PERRY WORLD HOUSE

CONFERENCE REPORT

# Preparing for Vector-Borne Disease in a Warming World

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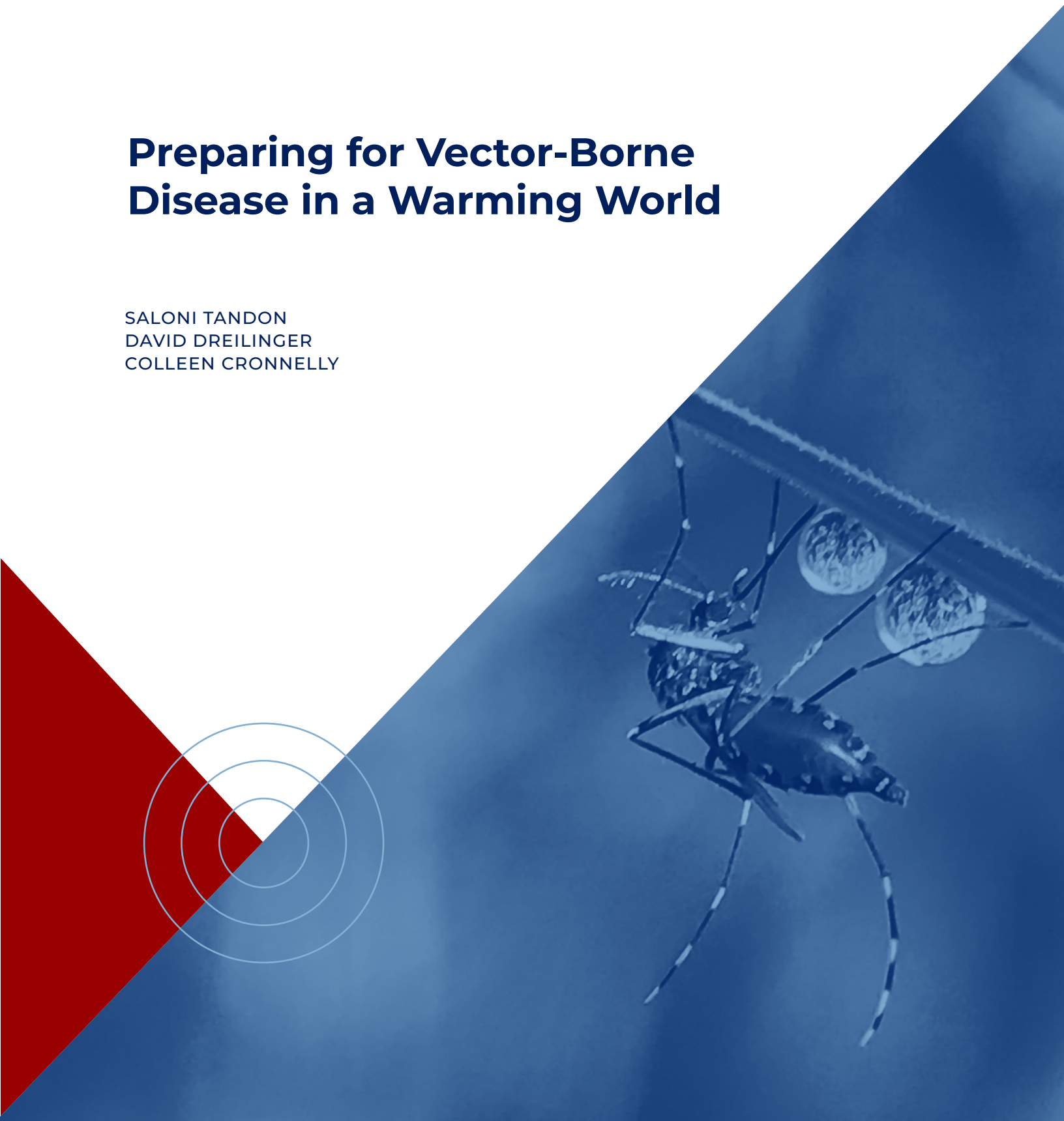

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## ABOUT PERRY WORLD HOUSE

Perry World House is a center for scholarly inquiry, teaching, research, international exchange, policy engagement, and public outreach on pressing global issues. Perry World House's mission is to bring the academic knowledge of the University of Pennsylvania to bear on the world's most pressing global policy challenges and to foster international policy engagement within and beyond the Penn community.

Located in the heart of campus at 38th Street and Locust Walk, Perry World House draws on the expertise of Penn's 12 schools and numerous globally oriented research centers to educate the Penn community and prepare students to be well-informed, contributing global citizens. At the same time, Perry World House connects Penn with leading policy experts from around the world to develop and advance innovative policy proposals.

Through its rich programming, Perry World House facilitates critical conversations about global policy challenges and fosters interdisciplinary research on these topics. It presents workshops and colloquia, welcomes distinguished visitors, and produces content for global audiences and policy leaders, so that the knowledge developed at Penn can make an immediate impact around the world.

> SECTION 1

# Background

**<< While climate-driven threats to public health are vast and complex, trends in vector-borne diseases, which cause more than 700,000 deaths annually, are a fast-rising concern. >>**

The World Health Organization (WHO) has called climate change "the single biggest health threat facing humanity" (WHO, 2023). With warming at approximately 1.14°C above preindustrial levels and set to increase, the Intergovernmental Panel on Climate Change (IPCC) predicts with very high confidence that climate-related illness will also rise (IPCC, 2022). While climate-driven threats to public health are vast and complex, trends in vector-borne diseases (VBDs), which cause more than 700,000 deaths annually (WHO, 2020), are a fast-rising concern.

As the world rapidly warms, where and how vectors, such as mosquitoes and ticks, thrive and transmit disease will impact public health. By 2050, some 50 percent of the global population may be exposed to disease-transmitting vectors (IPCC, 2022). Already, between 2013–2022, 17 percent more of the world became warm enough and wet enough to support malaria transmission (Wong, 2023). Dengue fever is expected to intensify where it is already endemic and spread to parts of Asia, Europe, North America, and Australia (Surprenant, 2023). Throughout 2023 and into 2024, the Andean region battled record levels of dengue,[1] and in 2023, California saw its first-ever locally transmitted case (Teirstein, 2024). As vectors move due to the changing climates they inhabit, they will interact with previously unexposed or "immunologically naïve" hosts (Ryan, et al., 2019; Colón-González, et al., 2021), opening new possibilities for outbreaks of rare diseases and even the next pandemic (Teirstein, 2024).

Other global trends like rapid urbanization, migration, and growing socioeconomic inequality, including in access to healthcare, will shape the challenge (Mahon, 2024). By 2050, two billion more people are expected to inhabit urban areas—some 68 percent of the global population. The majority of urban dwellers will live in unplanned informal settlements in Asia and sub-Saharan Africa (United Nations-DESA, 2018; United Nations-Stat, 2021). More densely populated urban spaces, especially those with insufficient infrastructure and services like window screens, plumbing, or trash collection may underwrite vector breeding and disease transmission (Nolan, 2023). These could be offset, however, with sound urban planning and increased access to healthcare. Climate-related migration (possibly 1.2 billion climate migrants by 2050) (United Nations-Stat, 2021) and conflict could pose additional public health stressors. As with all

1 The Andean region is a bellwether for how climate change and vector-borne disease could affect public health. In 2023, Peru battled its worst dengue outbreak on record, recording more than 270,000 cases—nearly four times the number in 2017, the last El Niño year. In 2024, dengue fever cases continue to rise. Meanwhile in Ecuador, eight thousand dengue cases were reported since the beginning of 2024. As of March, 1.87 million suspected cases were reported across the Americas, representing an increase of 249 percent from the same period in 2023.

crises and/or shocks, those with the least resources to cope will bear the worst impacts—globally, nationally, and locally (Magalhães, 2023).

To begin addressing these evolving challenges and to advance discourse and policy solutions at the nexus of climate change and health, Perry World House convened the workshop "Preparing for Vector-borne Disease in a Warming World." The conference brought together academics, policymakers, and practitioners from a variety of institutional and national contexts to discuss how the frontier of VBD is changing, to identify gaps and needs, and to extract lessons learned, specifically, from the recent outbreak of dengue in the Andean region. Building on Perry World House's work on climate change adaptation, participants put forth actionable policy solutions and measures that could be taken to stem VBDs in the future.

> SECTION 2

# Sound Data, Comprehensive Monitoring and Collaborative Science

A panel of experts discussed the changing frontier of VBD given predicted trajectories of global warming. One panelist presented the "burning embers"[2] synthesis of how risks in a particular system could change with additional warming. Even in a "middle of the road" adaptation scenario, a 2°C rise above preindustrial levels is likely to cause a high impact on and risk of malaria, dengue, Lyme disease, and other VBDs. In the best-case scenario, where adaptation is more effective than it is today in preventing adverse climate-sensitive health outcomes, the predicted impact of climate change on diseases like dengue and malaria improves, but the threat remains moderate to high (IPCC, 2022).

Despite efforts to map and model the prevalence and spread of disease as temperatures rise, panelists highlighted that global trends in VBD are not sufficiently documented and that data on the health impacts of climate change remain inadequate. They underscored the need for more and better data at appropriate and comparable scales that could, for instance, overlay weather patterns with vector behavior. They suggested employing community surveillance and science as ways to ascertain large amounts of data while engaging and informing local people. The experts also discussed the need to change incentives to reward collaboration in academia and science, which could feed central data repositories.

Panelists emphasized that the current status of VBDs is influenced by a complex interplay of factors beyond temperature. They argued that including migration and human mobility in policy and research would advance disease surveillance and management. They highlighted that without migrant-sensitive health information systems, people on the move risk being stigmatized as agents of disease. Given the multidisciplinary dimension of the VBD challenge, panelists underscored the need for integrated surveillance systems and models as well as system-based approaches. In addition to migration patterns, these would account for, inter alia, land-use changes, like rewilding, which over decades changes vector habitat; as well as rapid urbanization; human behavior; and socioeconomic factors, like poverty, all of which influence VBD outcomes. Others emphasized focusing research on children, who are disproportionately vulnerable to climate change–related health risks (the UN Children's Fund calculates that one billion children are at extremely high risk of the impacts of the climate crisis), as well as recognizing the strong connection between diarrhea, malaria, and undernutrition, implying that populations with preexisting stressors are already at a heightened risk for VBDs, especially children (UNICEF, 2023).

2 The Burning Embers graphic started appearing in IPCC reports in 2001. In the Sixth Assessment report, it shows the change in the levels of impacts and risks assessed for global warming of 0–5°C global surface temperature change relative to the preindustrial period (1850–1900) over the range. See: https://www.ipcc.ch/report/ar6/wg2/figures/summary-for-policymakers/figure-spm-3.

> SECTION 3

# A Case Study of the Dengue Outbreak in Peru

An examination of Peru's recent dengue outbreak offered a valuable opportunity to examine these challenges in greater depth and to identify the factors contributing to the severity and impact of VBD outbreaks in resource-limited settings, including:

- Understanding the specific stressors and challenges faced by the Peruvian healthcare system during the dengue outbreak, and how these factors may be similar or different from those faced by other countries in the region or around the world;
- Identifying the key vulnerabilities and gaps in Peru's outbreak preparedness and response capacities, and exploring how these weaknesses may have contributed to the severity and duration of the outbreak; and
- Drawing lessons and insights from Peru's experience that can inform future efforts to strengthen health system resilience and improve VBD outbreak preparedness and response, both in Peru and in other countries facing similar risks.

## The 2023 Dengue Outbreak in Peru

In 2023, Peru battled its worst dengue outbreak on record, recording more than 270,000 cases—with 820 cases per 100,000 population. In 2024, dengue fever cases continue to rise, with projections indicating a potential doubling of cases compared with 2023 (Instituto Nacional de Salud del Perú, 2024). Meanwhile, in Ecuador, eight thousand dengue cases were reported since the beginning of 2024, marking a 30 percent increase from the same period in 2023 (Ministerio de Salud Pública del Ecuador, 2024). As of March, 1.87 million suspected cases were reported across the Americas, representing an increase of 249 percent from the same period in 2023 (PAHO, 2024).

### Perceived Causes of the Dengue Outbreak in Peru 2023

Experts explained that the increase in dengue cases over the past four decades in Peru were largely driven by human factors, including climate change, land-use change, and migration. Panelists noted that Peru faced several additional challenges that exacerbated the dengue outbreak:

**Naïve populations:** Panelists explained that several segments of the population in Peru were unfamiliar with dengue and its symptoms. This delayed recognition of cases, as well as care and treatment. It also led to further dengue spread because breeding sites were not quickly identified. A panelist noted that there was typically limited knowledge about where mosquitos breed in Lima, with 60 to 80 percent of breeding sites different from expected, such as in cement water tanks or other passively rain-filled containers.

**Political instability:** Panelists highlighted that Peru had experienced significant political turnover in the last decade, with sixteen ministers of health appointed, each having a tenure of roughly six

months. Panelists shared that this instability made it challenging for the healthcare infrastructure and the government to implement consistent, long-term strategies to combat VBDs. Most critically, changing priorities and leadership hindered the development of effective surveillance and control measures. One panelist outlined the political disincentives to pursuing long-term structural improvements to the Peruvian health system.

**Hard-to-reach populations:** Panelists shared that healthcare officials had difficultly accessing some communities, particularly those along the Amazon River, where the Aedes aegypti mosquitoes would lay eggs and spread disease. Because healthcare authorities had trouble reaching these populations with education, prevention, and treatment, it was harder to contain the spread of dengue.

**Communication issues:** Panelists noted that local communication was inadequate to control the outbreak. They suggested that Peru needed more public health professionals trained in health communications.

**Limited data, and proactive planning:** Panelists noted that Health National Adaptation Plans did not specify the kind of data that is needed for proactive planning, and therefore, it was not collected.

**Ineffective vector-control strategies and insufficient disease-monitoring and surveillance:** Despite having experience working with dengue, there were problems with information and limited capacity to provide potable water in highly endemic regions.

**Migration:** Panelists explained how economic and social structures dating back to Peru's colonial era influenced unsustainable patterns of urbanization, informal settlements, and lack of city services, which introduced vectors, breeding grounds, and carriers in urban locations.

To address the dengue outbreak, panelists—including public health officials—explained that Peru declared a state of emergency, implemented environmental-control measures to reduce mosquito populations, opened a field hospital to scale up healthcare capacity, and provided training to clinicians nationwide to ensure effective case management and prevention. At the community level, some organizations sought to control the epidemic by shifting from a top-down "militarized" approach to a more responsive approach in which they allowed the healthcare officials at the grassroots level to lead in containing the spread of the vectors. Unfortunately, despite the implementation of these steps, Peru faced another layer of challenges that eventually led to the extremely high prevalence of dengue. These included:

**Overwhelmed healthcare facilities:** Despite taking proactive measures, panelists noted that many people bypassed local clinics, which are typically the first line of defense in managing outbreaks, and directly sought care at larger hospitals. This overwhelmed hospitals, strained resources like beds and medical staff, and led to reduced care quality across the healthcare system.

**Public trust and compliance issues:** The requirement for residents to seek treatment at clinics rather than at home was intended to centralize and better manage treatment protocols. However, noncompliance suggested issues with public trust or awareness. Effective communication and community engagement, panelists noted, are critical for ensuring that the public follows government advisories during health emergencies.

**Political consequences:** The resignation of the minister of health in June 2023 under the pressure of rising case numbers reflected the political challenges associated with crisis management. Panelists highlighted that political instability complicates response efforts, shifts strategies, and causes disruptions.

Peru's experience with dengue is an instructive example, illustrating the importance of coordinated actions; the need for robust infrastructure for data, monitoring, communications, and healthcare; and the critical role of community trust and compliance in managing public health crises.

> SECTION 4

# Where Do We Go From Here?

Experts at the workshop, including those on a third panel that specifically discussed solutions, put forth nine critical recommendations. Each relates to a specific problem highlighted in the day's discourse. Recommendations are as follows:

## Surveillance, Data, and Attribution Science

### Recommendation 1: Develop Integrated Surveillance Systems

**Problem:** Traditional surveillance systems do not account for, inter alia, important linkages between vector ecology, climate variability, land-use change, and disease dynamics. Limited access to data hinders the development of robust warning systems and adaptation measures.

**Recommendation:** Establish integrated surveillance systems that collect, analyze, and share high-quality data on a range of variables, including disease incidence, vector populations, weather patterns, and socioeconomic and other environmental risk factors. Integrated surveillance systems should enable early detection and response to VBD outbreaks, inform targeted interventions, and help communities adapt to the changing risk landscape. These systems should feed and benefit from open data platforms and repositories that are user-friendly, interoperable, and provide equitable access to critical data. Additionally, incentive structures should reward scientists for collaborative research and knowledge sharing.

### Recommendation 2: Advance Evidence and Attribution Science

**Problem:** Insufficient evidence on how climate change impacts VBD—and the consequent impacts of VBD on public health, economics, and overall well-being—hinders policy action and resource allocation for VBD research and control.

**Recommendation:** Prioritize research to quantify the extent to which climate change influences VBD. Calculate and communicate the health and economic costs of VBD to inform policy decisions. Research priorities suggested by the panelists included:

- Conducting long-term, longitudinal studies to monitor changes in VBD incidence and distribution over time, in relation to climate and other environmental variables;
- Developing and validating predictive models that integrate climate, ecological, and socioeconomic data to forecast VBD risk at different spatial and temporal scales;
- Assessing the attributable burden of VBDs to climate change, using methods such as comparative risk assessment and detection and attribution studies; and
- Calculating the socioeconomic impact of VBD and the value of anticipatory and mitigatory action.

## Access to Finance and Therapeutics

### Recommendation 3: Advocate for Financial Resources at the Climate-Health Nexus

**Problem:** Only 2 percent of global climate change adaptation funding, and 0.5 percent of overall climate funding, is dedicated to improving health outcomes (Kuzmak, 2023) hindering efforts to prevent, prepare for, and respond to VBD.

**Recommendation:** Use the evidence base developed in prior recommendations to advocate for more resources to address the climate determinants of health. This would include securing finance from climate funds like the newly created loss and damage fund, as well as development banks, which panelists noted are increasing their lending to climate initiatives. Experts also recommended using the evidence base to call for more pre-positioned, or anticipatory, finance outbreak mitigation.

### Recommendation 4: Accelerate the Development and Equitable Distribution of VBD Vaccines

**Problem:** The lack of development of and access to vaccines, particularly in low-income countries, contributes to vulnerability to VBD. Panelists noted that pharmaceutical companies neglect the development of therapeutics to treat VBD because of limited market incentives. Moreover, the global capacity for vaccine production is concentrated in a few high-income countries, leading to inequitable access and supply shortages during public health emergencies (WHO, 2022d).

**Recommendation:** Accelerate the development and equitable distribution of VBD vaccines by providing increased basic research support, offering targeted incentives for pharmaceutical companies, building global vaccine manufacturing capacity, and adjusting stockpile levels to account for growing vulnerability. Panelists advocated for increased funding supporting academic and nonprofit research institutions to conduct preclinical studies, develop novel vaccine platforms, and optimize vaccine candidates for clinical trials. They highlighted recent progress in developing effective dengue and malaria vaccines, including using mRNA technology. Panelists also called for the development of a global VBD vaccine fund to pool resources and coordinate investments in vaccine development and distribution. They urged investment in capacity building and technology transfer initiatives to enhance vaccine manufacturing capabilities in low- and middle-income countries.

## Governance and Communications

### Recommendation 5: Strengthen Governance, Public Health Policymaking, and Service Delivery

**Problem:** Corruption and lack of coordination between health and non-health sectors limits the effectiveness of public health interventions and governments' ability to respond to threats. Government agencies have limited capacity and lack incentives to collaborate or share knowledge, particularly when there are competing priorities or limited funding.

**Recommendation:** At the national level, implement a One Health[3] approach that fosters collaboration among government agencies and their partners. Key elements of a One Health approach to VBDs suggested by panelists include establishing multisectoral coordination mechanisms at national

3 One Health is a collaborative, multisectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes while recognizing the interconnection between people, animals, plants, and their shared environment. See: https://www.cdc.gov/onehealth/basics/index.html.

and local levels; conducting joint risk assessments and surveillance activities across human, animal, and environmental sectors; and putting in place incentives to collaborate. To further improve governance, participants recommended implementing anti-corruption measures and transparency mechanisms to ensure that resources for VBD control are used efficiently and reach the intended beneficiaries. They also suggested democratizing public health by promoting community-led interventions that involve local people in the planning, implementation, and monitoring of VBD.

### Recommendation 6: Improve Communication and Education to Build Trust

**Problem:** Misinformation coupled with distrust of scientists, healthcare workers, and government officials hinders VBD prevention and control. These challenges are particularly acute in marginalized communities and localities where awareness is low.

**Recommendation:** Develop communication and education strategies tailored to the specific needs, values, and contexts of local communities. Promote dialogue, understanding, and collaboration between academia, policymakers, and the public, including by engaging trusted community leaders, local health workers, like nurses, and other local stakeholders as champions. Incorporate VBD and climate change education into school curricula and community-based learning programs.

> SECTION 5

# Conclusion

**<< Stemming the impacts of climate change on public health is firmly on the global policy radar. >>**

Stemming the impacts of climate change on public health is firmly on the global policy radar. In November 2023, for the first time in its twenty-eight-year history, the Conference of the Parties (COP28) to the UN Framework Convention on Climate Change (UNFCCC) dedicated a day of its proceedings to discussing the impacts of global warming on public health, with over one hundred health ministers in attendance. Nearly 125 countries, including the United States, signed a COP28 Presidency- and WHO-led Declaration on Climate and Health. This was released alongside a set of ten principles to bolster financing for climate and health. Stakeholders pledged an estimated US$1 billion to support health system transformation and to address the environmental determinants of health. Delegates to the Climate Conference also adopted language under the auspices of the Global Goal on Adaption urging state parties to build resilience and reduce climate-related mortality and morbidity, especially in the most vulnerable communities (UNFCCC, 2023)

Progressing toward these globally agreed development goals will necessitate informed policy action and strategic investments that prepare health systems, institutions, and practitioners to collectively tackle the challenges at hand. For VBD, this means moving toward a comprehensive, proactive, and collaborative agenda that engages diverse stakeholders across their sectoral areas of expertise. The summary of proceedings and recommendations presented in this paper offers a roadmap for working toward this objective and building resilience to health threats linked to a changing climatic system.

> APPENDIX 1

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> APPENDIX 2

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