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# Climate Change and One Health

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**ABSTRACT**

This paper argues that human health cannot be taken care of without caring for animal health and the ecosystem. Underlining their interconnectedness and advocating a One Health policy, it examines how climate change is affecting the three as an interlinked dynamic system. Before listing the challenges and opportunities for bettering health outcomes it explores the major impacts of climate change: heat stress, food security, deforestation, climate variability and disease vectors, biodiversity loss, etc.

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*One Health relies on the understanding that humans, animals, and the environment are inherently interconnected and co-dependent. It is estimated that 60 percent of existing human infectious diseases are zoonotic, and at least 75 percent of emerging infectious diseases originate from animals. Healthy ecosystems are essential for the survival of humans and animals. We can no longer think of one group's health without considering the health status of others. This realization is a turning point from the past 50 years, where only human health had been the primary focus.*[1]

***— Monique Eloit, Director General of the World Organization for Animal Health (OIE)***

## ORIGINS OF ONE HEALTH

The origins of One Health can be traced back to the pioneering work of the German physician and pathologist Rudolf Virchow (1821–1902). He introduced the term *zoonoses* to describe diseases transmitted between animals and humans, thus emphasizing their interconnectedness. He famously commented, "… between animal and human medicine, there are no dividing lines, nor should there be." He gave impetus to the realization that there was a need for interdisciplinary collaboration.[2] Virchow's work on diseases such as *trichinosis* clearly illustrated the need to have veterinary science included in more general health measures.

In the middle of the 20th century, Calvin Schwabe, an American epidemiologist and veterinarian, revitalized and developed Virchow's thinking. He coined the term *One Medicine* in his seminal work *Veterinary Medicine and Human Health*.[3] Schwabe promoted the idea that one should transcend disciplinary silos and work to solve problems affecting both human and animal health, such as zoonotic diseases, food safety, and sustainable agriculture. His conceptual thinking formed the foundation of what would eventually be referred to as *One Health*.

### Response to Global Health Crises

Zoonotic pandemics, like SARS in 2003 and bird flu (H5N1) in the early 2000s, led to a strong realization of the interconnected nature of human and animal life. Such experiences underscore how changes in biodiversity, the wildlife trade, or global connectivity increase the interface across human-animal interaction modes that enable disease flow or exchange.[4]

The Wildlife Conservation Society (WCS) realized these problems and organized an important meeting at Rockefeller University in 2004. The meeting formulated the "One World, One Health" framework. It outlined the *Manhattan Principles*, which are twelve recommendations for establishing a more holistic approach to preventing epidemic/epizootic disease and for maintaining ecosystem integrity for the benefit of humans, their domesticated animals, and the foundational biodiversity that supports us all.[5] This meeting was pivotal in defining One Health as an important policy.

### Institutional Collaborations

In 2008, the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organization for Animal Health (OIE) signed a tripartite agreement to institutionalize the One Health approach. This collaboration aimed to enhance global responses to zoonoses, antimicrobial resistance (AMR), and food safety issues.[6] The tripartite engagement (quadripartite after UNEP joined in March 2022) also reflected a shift towards multilateral coordination in addressing shared health challenges across sectors.

Later initiatives built on these efforts, as evidenced in the Global Health Security Agenda, which incorporates the principles of One Health into strategies for pandemic preparedness and response. The COVID-19 pandemic further underscored the relevance of One Health in addressing zoonotic diseases, with institutions calling for greater investment in interdisciplinary research and policy frameworks.

One Health policy implies an additional saving of lives of humans and animals, a reduction in costs, and an enhancement in social and environmental services that can be achieved by closer cooperation between the human health, veterinary, and departments/ministries concerned with the ecological sustainability which cannot be achieved if these departments/ministries were to continue working separately.[7]

In the 21$^{st}$ century, One Health is emerging as an essential strategy for handling complex health challenges.

## CLIMATE CHANGE AND CLIMATE ACTION

The primary feature of modern climate change is global warming, caused by anthropogenic activity. It threatens the existence of many life forms, including ours. There is a climate cataclysm looming, and we are underprepared for it. With rising greenhouse gas emissions, climate change is occurring at rates much faster than anticipated. The Earth's climate system has its feedback loops which aggravate the problem (Figure 1). The impacts, for most life forms including ours, can be devastating. They include extreme and changing weather patterns and rising sea levels. The infographic below, borrowed from the United Nations (UN) website,[8] suggests that (i) by 2035 earth surface temperatures will have risen by 1.5$^{o}$C above preindustrial levels and (ii) highly vulnerable regions will experience fifteen times more mortality during disasters compared to low vulnerability regions.

Worried about the future of the globe, the UN has included "Climate Action" as Goal No. 13 in its seventeen Sustainable Development Goals (SDGs), which it wants member nations to achieve by 2030. In addition, more than half of the SDGs have an environmental focus or address sustainability concerns, while over 86 of the 169 targets directly concern the environment – including at least one in each of the 17 SDGs. This means that no single goal can progress significantly without particular attention to implement the environmental dimension.[9]

While focusing on important actions regarding climate change the Inter-governmental Panel on Climate Change (IPCC) states in Section C.3.7 of its Summary for Policy Makers "Human health will benefit from integrated mitigation and adaptation options that mainstream health into food, infrastructure, social protection, and water policies. Effective adaptation options exist to help protect human health and well-being, including: strengthening public health programs related to climate-sensitive diseases, increasing health systems resilience, improving ecosystem health, improving access to potable water, reducing exposure of water and sanitation systems to flooding, improving surveillance and early warning systems, vaccine development, improving access to mental healthcare, and Heat Health Action Plans that include early warning and response systems. Adaptation strategies which reduce food loss and waste or support balanced, sustainable healthy diets contribute to nutrition, health, biodiversity and other environmental benefits."[10]

## CLIMATE CHANGE AND ONE HEALTH

Climate change has profound implications for human and animal health. Rising global temperatures, shifting weather patterns, and ecosystem disruptions contribute to health risks that transcend geographical and species boundaries. On the one hand climate change works like an all-pervading situation changer for all forms of life, on the other consequential adverse changes in environmental health and animal wellbeing have additional cascading repercussions for human health.

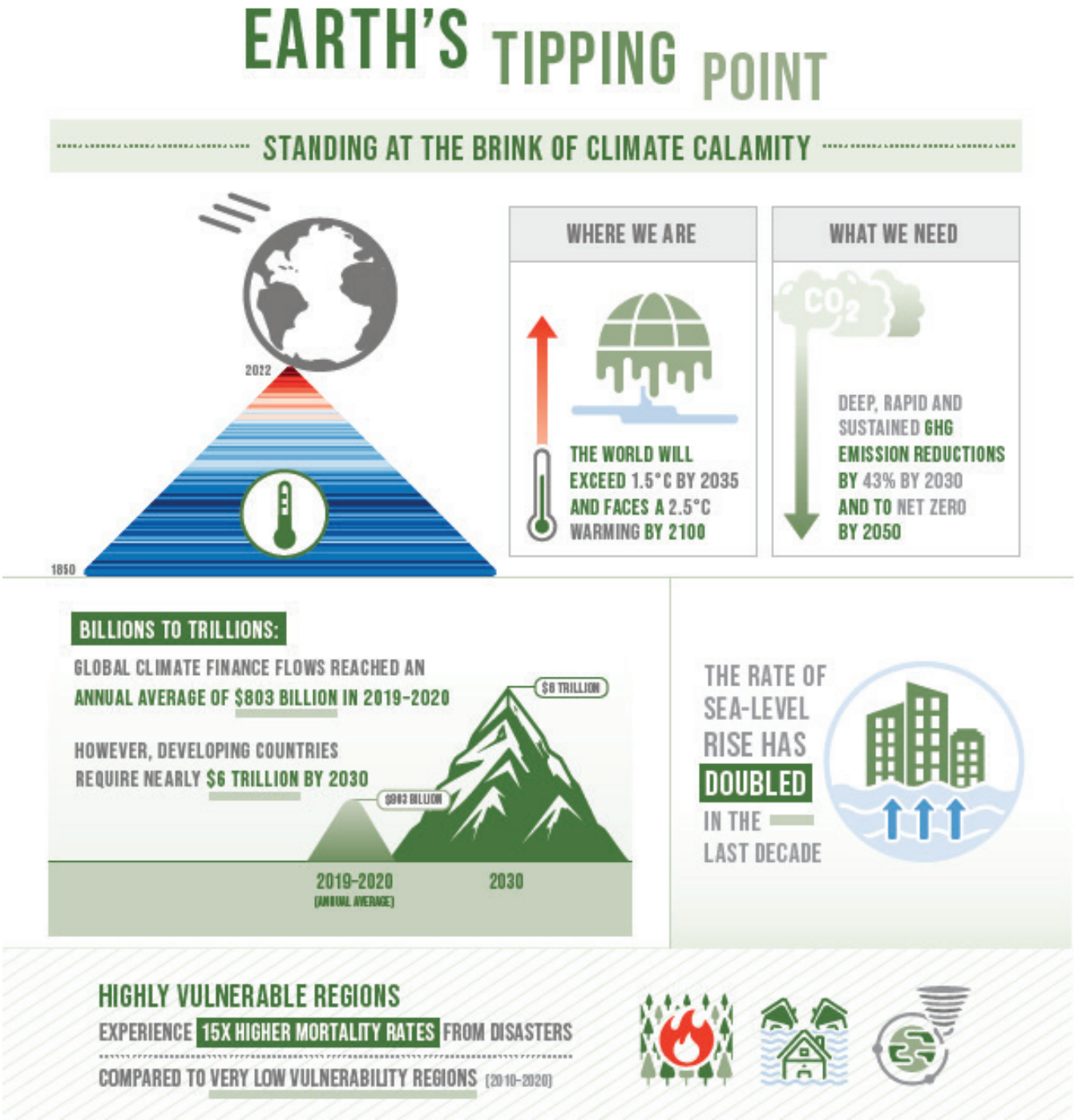


**Figure 1:** Earth's tipping point.

***Source:*** https://www.un.org/sustainabledevelopment/wp-content/uploads/2023/08/2309739_E_SDG_2023_infographics-13-13.pdf

Below we discuss certain impacts of climate change on human and animal wellbeing.

## Heat Stress

Rising temperatures affect animal health. Heat stress in wildlife and domesticated animals leads to reductions in work capacity, fertility, and survival rates. Heat stress in cattle results in less production of milk and slower growth rates.[11]

For humans, the increasing severity and frequency of heat waves is resulting in direct heat-related illnesses and mortality. Individuals with pre-existing health problems, the elderly, and children are especially vulnerable. Climate

change also increases the frequency and severity of extreme weather events like droughts, cloud bursts, hurricanes, and floods. Outbreaks of waterborne diseases such as cholera and leptospirosis are direct consequences of flooding.[12]

## Food Security

Global temperature increases and alterations in rainfall patterns reduce crop productivity. This is particularly true for food grains such as rice, wheat, and maize. Research shows that for each 1°C increase in global temperature, wheat yields are projected to decline by 6%, while maize yields may drop by 7.4% globally. Agriculture in places like Sub-Sahara Africa and South Asia is heavily dependent on precipitation and temperature conditions. Climate change is undermining food security in such places.[13]

Climate change leads to the warming of oceans coupled with their acidification. Consequently, fisheries are depleted. This threatens food security for communities dependent on aquatic ecosystems.[14]

Heat stress causes corals to expel the algae that live in their tissues, causing them to lose their color and turn white. This phenomenon is colloquially known as coral bleaching. Healthy coral reefs provide aquatic life complex structures for shelter and a diverse array of food options. So when corals bleach and die, fish populations decline due to a lack of hiding places and food sources, impacting the entire reef ecosystem. This is already impacting the availability of fish stocks for humans in a significant manner. Fisheries are not only a major source of income for Pacific Island nations and coastal communities but also account for 50% of their protein intake.[15]

There is compelling evidence that poor nutrition translates into increased vulnerability to diseases.

## Deforestation

Climate change exacerbates deforestation. Temperature increases, changes in precipitation patterns, and prolonged and repetitive droughts shake up the tenacity of the forest to wildfires, pests, and diseases. Deforestation is understood to have contributed to the spread of the hendra virus in Australia. The continuous destruction of their habitats forced fruit bats (natural reservoirs of hendra virus) to migrate to urban localities. It compelled them to share the same habitat as horses and humans. Infected horses acted as amplifiers and spreaders of the disease to humans. In 1994, the hendra virus caused severe respiratory and neurological conditions in human beings in Queensland.[16]

## Enhanced Climate Variability and Vector-borne Diseases

An increase in climate variability is a direct fallout of modern climate change. Climate variability is aggravating the Indian Ocean Diploe which in turn leads to floods in East Africa and droughts in Indonesia. In 2006–2007 there was heavy rainfall in East Africa and an outbreak of Rift Valley fever (RVF). Water puddles create breeding grounds for Aedes and Culex mosquitoes, the primary vectors of RVF. The disease severely impacts cattle and sheep leading to fever, listlessness, anorexia, miscarriages, and adult deaths. Humans can become infected through contact with blood, body fluids, or tissues of infected animals. In addition, humans also contract RVF through direct mosquito bites. [17]

Changes in temperature and precipitation alter the distribution of disease vectors, such as mosquitoes and ticks, expanding their habitats into previously unaffected regions. This has led to an increased prevalence of diseases like malaria, dengue, zika, and lyme in humans.[18]

## Biodiversity Loss and Zoonotic Spillover

Complementing other direct human activities such as hunting, the introduction of invasive species through excursions, contamination by chemical pollutants getting washed into water bodies and their percolation into the earth, deforestation, etc., climate change also directly accelerates the destruction of natural habitats for animals. An associated issue is the fragmentation of ecosystems. Both disrupt the ecological dynamics of affected regions; a reduction in biodiversity, which in turn disrupts predator-prey dynamics. In many cases, the downstream consequence is an unchecked increase in the populations of pathogen-carrying species.

The transmission of pathogens from animals to humans is called zoonotic spillover. It occurs when disruptions in the ecological and behavioral barriers between human beings and animal life take place. Climate change alters ecosystems and thus creates conditions for zoonotic spillovers. There are conservative claims that 60% of emerging infectious diseases are a fallout of zoonotic spillovers.[19]

For context, we are citing a few examples other than the often-discussed Covid-19 case.

Rodents are reservoirs for diseases such as hantavirus and leptospirosis. Loss of habitats for their natural predators such as raptors and snakes has led to a surge in rodent populations in many regions of the world. In the western United States, reduced predator presence in fragmented ecosystems has coincided with increased hantavirus outbreaks linked to expanding deer mouse populations.[20]

Some species of fish eat the larvae and pupae of mosquitoes which helps in the natural control of mosquito populations. Frogs and dragonflies carry out similar functions. The degradation of wetlands results in a reduction in the populations of such predator species. This creates ideal conditions for the breeding of mosquitoes and, thus, for the spread of malaria and dengue.[21]

A decline in the number of foxes and coyotes in the northeastern United States has led to an increase in the population of white-footed mice. These mice transmit lyme disease to humans.[22]

## CHALLENGES

Human beings and animals will interact with each other and with the environment. These interactions are unavoidable. To take an example, in the hinterland in developing countries, villagers build animal sheds close to their homes. This close relationship is fertile ground for the spread of diseases. Vector-borne infections, zoonotic diseases, the management of AMR, the provisioning of safe and nutritious food, the supply of clean drinking water, etc. demand that all kinds of healthcare personnel stretching from doctors to paramedical staff, from veterinarians to cattle breeders, plus the general public work in close umbrella under the over-arching conceptual umbrella of One Health. For most developing countries, a complex and intricate health system of this kind is challenging to build.

### Fragmented Governance and Siloed Healthcare Systems

One major challenge in implementing One Health is the lack of combined governance. In most countries health, agriculture, and environmental sectors usually work separately, with little teamwork. This siloization makes it hard to create unified policies and share resources prudently. Governance systems of low and middle-income countries cannot generally adopt interdisciplinary approaches because of capacity constraints. Harmonization of these sectors requires highly politicized support and cooperative activities among nations, but varying objectives often limit their progress.[23]

### Funding Limitations of Transdisciplinary Research and Implementation

Implementing One Health requires massive investments in research, infrastructure, and human resources. Unfortunately, funding for transdisciplinary projects is usually inadequate. Public health budgets are dominated by human medicine, with veterinary and environmental health underfunded as a rule.[24] For example, fighting antimicrobial resistance necessitates integrated monitoring systems between the human, animal, and environmental sectors, which are costly to establish and maintain. Furthermore, donor funding is usually short-term outcome-oriented, which makes it hard to maintain long-term One Health initiatives. The constraints require innovative funding mechanisms. Global financing initiatives appear to be the most likely candidates for surmounting this challenge.

### Resistance to Cross-sectoral Collaboration

Cultural and institutional resistance to interdisciplinary collaboration is another significant barrier. Professionals in human, animal, and environmental health work in very rigid disciplinary boundaries with limited incentives to collaborate.[25] In addition, it has been noticed, especially during the Ebola outbreak, that mistrust between local communities and health authorities delayed effective containment. Likewise, the specific mandates and priorities of international organizations such as WHO, FAO, and OIE can also delay coordinated action. This resistance can be overcome by developing a culture of collaboration through education, joint training programs, and shared decision-making frameworks.[26]

## OPPORTUNITIES

### Enhanced Surveillance Systems for Early Detection of Diseases

The One Health approach helps create systems that watch over the health of people, animals, and the environment. Finding zoonotic diseases early is crucial when preventing pandemics. For instance, the Global Early Warning System (GLEWS), which is a team effort by the WHO, FAO, and OIE, shows how sharing data can improve predicting and responding to outbreaks.[27]

Improvements in genomic sequencing and tracking diseases have also made it easier to find where diseases come from. Adding environmental data, such as changes in climate and land use, can make predictions even better.

Some efforts have been made in the Global South in this direction. Below we tabulate an indicative list of some important efforts (Table 1).

### Advancements in Technology for Health Monitoring

New technologies such as artificial intelligence, big data analysis, and remote sensing offer great opportunities for conducting One Health policies. AI-powered models can be trained to predict disease outbreaks by analyzing large sets of data, including animal movements, weather changes, and human population details.[6] To substantiate through an example of what has already been achieved, satellite images have been used to find where mosquitoes live, which helps in malaria prevention efforts. Big data systems can enable real-time tracking of diseases, allowing for quick responses. However, the deployment of such technologies requires money for infrastructure and skill development, especially in resource-poor regions of the Global South.

### Community Involvement in Environmental and Health Stewardship

One Health policies do well when communities take part, as

**Table 1:** Important efforts towards One Health approach in the Global South.

| Country | Program Name | Start Year | Focus Area | Features/Achievements |
|---|---|---|---|---|
| **Bangladesh** | National One Health Framework | 2016 | Zoonotic diseases, AMR, food safety | Surveillance for Nipah virus, avian influenza, and rabies. Collaboration among key ministries. |
| **Brazil** | Integrated Health Surveillance | — | Zoonotic diseases | Managed yellow fever outbreaks; integrated vaccination campaigns for humans and animals. |
| **Ethiopia** | National One Health Steering Committee | 2017 | Zoonotic diseases, AMR | Rabies control via vaccination; AMR awareness campaigns in partnership with FAO. |
| **India** | National One Health Mission | 2021 | Zoonotic diseases, AMR, food safety, pandemics | Integrated zoonoses surveillance; strengthened coordination between animal, human, and environmental health sectors. |
| **Indonesia** | One Health Collaboration | — | Zoonoses, AMR, food safety | Monitored and controlled avian influenza outbreaks; improved rabies and leptospirosis surveillance. |
| **Kenya** | Zoonotic Disease Unit (ZDU) | 2011 | Zoonotic diseases | National Rabies Elimination Strategy; outbreak response for Rift Valley fever and anthrax. |
| **Nigeria** | One Health Platform | 2016 | Zoonotic diseases, AMR | Managed Lassa fever and avian influenza outbreaks; improved multisectoral collaboration. |
| **Peru** | Multisectoral Health Surveillance | — | Zoonotic diseases | Integrated control of rabies and Chagas disease in rural areas; enhanced rural health outcomes. |
| **South Africa** | Zoonotic Disease Research and Control | — | Zoonotic diseases | Rift Valley fever outbreak control; integrated rabies vaccination campaigns. |
| **Uganda** | One Health Platform | 2013 | Zoonotic diseases | Successfully managed Ebola and Marburg outbreaks; improved diagnostic laboratory capacities. |
| **Vietnam** | One Health Partnership Framework | 2010 | Emerging zoonotic diseases, AMR, biodiversity | Surveillance for avian influenza and swine flu; strengthened wildlife disease monitoring. |

local people usually notice changes in their surroundings first. Involving communities in watching for diseases, restoring habitats, and using sustainable farming can greatly improve health. Community programs in sub-Saharan Africa have successfully lowered the spread of diseases from animals to humans by encouraging wildlife protection and cleanliness.[28] Empowerment through education and participatory decision-making will strengthen the implementation of policies while assuring sustainability for a long period.

## CONCLUSION

Ecological disruptions and zoonotic diseases are proving to be extremely complex problems for life on the planet. The need to recognize the intricate connections between environmental, animal, and human health cannot be understated. A One Health approach is humanity's best bet for handling the direct and indirect impacts of climate change on all three.

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