to severe flooding and left 50,000 isolated, we found no clear climate change signal. However, since the trends are very small or differ in sign within a very small region, in many instances, this does not mean that climate change did not play an important role in influencing heavy rainfall. In many other regions, we found that there were not sufficiently high-quality weather observations available to allow for a meaningful trend analysis. In some cases, like the deadly floods in Kinshasa, the capital of the Democratic Republic of Congo, hardly any weather stations exist.

In other cases, such as Mexico, a country characterised by highly variable weather due to the influence of two oceans and large mountains, the decrease in density and quality of weather stations in recent years renders an assessment of local trends in rainfall impossible. Similarly, in Argentina, different types of global gridded weather data disagree with local station data, making the former unusable for attribution analysis in the region. In addition, in many regions in the Global South, such as Venezuela and Colombia, Sri Lanka and Indonesia, even where observations exist, state-of-the-art climate models are unable to reproduce the weather patterns driving heavy rainfall, thus prohibiting a quantitative assessment of the role of climate change.

The year 2025 therefore underscores just how important weather observations are. Observations not only allow us to understand what actually causes floods that are driving deaths and devastation, but they also are essential for understanding the role of climate change and thus adaptation needs, including developing early warning early action systems and improve accuracy of weather forecasts. In recent years, a number of initiatives such as the Systematic Observations Financing Facility (SOFF) have been launched to strengthen the coverage of weather stations particularly in Least Developed Countries and Small Island Developing States. However, these initiatives need to be broadened and receive long-term investment to begin to close the gap in data availability and quality between the global North and South.

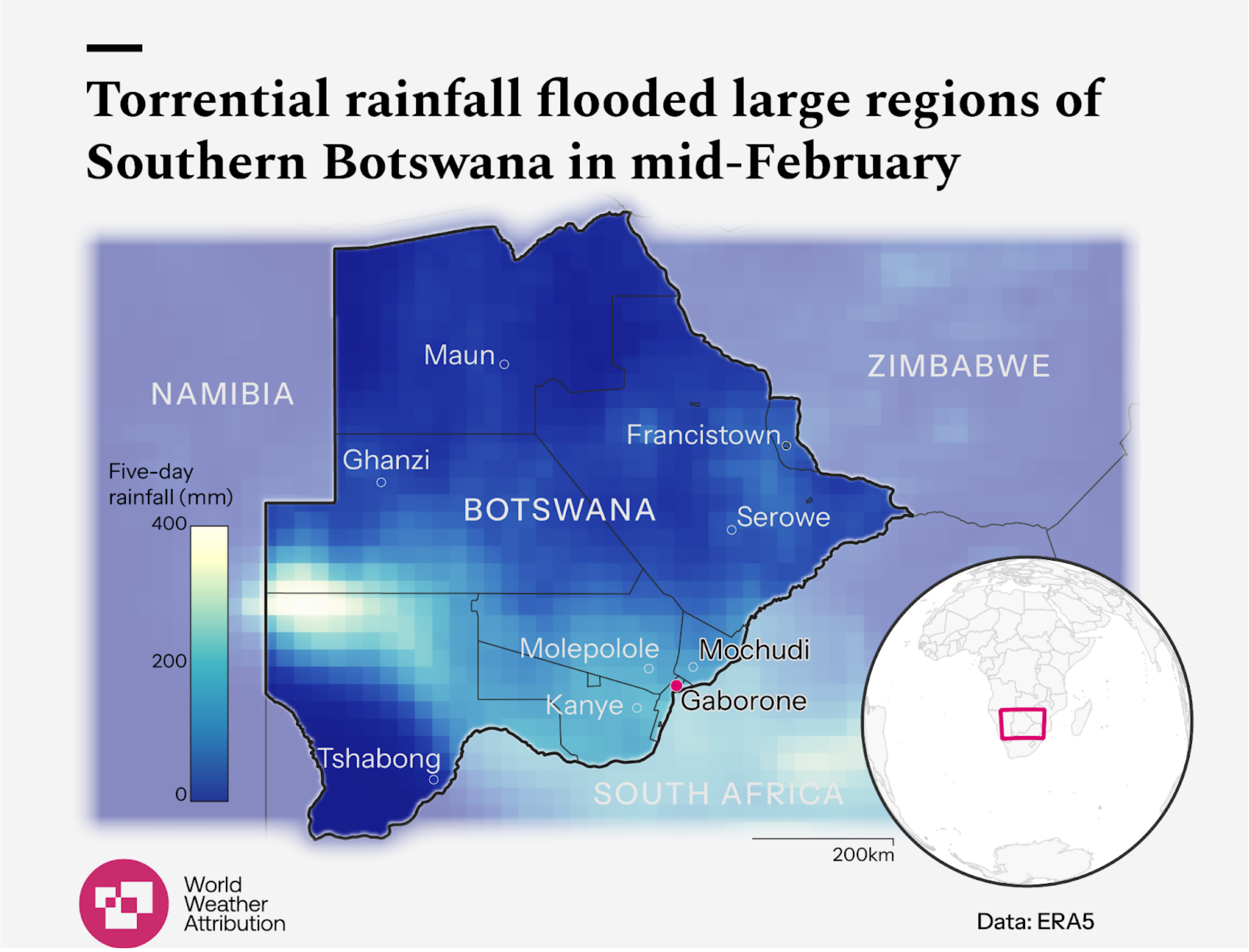

Fig. 4.a: The flooding across the border between Botswana and South Africa, caused by heavy rainfall from the 16th to the 20th of February, wreaked havoc on both countries, shutting down major ports of entry into South Africa, forcing the temporary closure of all government schools in Botswana, and causing widespread traffic chaos.

Floods and heavy rainfall

Another recurring theme that contributed to severe impacts from the studied heavy rainfall episodes, such as the one in Botswana in February 2025 (fig. 4), is the role of deforestation and urbanisation. During the rainy season, urbanised areas frequently experience flooding in fast growing cities. High-intensity rainfall overwhelms drainage systems and often leads to significant urban flooding. In the capital cities of Gaborone, Kinshasa and Islamabad, drainage infrastructure has not kept pace with its growing population density, and rapid urbanisation rendered low-lying areas particularly susceptible to severe flooding events. In other studies, such as in the DRC and Mexico, deforestation was likewise found to be an important driver. In the heavy rainfall events where landslides played an important role in the devastation, e.g. in Colombia and Venezuela, deforestation, the conversion of the Páramos to agricultural land, mining concessions, and overgrazing have reduced the natural ecosystem's ability to regulate rainfall-induced floods and increased susceptibility to landslides.

Adaptation efforts thus need to prioritise social and nature-based solutions that complement, rather than rely solely on, built infrastructure. Restoring ecosystems, strengthening community preparedness, and integrating risk into local planning can lead to more sustainable flood management, thereby reducing long-term vulnerability while enhancing resilience.

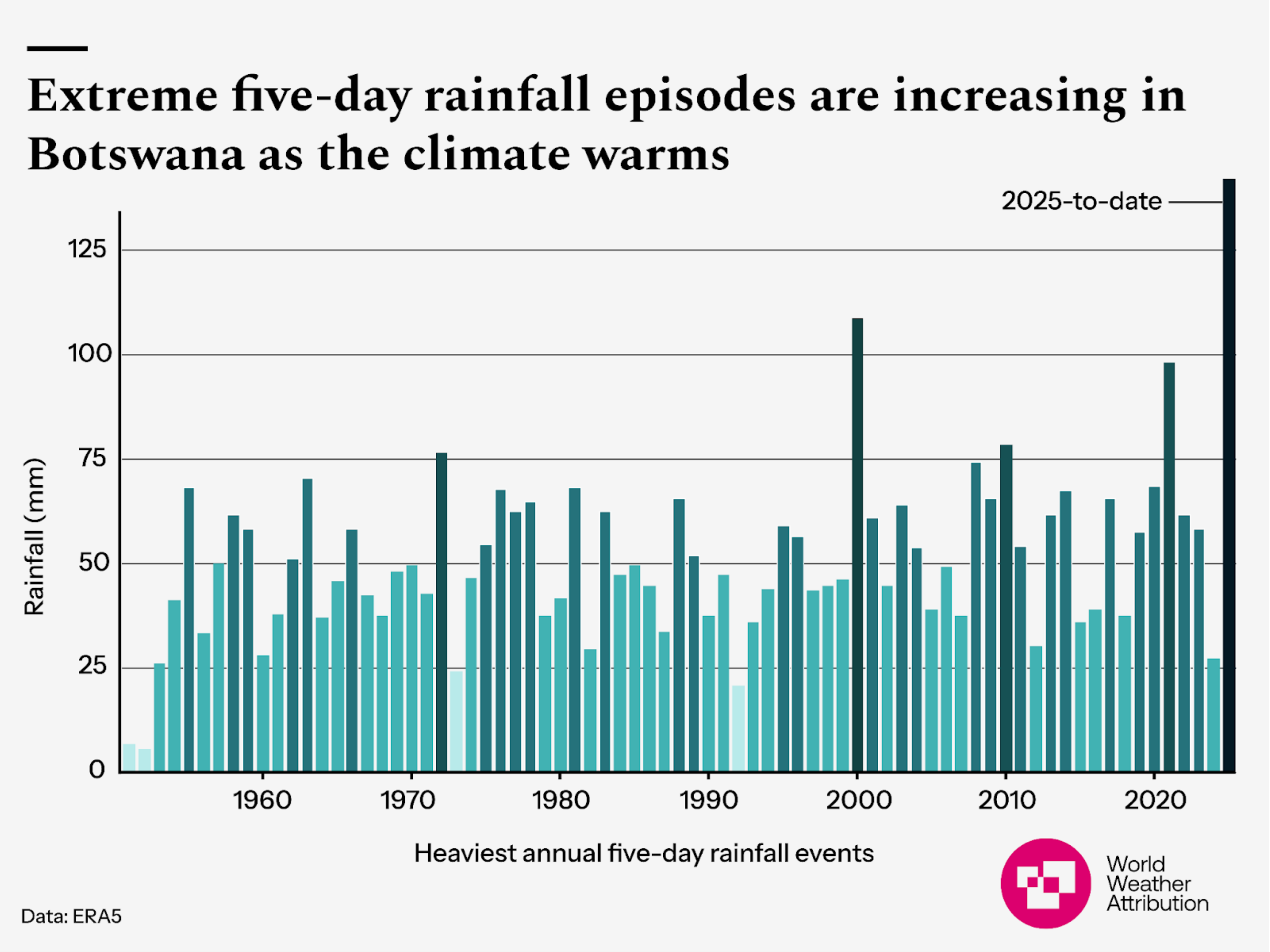

Fig. 4.b: The wettest five day period every year in Southern Botswana since 1950 in the ERA5 data set.

Drought

In 2025, only seven drought events reached WWAs trigger criteria. However, looking at annual rainfall in 2025 (fig. 5), we find that while some regions were comparably wet, e.g. Western South America and the Indian Subcontinent. There were many regions that had their driest year on record, including parts of central Africa, western Australia, central Brazil and large parts of the Middle East. In the same regions, this lack of rainfall, when combined with high evapotranspiration, turned into droughts (fig. 6).

For the Middle East, and in particular Iran, not only was 2025 very dry, but so were the four preceding years. This led to such a severe drought that on November 6th, 2025, Pezeshkian said that Teheran, the capital of Iran and home to more than 10 million people, may need to evacuate if no rain arrives by December (Reuters, 2025). Five years of drought have meant that the dams serving the city have not been replenished, and with 2025 receiving even less rain than the already dry preceding years, the water crisis has become extremely severe (Al Jazeera, 2025).

When studying the role of climate change in the severe drought in Iran and the neighbouring countries of Iraq and Syria, we updated a study WWA had conducted two years ago, when the same region was already in drought. The results were similar, but showing an even stronger role of human-induced climate change in the five year drought compared to the three year one analysed in 2023. While low rainfall years would have occurred in this region even without climate change due to its naturally arid climate and the high year-to-year variability in rainfall, multi-year drought events that are now 'extreme' to 'exceptional' would have been very rare in the past. The results for the five-year-long drought show an even stronger impact of human-induced climate change compared to the analysis on the three-year-long drought undertaken in 2023, reinforcing that such droughts are not only becoming more frequent with global warming, but also more prolonged.

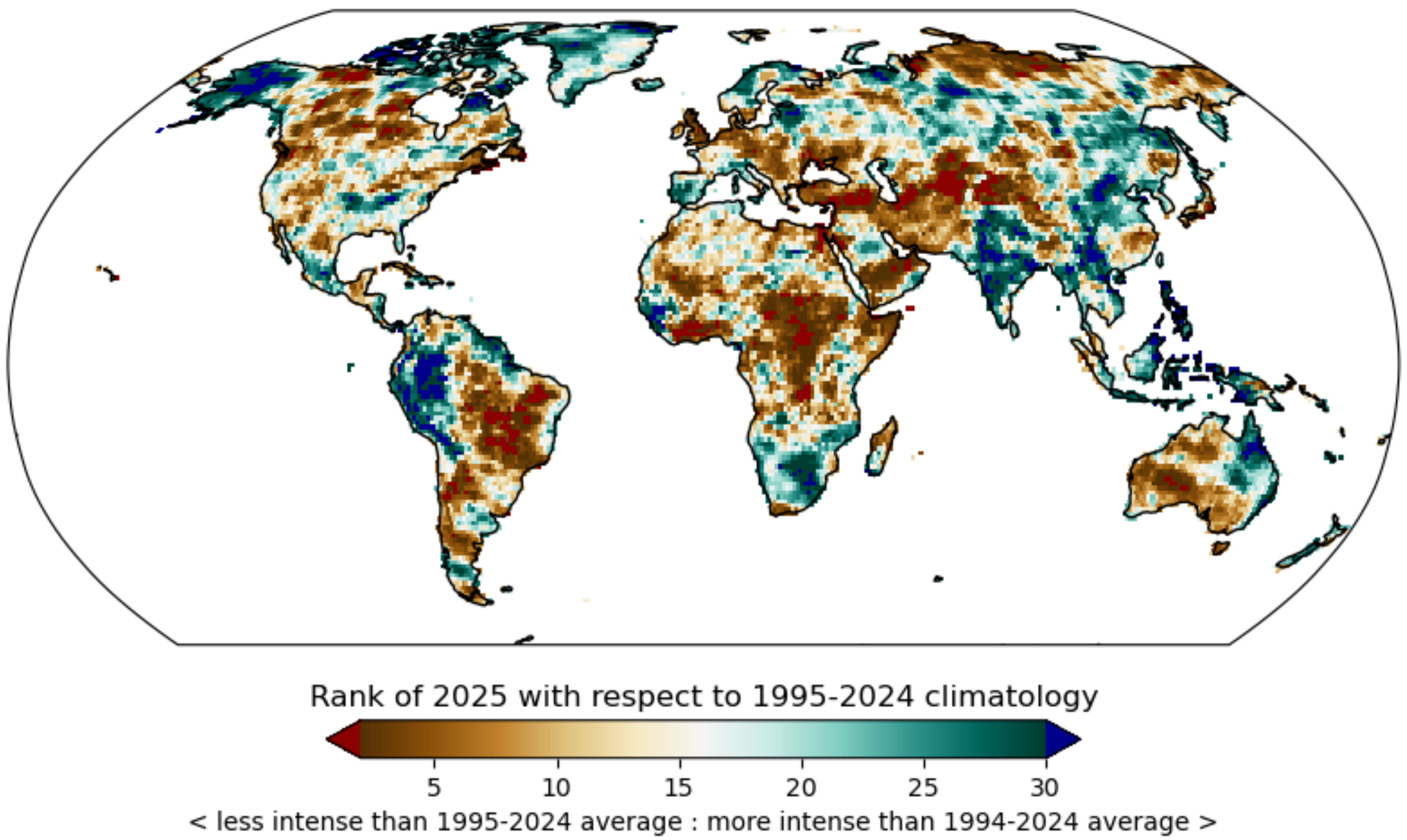

Fig. 5: Rank of annual rainfall for 2025. Rank 1 (red) means that 2025 was the driest year within the last 30 years, rank 31 (blue) shows the regions where 2025 was the wettest year.

Drought

While this was the only explicit drought study undertaken in 2025, Iran is not alone in facing water scarcity. It is estimated that nearly one-third of all major cities worldwide could exhaust their current water resources by 2050 (C40cities Report 2025). The confluence of urbanisation, increasing demand, and governance issues is driving increasing water scarcity around the world, and is only amplified by climate change. Resilient urban water management will require a diversified water supply, demand management, upgraded and more efficient water infrastructure, and increased institutional capacity to manage increasingly limited water resources.

In addition, increasingly dry conditions often, but not always, play an important role in the occurrence and severity of wildfires, discussed in the next section.

Varzaneh Desert. Image by Ninara.

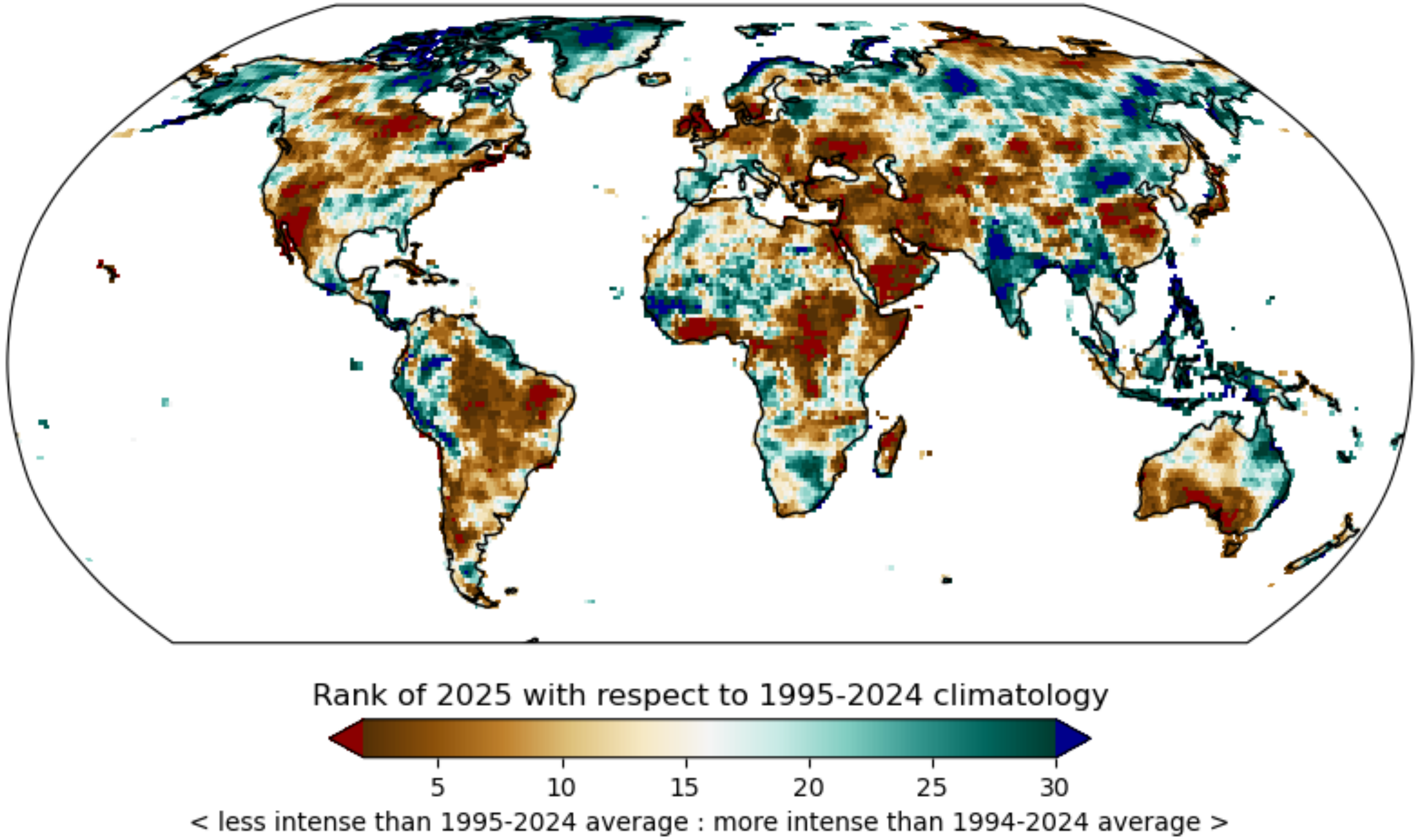

Fig. 6: Rank of annual SPEI for 2025. Rank 1 (red) means that 2025 was the worst 12-month drought within the last 30 years, rank 31 (blue) shows the regions where 2025 was the year of least moisture stress.

Wildfire

In 2025, WWA undertook four attribution studies on the hot, dry, and windy conditions that drive extreme wildfire events. With global increases in extreme heat and dryness due to climate change, fire weather conditions are increasing in many regions of the world.

Individual wildfires are ignited by people, and by natural processes such as lightning. The development of a major wildfire from an ignition is also affected by fuel load and vegetation connectivity. Hot, dry and windy conditions mean that if an ignition does occur, the chances of a fire burning hotter and spreading more quickly are much higher. Due to the increase in fire weather highs, extremely large and hot-burning wildfires have intensified in recent decades.

Other human activity can compound (and diminish) the likelihood of extreme wildfires, with burned area increasing due to landscape fragmentation and deforestation in regions that used to be less fire-prone, forested environments, such as rainforests.

In January, after an extremely delayed end to the dry season overlapped with the strong Santa Ana winds, the most economically destructive wildfires in the modern record burnt through the Pacific Palisades and Altadena neighbourhoods in Los Angeles. These fires have been linked to about 400 deaths, 30 bn USD in insured losses – the greatest insured wildfire losses on record, and likely much higher uninsured losses. Across multiple lines of evidence, we found a significant increase in the conditions that drove the wildfires. The best estimate of the increase in likelihood of extreme fire weather due to climate change was 35%, combined with an increase in the chance of the delay to the wet season and the pressure system that drove the extreme winds.

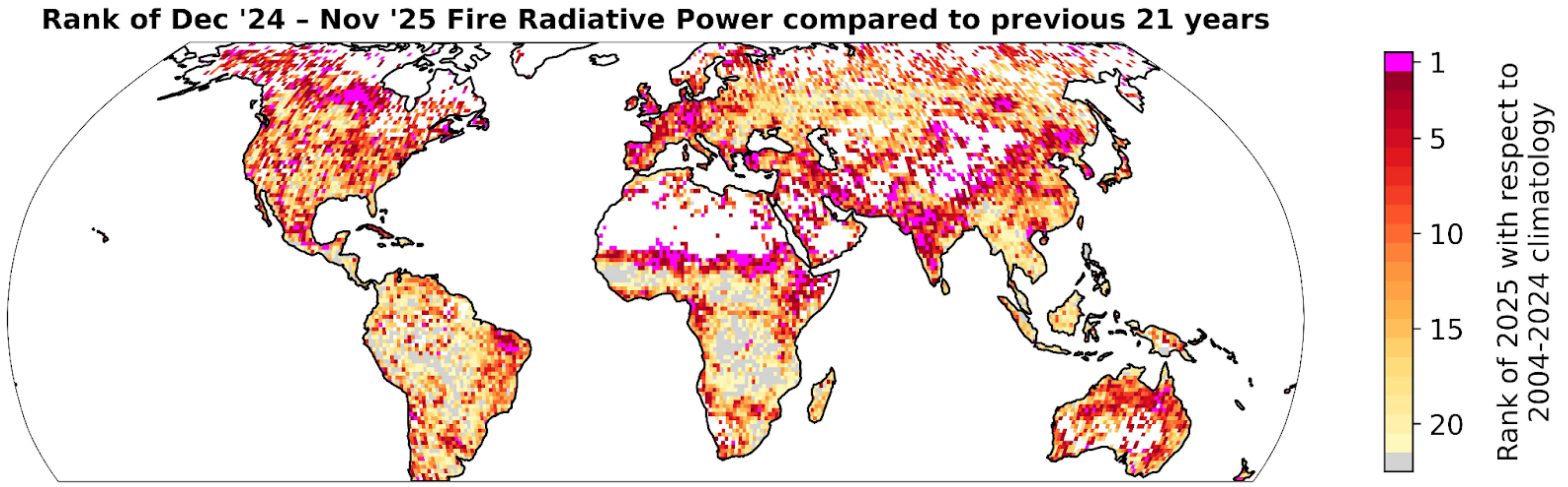

Fig. 7: Map of the past year's rank of fire radiative power (FRP) – the satellite-detected thermal energy release from active fires – compared to fire years since 2004. Low rank means that FRP was higher than average. FRP is derived from the GFAS satellite product (reliable from 40°S to 70°N) with cells that did not experience fires in the past 12 months masked out.

Wildfire

South Korea experienced by far its most extreme wildfire year on record since 1997, with the burned area in March alone over four times greater than the previous annual record. The weather conditions that drove these fires were rare in today's climate, about a 1-in-300 year event, and would have been near impossible without climate change. While the event itself was rare, the emergence of extreme fire weather conditions like these is being seen globally. This is of particular concern to regions that are less adapted to extreme wildfires, such as South Korea.

Southern Europe also experienced an extreme fire season this summer, with record-breaking fires in northwestern Spain, northwestern Türkiye and Cyprus. In Aegean Greece, Türkiye and Cyprus, the fire weather conditions amounted to a 1-in-20 year event, having been made five times more likely due to climate change. In northwestern Iberia, the fire weather extremes were 40 times more likely than they would have been without climate change – according to the observational record.

All countries we have studied have strengthened wildfire management and response in recent years e.g. through new wildfire risk management initiatives, expanded firefighting forces, and altered legal frameworks. As climate change increases risks, adaptation efforts can be strengthened by further educating the public about wildfire risks and fire safety behaviours, increasing investment in proactive wildfire mitigation and wildland-urban interface vegetation management, and integrating Indigenous, traditional, and contemporary fire management practices into policy.

Forest fire in Sancheong, Gyeongsangnam-do. Image by Gyeongnam Regional Government.

A bank burns on Sunset Boulevard. Image taken on January 8 by Cal Fire.

Wildfires in Spain. Image by the Spanish Red Cross.

Tropical Cyclones

The Western North Pacific remains the most active tropical cyclone basin globally, and 2025 was no exception. Several notable systems developed, including Typhoons Ragasa, Kalmaegi, and additional storms that affected the Philippines as well as parts of Vietnam and Laos. We did not conduct a new attribution analysis for these events, as the underlying climatic conditions in the region were very similar to those examined in last year's study that focussed on the very active typhoon season in and around the Philippines. That assessment found that anthropogenic climate change has increased the probability of three or more major typhoons (Category 3 or higher) making landfall in the Philippines within a single year by approximately 25%.

The Atlantic basin experienced relatively few hurricanes during the 2025 season (fig.8). However, one particularly intense storm, Hurricane Melissa, caused severe impacts across the Caribbean. Together with a large team of scientists from Cuba and Jamaica, WWA assessed the role of climate change in the rainfall associated with Melissa, as well as the wind speeds at the point of making landfall and the underlying environmental conditions.

Climate models underestimate rainfall extremes associated with hurricanes, a known limitation in the Caribbean due to coarse spatial resolution. Thus, the study could only estimate the lower bound, concluding that rainfall intensities in storms like Melissa have increased by more than 9%.

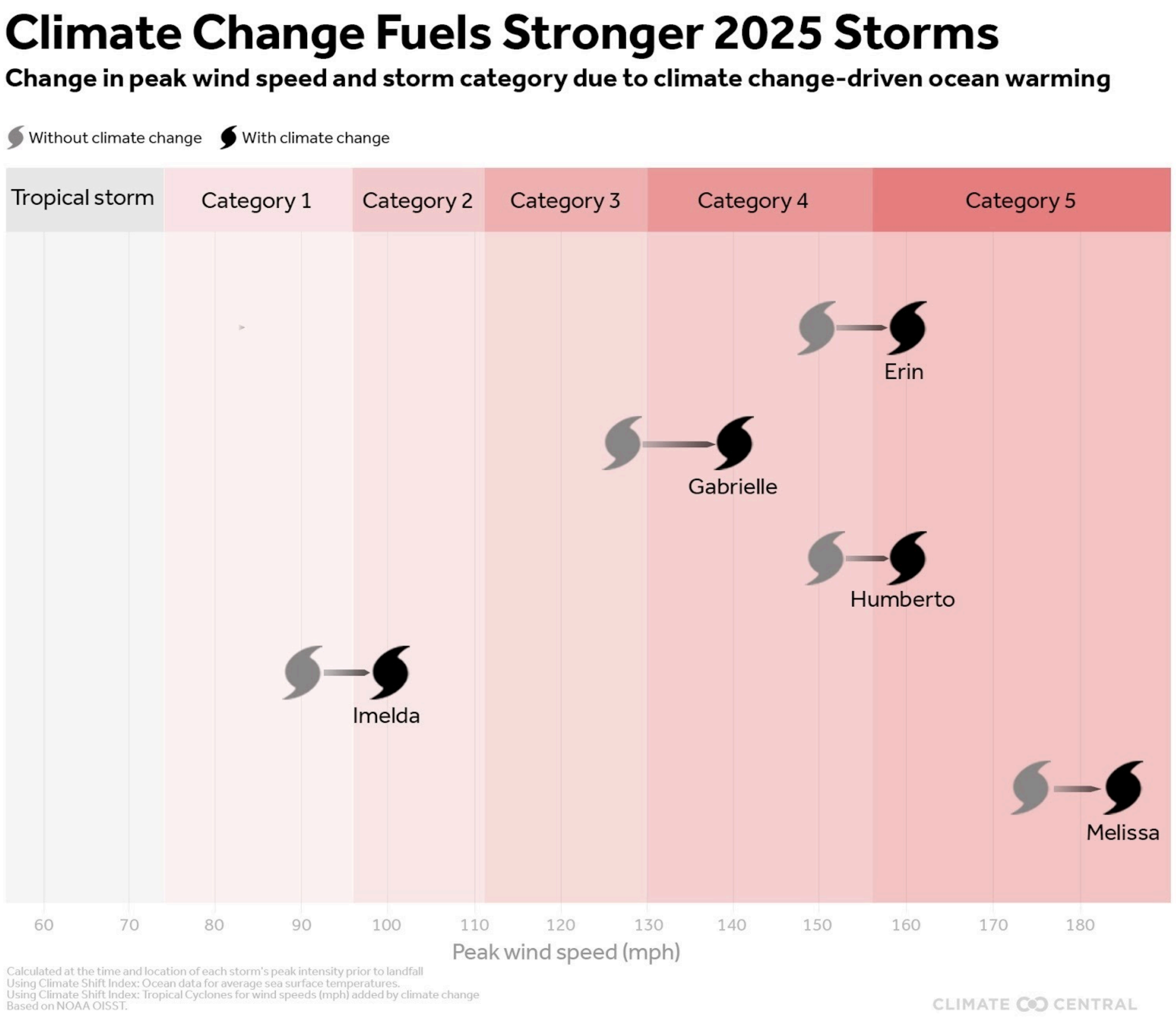

Fig. 8: All Atlantic hurricanes in 2025 strengthened by at least 9 mph during the 2025 hurricane season as analysed by Climate Central.

Tropical Cyclones

Using simulations to assess the role of climate change in the wind speeds, we found that strong hurricanes like Melissa are now much more common. In a climate 1.3°C cooler, storms of this strength would occur about five times less often, and their peak winds would be roughly 7% weaker (fig 9.a). While this may not sound like much, small differences are extremely important because even slight increases in wind speed can greatly exacerbate the resulting damage.

In both Jamaica and Cuba, forecasts for Melissa were available more than a week before landfall, with steadily improving confidence in the storm's track and intensity. This advance warning helped protect many of the 2.6 million Jamaicans and 3.8 million Cubans exposed to extreme winds (fig. 9.b). Cuba evacuated over 735,000 people from low-lying and coastal areas, while Jamaica opened 881 emergency shelters, evacuated people in the storm's path, pre-positioned supplies, closed airports, and diverted cruise ships. These actions almost certainly saved lives. However, with a storm as intense as Melissa, even strong preparedness efforts cannot prevent all impacts, as such extremes push the limits of what existing infrastructure and adaptation measures can achieve.

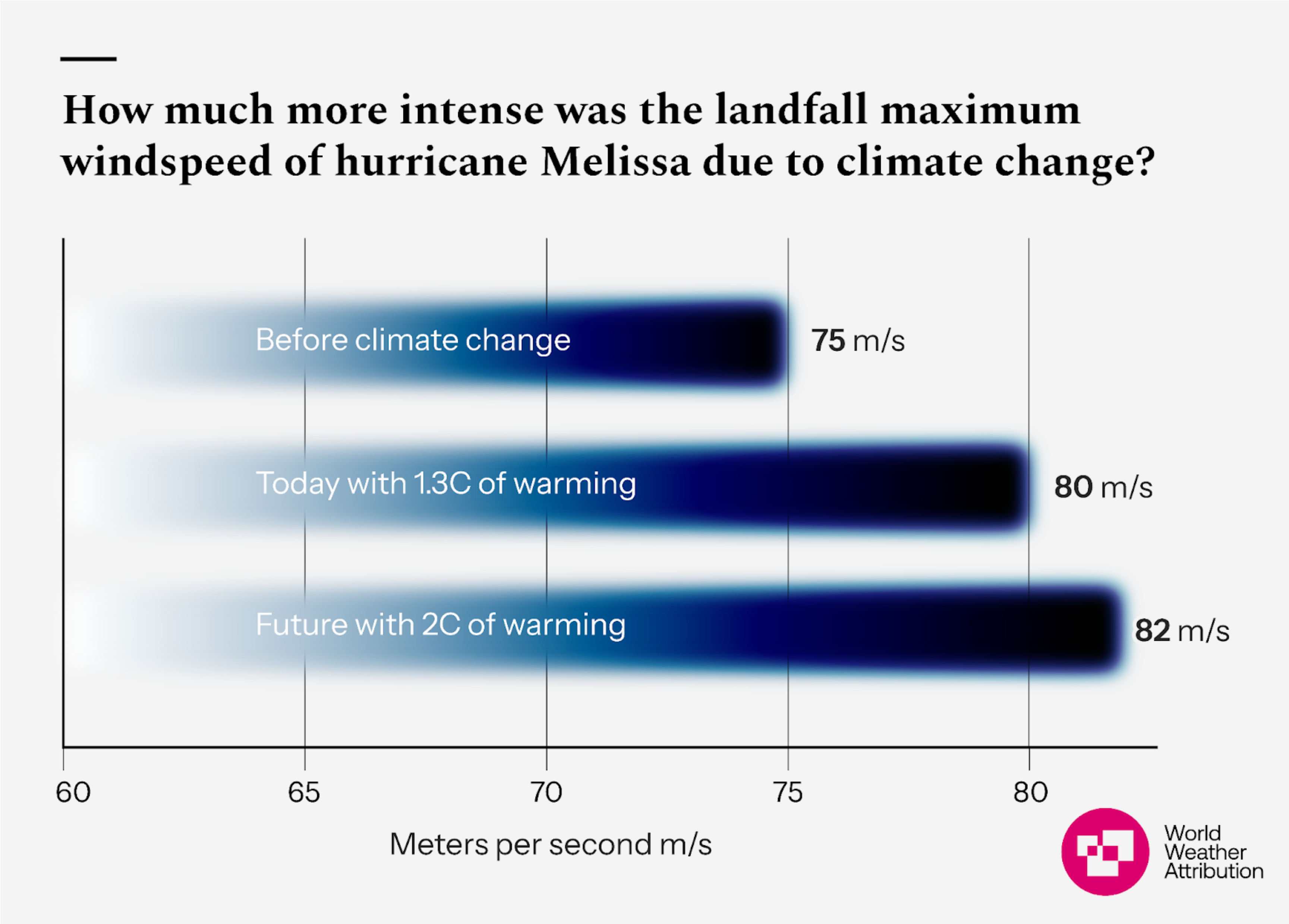

Figure 9.a: Today, at 1.3°C above preindustrial warming levels, the landfall maximum wind speeds of Melissa are about 7% more intense.

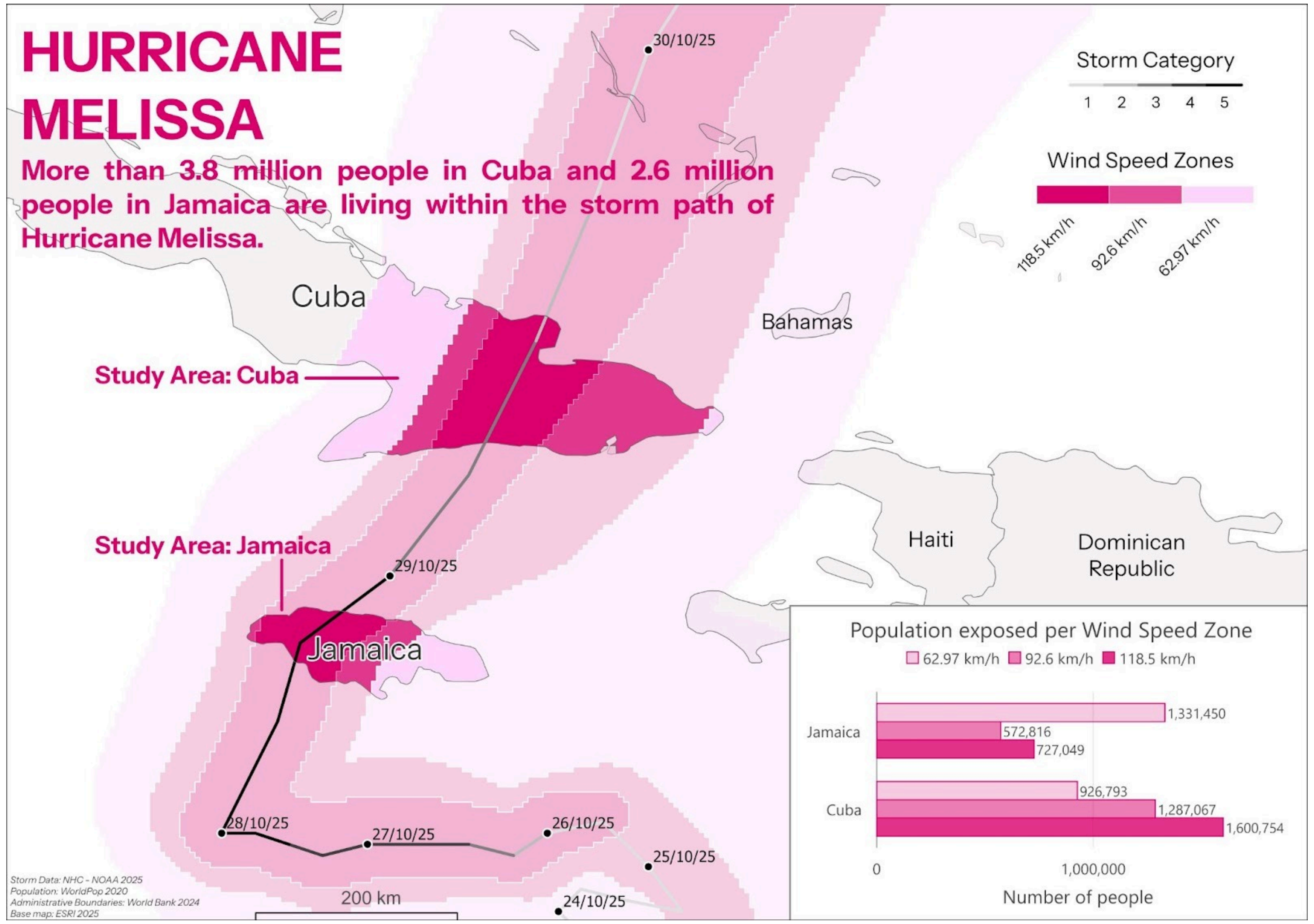

Fig 9.b: Population exposure per wind speed zone of Hurricane Melissa. Data: Storm Data: NHC - NOAA 2025; Population: WorldPop 2020; Administrative Boundaries: World Bank 2024; Base map: ESRI 2025.

Tropical Cyclones

WWA concluded 2025 with the analysis of the role of climate change in two cyclones, or rather cyclonic storms, Senyar and Ditwah, that formed unusually close to the equator and brought torrential rain to parts of Indonesia, Malaysia and parts of Thailand (Senyar) and Sri Lanka (Ditwah). Focusing the analysis on the rainfall that caused the majority of the impacts, the study found that an increase in heavy rainfall with global warming of 9 to 50% is observed over Sumatra and Malaysia, and 30 to 160% over Sri Lanka. While the very low quality of the available climate models prevented a quantitative assessment of the exact contribution of human-induced climate change, it is clear that climate change is an important driver. Once again, for a major weather and climate-related disaster in the Global South, with over 1,000 fatalities and millions of people affected, the lack of climate models tailored to the region and the comparatively limited quality of global observations-based data sets prevented a fully confident assessment of the influence of climate change.

This further underscores the importance of building stronger scientific capacity in vulnerable regions and a fairer distribution of global research funding for achieving climate justice.

Cyclone Ditwah in Sri Lanka. UNDP 2025. Eranga Jayawardena/AP Photo.

The Ministry of Health of Jamaica and PAHO asses the damage on public health infrastructures after Hurricane Melissa. Image by PAHO.

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