

Editorial

From climate extremes to health emergencies: activating One Health for anticipatory action

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Climate change increasingly presents a systemic public health challenge, particularly where extreme heat, floods, cyclones, salinity, and other hazards intersect with poverty, inadequate water, sanitation, and hygiene (WASH), insecure livelihoods, environmental degradation, and limited health system capacity. Climate hazards rarely manifest in isolation. Through interconnected hazard-exposure-vulnerability-response pathways, a single environmental shock can induce physiological stress, alter vector and pathogen dynamics, disrupt food and water supplies, and modify human-animal interactions. Furthermore, these events frequently drive population displacement and inflict severe damage on public health infrastructure. Consequently, climate-sensitive risks extend far beyond individual diseases to encompass broader human, animal, and environmental systems. This systemic intersection underscores the critical necessity of prioritizing prevention and preparedness alongside post-event mitigation (Romanello *et al.*, 2025). Resilience requires early action through effective warning systems, safe WASH, food and water security, continuity of essential health services, and protection of vulnerable populations. Yet, these functions often remain divided among health, agriculture, water, environment, and disaster management sectors. The fundamental challenge of aligning cross-sectoral and multi-level risk data, decisions, and interventions is effectively operationalized via the One Health framework. This framework leverages the inherent interdependence of human, animal, plant, and ecosystem health to institutionalize coordinated prevention. The Quadripartite One Health Joint Plan of Action (OH JPA) provides a common framework spanning health system resilience, zoonotic and vector-borne diseases, food safety, antimicrobial resistance (AMR), and environmental risks. In August 2026, the Quadripartite extended the OH JPA through 2029, creating further scope for countries to strengthen national One Health action (Fernandes, 2026). By explicitly linking early warning signals with unified community and environmental responses, an integrated One Health approach can protect infrastructure, keep medical networks operational during disasters, and shield vulnerable populations before climate hazards become health emergencies.

Bangladesh illustrates how climate hazards can create diverse and interconnected health risks. Its dense population, riverine and coastal environments, rapid urbanization, and climate-sensitive livelihoods contribute to widespread exposure. Rising wet-bulb globe temperatures, which reflect heat, humidity, and radiant exposure, indicate an increasing risk of heat stress across the country (Kamal *et al.*, 2024). In Dhaka, the combination of heat and high humidity has been associated with increased cardiovascular morbidity (Rahman *et al.*, 2025). Similar heat-related cardiovascular, respiratory, and metabolic risks are reported across low- and middle-income countries (Siddiqui *et al.*, 2025). In coastal areas, higher drinking-water sodium concentrations have been linked

to blood-pressure outcomes among women (Khan *et al.*, 2026a). Flooding introduces additional risks through displacement, contaminated water, food insecurity, and the disruption of essential services. Evidence links monsoon flooding with child undernutrition and indicates an association with elevated prenatal depressive symptoms in rural communities (Broyles *et al.*, 2026; Hanif *et al.*, 2025). Dengue has also shown marked changes in geographic distribution and seasonality since 2019, with temperature, humidity, and rainfall associated with its incidence in recent years (Khan *et al.*, 2026b). Together, these trends signal a critical paradigm shift in our understanding of climate-driven health vulnerabilities: the threat extends far beyond acute, extreme disasters to a compounding reality where repeated environmental stress within daily working and living settings can also inflict chronic, cumulative harm.

Climate-related risks also extend to livestock, poultry, and aquaculture, where humans, animals, and ecosystems coexist in close proximity. Farms, aquaculture facilities, and live-bird markets offer direct transmission pathways for pathogens through food, water, waste, and routine agricultural operations. These vulnerabilities are exacerbated by environmental pressures such as heat stress, flooding, water quality issues, and animal crowding, all of which compromise animal immunity and consequently increase reliance on veterinary pharmaceuticals. Such conditions create an ideal breeding ground for antimicrobial resistance (AMR), a multifaceted crisis where drug administration, infection dynamics, and environmental pollution intersect across human and animal health. In Bangladesh, alarming occurrences of multidrug-resistant *Campylobacter* and residual antimicrobials have been reported in poultry farms and live-bird markets (Neogi *et al.*, 2020; Hasan *et al.*, 2025). Genomic surveillance in Mymensingh detected third-generation cephalosporin-resistant *Escherichia coli* in hospital wastewater, livestock effluents, aquaculture ponds, and river ecosystems. Highly conserved core genomes between some hospital and downstream river isolates provided evidence consistent with environmental dissemination (Rahman *et al.*, 2026). Globally, an analysis of AMR surveillance records, covering approximately 32 million isolates from 101 countries, found that climate and socioeconomic conditions contribute to the changing AMR landscape (Li *et al.*, 2025). Therefore, AMR cannot be managed through clinical stewardship alone. Resistant organisms, antimicrobial residues, and contaminated waste can move across healthcare, food-production, and environmental systems. Climate adaptation should likewise be judged not only by whether it protects production or reduces one hazard, but also by whether it avoids creating new health and environmental risks.

Reducing climate-related health risks requires surveillance systems that connect climate, environmental, animal, and human-health signals and translate them into timely action. Heat forecasts should trigger cooling measures, occupational protection, and health-service preparedness. Vector and pathogen signals should guide vector control and clinical readiness. Flood warnings should activate measures for safe water, sanitation, food protection, and continuity of essential services. Geographic information systems, remote sensing, laboratory surveillance, and interoperable datasets can strengthen this capacity, but technology alone is insufficient. Each important signal needs a clear threshold, a responsible institution, a communication pathway, available resources, and an agreed response. While health data can reveal important patterns, coverage, quality, and comparability remain limitations. For example, a national study in Bangladesh combined a systematic review with over 2.8 million reported cases from the government data repository, identifying a substantial burden of climate-sensitive diseases while highlighting these limitations (Kabir *et al.*, 2025). Such records can identify patterns, but they cannot by themselves establish that climate change caused individual outcomes. Sound attribution requires information on exposure intensity and duration, baseline disease patterns, confounding factors, temporal lags, and interactions among environmental and social conditions (Ebi *et al.*, 2025). Better attribution can improve intervention design, but uncertainty should not delay feasible, low-regret measures against well-established hazards. Frontline health workers, farmers, households, and community organizations should also contribute. They may detect animal illness, vector activity, water deterioration, food-safety problems, or service disruption before formal systems do. Local and empirical knowledge can therefore complement laboratory, epidemiological, meteorological, and remote-sensing data, shortening the path from detection to action. Reviews of climate-health adaptation similarly highlight early-warning systems, community networks, technology, organizational capacity, and intersectoral collaboration as important elements of resilience (Hossain, 2025).

Ecosystem-based adaptation and nature-based solutions—including wetlands, watershed restoration, and urban green infrastructure—advance climate resilience, biodiversity, and human well-being, though their efficacy depends on localized socio-economic and ecological contexts (Neogi, 2025). While essential, these interventions and associated circular methodologies in agriculture, livestock, and wastewater management (e.g., composting, anaerobic digestion) can inadvertently alter exposure pathways and translocate hazards. Consequently, operationalizing the One Health framework requires a paradigm of “safe circularity,” which

optimizes resource efficiency only under strict biological and chemical safety protocols against pathogens and antimicrobial-resistant organisms (Neogi, 2026). Adaptation strategies must therefore be evaluated through a holistic framework encompassing ecological feedback, health preservation, equity, long-term maintenance, and unintended systemic consequences.

Effective climate-health protection requires governance that connects policy, resources, responsibilities, and action across macro, meso, and micro levels. At the macro level, national governments and major institutions establish policies, standards, financing arrangements, surveillance priorities, and preparedness requirements. They also align climate adaptation with health security and One Health strategies. At the meso level, districts, municipalities, health and veterinary services, laboratories, water and sanitation authorities, agricultural and fisheries institutions, and disaster-management agencies translate national priorities into local plans, surveillance, resource allocation, and coordinated preparedness. At the micro level, frontline workers, farmers, households, and community organizations identify local risks, implement protective measures, and report on practical effectiveness. These levels must be linked vertically: national forecasts, standards, and resources should support local action, while local observations and implementation experience should inform higher-level decisions. They must also be linked horizontally across health, environment, agriculture, livestock, fisheries, water, food, and disaster-management sectors. The Health National Adaptation Plan 2026–2031 and the National International Health Regulations Authority (established in July 2026) have strengthened its national framework, strategic leadership, and public health emergency preparedness. However, prevalent challenges to One Health implementation in Bangladesh include project-driven collaboration, institutional silos, weak interministerial and subnational coordination, limited engagement of environmental and climate sectors, unclear responsibilities, and insufficient sustained financing (Chowdhury *et al.*, 2026). Ultimately, effective governance depends on timely information sharing, clear responsibilities, available resources, and mutually reinforcing actions across all levels.

Sustained progress necessitates an evidence-to-action cycle that demonstrates whether climate-health interventions effectively reduce risk and protect people over time. Currently, much of the available evidence is observational, geographically fragmented, or narrowly focused on individual hazards and diseases. Longitudinal and quasi-experimental studies, harmonized indicators, high-resolution spatiotemporal exposure data, and linked human-animal-environment datasets are crucial to clarify which interventions are effective, through what mechanisms, at what scale, and for whom. Comprehensive policy evaluation must also consider economic costs, distributional impacts, and unintended ecological or biological externalities. Key measurable outcomes include reductions in heat-related morbidity, the preservation of critical infrastructure during extreme weather events (such as floods and cyclones), enhanced water and nutritional security, and safer food-animal systems. Furthermore, interventions should aim to promote responsible antimicrobial stewardship, facilitate the early detection of emerging biosecurity threats, and mitigate exposure levels among socio-economically marginalized populations. Equity must remain central, as exposure and adaptive capacity vary significantly with occupation, housing, income, access to water and healthcare, age, mobility, and other social conditions. Moreover, research and implementation must form an iterative learning cycle, using empirical data from operational deployments to refine policy and practice. Consequently, One Health must transcend superficial administrative or zoonotic boundaries to align institutions, diagnose systemic drivers, synthesize disparate datasets, and execute tactical interventions. This integrated approach is essential to unify traditionally siloed programs—such as WASH, food safety, and vector management—which share deeply interconnected health impacts. The OH JPA provides the integrative framework needed to unify these sectors through harmonized risk pathways, interoperable data architectures, common indicators, and coordinated operational thresholds through baseline methodology and systematic evaluation (Fernandes, 2026).

Escalating regional crises demonstrate that climate hazards intersect with social, environmental, and structural vulnerabilities to imperil global populations. Consequently, public health strategies must undergo a paradigm shift, transitioning from reactive emergency management to proactive risk mitigation. Rather than evaluating systemic capacity solely by post-event response velocity, research and practice must prioritize the detection, anticipation, and reduction of the structural vulnerabilities that transform environmental hazards into public health emergencies. Operationalizing this transition requires resilient healthcare infrastructure, integrated epidemiological surveillance, secure supply chains, and participatory governance models that facilitate bidirectional data transmission across macro, meso, and micro-institutional levels. Ultimately, the efficacy of climate adaptation must be quantified by empirical health outcomes—such as reduced morbidity, sustained essential services, secure zoonotic interfaces, and mitigated health inequities—rather than bureaucratic metrics, such as the proliferation of committees or policy documents. This framework demands a fundamental reorientation: from fragmented crisis management to integrated systems oversight, from disease-specific

monitoring to environmental risk-factor surveillance, and from post-crisis recovery to anticipatory intervention. Within this architecture, the One Health approach serves as a critical operational mechanism, bridging climate intelligence, early prevention, and coordinated public health governance.

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