BUILDING FUTURE RESILIENCE

Tackling the Interconnected Threats of Pandemics and Climate Change

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PANDEMIC ACTION NETWORK

Introduction

As humanity grapples with two of the most pressing challenges of our time — climate change and pandemics — it has become clear that these threats are deeply interconnected. Climate change amplifies the risks of pandemics by altering ecosystems, increasing the risk of zoonotic spillover, and shifting the behaviors of pathogens, vectors, and hosts. At the same time, pandemics, epidemics, and other health emergencies place immense stress on health systems and infrastructures, which can challenge response to climate-induced emergencies at the global, national, and local levels. Addressing these dual crises requires urgent, collective action that integrates climate adaptation, preparedness, and health resilience into a cohesive strategy.

This report, iterated from a paper originally developed and presented to World Economic Forum CEOs on the sidelines of the UN General Assembly in 2023, outlines the many connections between climate change, health, and pandemic threats, highlights the interlinked challenges they pose, and proposes actionable pathways for building robust, integrated, and context-specific resilience.

The Interconnected Challenge

We are facing two major existential threats: climate change and pandemics. These global threats are highly interconnected, and their risk to lives, livelihoods, and human progress is growing. There is abundant evidence of the **health impacts of climate change** and that **climate change is making future pandemics more likely** due to the increasing frequency, geographic spread, and severity of infectious diseases. A Nature study highlights that **biodiversity loss is the biggest environmental driver of infectious disease outbreaks**, making them more dangerous and widespread. Researchers found that the loss of species had the greatest impact on increasing the risk of infectious disease, followed by climate change and the introduction of non-native species.

Increasing Risk of Zoonotic Spillover

The risk of zoonotic spillover of diseases is heightened due to the increased proximity of animal and human habitats as well as increased human-animal interaction. From 2012 to 2022, Africa **experienced a 63% rise in zoonotic outbreaks** compared to the previous decade. A Journal of Public Health in Africa modeling study projects that by 2070, the risk of cross-species viral transmission would **increase due to geographical range shifts affecting 3,139 mammal species**. Ebola, Mpox, Marburg, H5N1 avian influenza, Lyme disease, and Lassa fever have all been **transmitted to humans through other species and are expected to spread more widely** as the world warms.

- **Mpox**, caused by a virus transmitted through close contact with infected animals or humans, has historically been confined to certain parts of Central and West Africa. However, recent outbreaks have occurred in non-endemic countries, including over **95,000 cases across 115 countries in 2022** and more than 2,863 cases across Central Africa in 2024, which prompted the declaration of a **Public Health Emergency of International Concern** by the World Health Organization (WHO) and first ever **Public Health Emergency of Continental Security** by the Africa Centres for Disease Control and Prevention. By December 2024, total African cases **neared 14,000**. The spread of this virus to non-endemic countries, including in Europe and the United States (U.S.), highlights increased infectious disease risk driven by changing land use, ecological disruption, increased human-wildlife interactions, and new exposure to disease reservoirs, as well as global interconnectedness.
- **Marburg virus**, a highly virulent pathogen causing hemorrhagic fever, is transmitted to humans from fruit bats and spreads through human-to-human contact via body fluids. In September 2024, Rwanda **reported its first-ever Marburg virus disease outbreak**, linked to exposure to **fruit bats in a**

mining cave. Marburg outbreaks are also influenced by environmental shifts, including changes in bat habitats driven by climate change and deforestation.

- **H5N1 avian influenza** also highlights the increasing risk of zoonotic spillover. The current outbreak in the U.S. has spread from poultry to dairy cattle to humans — leading to **66 total confirmed reported human cases** in the country and **one human death** as of January 5, 2025. Increased attention, testing, and preventative measures are needed to prevent H5N1 from mutating into a more virulent strain, **more susceptible to human-to-human infection**.

The rise of these zoonotic viruses, including their spread to new areas and animals, underscores the heightened risk of spillover — closely linked to changing human interactions with nature and climate change. Without decisive action to curb deforestation, address ecological disruptions, and strengthen surveillance and response systems, the frequency of such spillovers and subsequent public health crises is likely to rise.

Shifting Weather Patterns and Increasing Temperatures Changing Disease Pathways and Incidence

Warming temperatures can affect the risk of spillover to humans from other disease systems. Thermal performance curves (TPCs)[1] illustrate the ways in which temperature affects the physiological traits of pathogens, vectors, and reservoir hosts, which can determine the emergence and rate of disease spread in a susceptible population. TPCs are commonly used to predict the potential effects of rising temperatures resulting from climate change on vector-borne (and other) infectious disease systems. Thermal adaptation, acclimation to a warming climate, or both can potentially shift TPCs and thermal tolerance limits with important implications for spillover opportunities and expansion of the geographic range of certain diseases including those that are vector-borne.

Rising temperatures **extend the breeding season and geographic range of vectors**, enabling diseases like malaria, dengue, and Zika to spread to moderate climates, including Europe and the U.S. By 2050, an estimated 500 million more people **could face exposure to vector-borne diseases**. For example, malaria is **now spreading to higher altitudes in Africa due to climate change**. There is even the prospect that pathogens frozen in the permafrost **may be released as the climate continues to warm**. Depending on their ability to adapt, vectors may no longer carry certain pathogens, carry pathogens to different hosts or locations, or carry new pathogens as climate-mediated ecosystem changes bring different pathogens, vectors, reservoir, and human hosts together.

Health Impacts of Extreme Weather Events

Sudden and severe weather events like floods or hurricanes are also increasing incidence and severity as a result of climate change. These events not only are a direct threat to human health and safety, but also threaten essential healthcare infrastructure, increase demand for emergency health services, and undermine capabilities for outbreak response. A 2023 report found that **1 in 12 hospitals around the world could face partial or total shutdown from climate change extreme weather events**, the majority of which are in low- and middle-income countries (LMICs). It is estimated that climate-induced impacts **would account for a further US$1.1 trillion in extra costs to healthcare systems by 2050**.

In some cases, health systems are forced to stop or deprioritize infectious disease work due to climate-induced emergencies. Puerto Rico, for example, was **forced to stop Zika surveillance and response in the aftermath of Hurricane Maria**. In other cases, the direct effects of extreme weather events include increased risk of outbreaks or other health risks. The **devastating 2022 floods in Pakistan** also triggered a public health crisis with a rise in waterborne diseases like cholera and dengue. Broader disruptions to healthcare also worsened access to care for chronic conditions like diabetes and hypertension and the compounded challenges deepened existing inequalities, particularly for vulnerable

[1] Thermal performance curves (TPCs) describe how well an organism functions at different temperatures. For example, they show the temperature range in which a pathogen, vector (such as a mosquito), or host thrives, grows, or reproduces. Changes in these curves mean that shifts in temperature can make certain organisms more or less capable of surviving and spreading, potentially creating new risks for disease transmission.

populations. Cyclones, for example, are also well documented as having a potentially **devastating impact on the safety and function of medical infrastructure**.

Climate change also increases the risk of supply-chain disruptions, including through impacts on maintaining cold chains, which are essential to protect the thermostability of vaccines and drugs.[2] Following the 2018 floods in Kerala, India, hospitals **faced power outages anywhere from three to nine days** causing shutdown of cold storage systems. Entire stocks of vaccines and other essential medical supplies were damaged, with an estimated total loss of over US$15 million. A 2015 heat wave in India caused the closure of several pharmaceutical factories, leading to shortages of essential medicines. Since the majority of the production of active pharmaceutical ingredients (API) is **concentrated in a few regions in China and India**, a climate-induced disaster in just one of these regions could have dramatic repercussions on global access to medicines.

Water and Disease

Climate change also **impacts water availability and quality**, heightening the risk of waterborne and foodborne disease like cholera, as warming water sources foster bacteria and other pathogen growth. In part fueled by climate change, global cases of cholera **increased by 13% percent between 2022 and 2023**, while deaths from cholera increased by 71% during the same period. Shifting rainfall patterns and displacement, including from natural disasters, is also forcing an increasing number of people into unsafe conditions without proper sanitation or access to clean water, which is a harbinger for disease and infection, like polio. Following the 2023 earthquake in Turkey, overcrowding in emergency centers was **linked to unsafe drinking water and other potential risk factors** for developing respiratory infectious diseases.

[2] Currently, most vaccines must be stored between 2-8 ℃. Both heat, as well as accidental freezing, can cause vaccines to lose their potency.

Climate Change Deepening Global Health Inequities

Climate change — and its impact on increasing disease threats and stressing health systems — also intensifies global health inequities, which **disproportionately affect vulnerable groups** such as women, youth, the elderly, ethnic minorities and Indigenous people, low-income populations, remote communities, migrants and displaced people, and sexual and gender minorities. Regions like Africa and southern Asia are particularly at risk of increased inequities due to resource constraints, inadequate infrastructure, and limited access to essential medical equipment, which already weakens health systems and hinders their capacities to adapt to environmental challenges.

We have seen through COVID-19 that the health and economic impacts of the pandemic were **disproportionately borne by the most vulnerable**. Vulnerable populations were also **least likely to receive access to a COVID-19 vaccine**. The destruction of health infrastructure and disruption of services after extreme weather events also **disproportionately affects vulnerable groups**. Women and girls in particular, face compounded inequities, as they are already least likely to access essential health services due to entrenched norms and stigma, and maternal and reproductive health services are often deprioritized during health and other emergencies. Migrants, displaced populations, and sexual and gender minorities often lack access to equitable healthcare services, which also leaves them disproportionately exposed to the physical and mental health consequences of both pandemic- and climate-related disasters.

Pandemic Impacts on Climate Change Efforts

The response to the global COVID-19 pandemic, despite the temporary reduction in greenhouse emissions from the lockdowns in the first half of 2020, also negatively impacted the global response to climate change. One climate-related side effect includes a **massive global increase in biomedical waste**. COVID-10 also severely stressed the capacity of fragile health systems, particularly in LMICs, which continues to challenge their ability to respond to an increasing number of **climate change-fueled storms, floods, and health emergencies**.

These are among the many examples of the interconnectedness of climate change, pandemic threats, and global health equity — and they both highlight the complexity of the challenge as well as the need for holistic and integrated solutions. Vulnerabilities in health access and infrastructure, disease detection and surveillance systems, supply chains, and climate mitigation and adaptation capabilities are also exacerbated in LMICs, increasing their risk of compounded crises. As we know too well from COVID-19, a health emergency anywhere can be a health emergency everywhere, and it is imperative that we work toward global, regional, and local systems that uphold health and resilience for all.

Key Areas for Action

Mitigating the risks of climate change and pandemics — and building resilient health systems — **requires action by all countries**, working in concert at national, regional, and global levels toward integrated solutions.

The deep interlinkages between climate change and pandemics requires a shift in policy thinking and investments to fuel integrated solutions that drive health and resilience for all. Priority areas for action follow:

Three Key Areas for Action

- Better articulate, map, and plan for the integrated vulnerabilities from pandemic and climate threats
- Invest in targeted solutions to respond to known risks at the pandemic and climate change interface
- Prioritize, build, and finance pandemic- and climate-resilient health systems

1. Better articulate, map, and plan for the integrated vulnerabilities from pandemic and climate threats

While there is increasing recognition of the interconnected risks posed by pandemics and climate change, there is a pressing need to better map vulnerabilities — especially at the regional and local levels — to fuel proactive planning and mitigation efforts. Because solutions at the nexus of climate and pandemics will not be one-size-fits-all — some regions are facing more droughts, heat waves, and wildfires while others more storms and floods, etc. — it is especially important to drive context-specific assessments to channel attention and investments toward the most pressing needs. With this in mind, stakeholders should:

- Develop joint vulnerability atlases for pandemics and climate change, showing the different factors that make a particular area or population more vulnerable to a disease outbreak, a natural disaster, or an environmental problem. This information can then be used to further targeted interventions to increase health and climate resilience.

- Prepare localized resilience and preparedness strategies to address region- and community-specific vulnerabilities. Localized strategies should reflect context-specific risks, such as disease reservoirs, health system capacities, and risks of weather events like heat waves, floods, or droughts and use risks to inform priority actions and investments. Areas of focus should include actions like enhancing disease surveillance and control systems, building a ready and resilient health and community workforce, and investing in early warning systems. Community engagement will be essential to create context-appropriate solutions that are effective and inclusive.

2. Invest in targeted solutions to respond to known risks at the pandemic and climate change interface.

There are many known solutions that can help address the interlinked vulnerabilities of pandemics and climate change. It is essential to invest in mitigation techniques, tactics, and strategies now so that we are prepared to protect lives and livelihoods when a crisis emerges. Some targeted solutions include:

- Integrating climate and health data systems to enable quicker and more efficient early warning and response systems for health risks — ranging from the health impacts of cyclones to upticks in

malaria transmission from changing weather patterns. Currently, most public health systems do not consider climate information and seldomly use it to generate disease forecasting that could aid decision-making. This could include scaling up initiatives like WHO's data efforts in Mozambique.

- Developing early detection systems that prioritize high-impact areas where different pathogens, vectors, reservoirs, and human hosts are brought together and risks have changed due to climate change. Supporting African experts to collect data and build early detection and warning systems while integrating AI will be essential to building effective systems for some of the highest-risk areas of the world.

- Strengthening diagnostic infrastructure and innovation to address diseases exacerbated by climate change, particularly in LMICs. This includes increasing investment in diagnostics and surveillance systems for climate-exacerbated diseases and supporting research and development of new diagnostics tailored for climate-related challenges, such as technologies that promote decentralized self-testing.

- Advancing sustainable sourcing and climate-ready infrastructure to source medical supplies and inputs for drugs, vaccines, therapeutics, and other tools from sustainable, geographically diverse, and resilient suppliers to mitigate disruptions from crises. Steps must also be taken to shore up health and health and production infrastructure, including building facilities in areas less vulnerable to climate-induced events, and ensuring facilities can withstand extreme weather. A significant number of health facilities are still being built in areas highly prone to disasters.

- Developing and scaling heat-stable and other innovative countermeasure technologies to eliminate reliance on cold chains, which are vulnerable to climate-related disruptions. Many new technologies, including mRNA vaccines, are highly reliant on ultra-cold chains. Not only does this exacerbate inequities in access with many LMICs unable to support robust cold chain capacities, but it also makes accessibility to essential countermeasures highly vulnerable in crisis situations with extreme heat and/or limited electricity. Recent innovations — such as room-temperature RNA formulations, microneedle vaccines, and needle-free platforms — demonstrate the potential for climate-resilient solutions that can uphold access to essential medical tools regardless of environmental or geographical challenges.

3. Prioritize, build, and finance pandemic- and climate-resilient health systems

The intersection of climate, health, and pandemics is increasingly understood. Yet, there is limited action to fund integrated solutions: **almost no climate finance currently targets the health sector, and nearly no global health finance targets climate adaptation**. We also have an extremely limited understanding of the scale of investment needed to build and sustain the pandemic- and climate-resilient health systems we need for the future. Stakeholders should support:

- Standing up an expert Commission to explore what it would cost to build pandemic- and climate-resilient health systems, with a focus on LMICs. Such a **Commission** would identify the types and levels of investments needed to save the most lives from increasing climate and pandemic threats and improve people's well-being. Experts from across sectors would help determine the policy interventions needed to support the most pandemic- and climate-resilient health systems possible, prioritizing community-, country-, and regionally-led solutions. It would produce a landscape analysis of existing work, offer a framework for LMICs to guide them on cost-effective investments to future-proof health systems, and provide a holistic costing and gap

analysis of investments needed at all levels to build the systems required to protect lives and livelihoods from increasing climate and pandemic threats.

- Financing to implement the recommendations of the Commission, including through new and innovative funding mechanisms. Potential tools to leverage include:
    - Delivering additional resources for climate- and pandemic finance through the International Monetary Fund's **Resilience and Sustainability Trust (RST)**.
    - Linking health and climate adaptation funding and **prioritizing strategic investments that purposefully cut across the shared agenda**. This would require full funding for global health institutions and climate-related bodies/investment vehicles, as well as ensuring multilateral climate funds increase emphasis on directly funding the health sector.
    - Including **pandemic debt suspension clauses** in all new sovereign lending.
    - Maximizing opportunities for private capital mobilization through enhanced multilateral development bank loan guarantees and issuance of climate and health bonds.
    - Securing agreement on targeted international levies such as maritime and fossil fuels to support the climate/health/pandemic agenda.
    - Adopting a **comprehensive package** of enhanced global financing tools to accelerate and sustain action on climate- and pandemic-resilience.

Conclusion

The interconnectedness of climate change and pandemic threats must be recognized, prioritized, and reflected in shared solutions. Climate change is increasing the likelihood of future pandemics, and pandemics exacerbate and compound some of the negative impacts of climate change.
Addressing these crises in isolation is not a viable option. Holistic, multi-sector, and integrated solutions are essential to build resilience against both threats. The convergence of these agendas presents a critical opportunity to rethink and rebuild systems that respond to the twin challenges of pandemics and climate change, while upholding resilience and equity. It will require strategic and coordinated action, innovative policy frameworks, and the involvement of diverse stakeholders across sectors and geographies.
We call on all stakeholders to:

- Better articulate, map, and plan for the integrated vulnerabilities from pandemic and climate threats
- Invest in targeted solutions to respond to known risks at the pandemic and climate change interface
- Prioritize, build, and finance pandemic- and climate-resilient health systems

The risks are mounting but so are the opportunities for innovation and collaboration. By acting now, we can create a safer, healthier, and more sustainable future where resilience and equity are at the core of our shared global response.

Pandemic Action Network drives collective action to ensure the world is prepared to respond to outbreaks and prevent the next pandemic. Launched in April 2020 by leaders in global health advocacy, crisis response, and communications, we are a robust partnership of over 400 diverse organizations aligned in a belief that every effort made in the fight against COVID-19 should leave a long-term legacy — one where humanity is better prepared to deal with outbreaks and prevent a deadly and costly pandemic from happening again.

For more information on this working document, please contact **Eloise Todd**, Executive Director and Co-Founder, Pandemic Action Network.

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