EMERGING DISEASES AND CLIMATE CHANGE

ACTION NEEDED TO PREVENT **NEW PANDEMICS**

Spotlight Series

September 2021

FII INSTITUTE
Future Investment Initiative Institute | Impact on Humanity

EMERGING DISEASES AND CLIMATE CHANGE

PREVENTING CLIMATE CHANGE FROM TRIGGERING NEW PANDEMICS

Climate change is a growing factor in the emergence of infectious disease. We need decisive action now to limit global warming, more investment in research to improve our understanding, and "One Health" policies that consider together the well-being of people, animals and ecosystems.

WHY THE NEXT PANDEMIC LOOMS LARGE

IF COVID-19 WAS NOT EVIDENCE ENOUGH, the heatwaves, wildfires and floods that have hit many parts of the world in 2021 dramatically underscored humanity's vulnerability to shifts in the natural world and the urgency of action to prevent them. Not least because the two phenomena are linked: climate change is a growing but little understood factor in the emergence of infectious disease that could lead to more – and more devastating – pandemics in the future.

The human and economic cost of the Covid-19 pandemic and the global effort to contain it is huge and mounting. More than 200 million people have been infected and more than 4.6 million have died as of September 2021;[1] as many as 169 million could be pushed into extreme poverty[2] by the economic fallout, which is hitting developing countries the hardest.

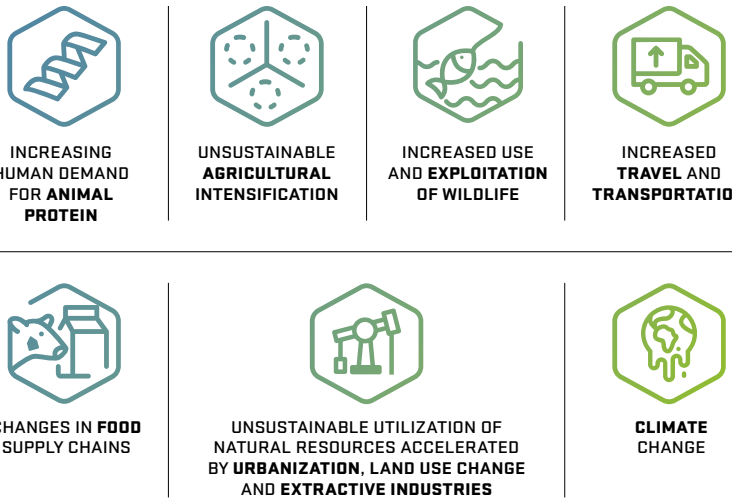
A GROWING RISK

Pandemics are rare, in the past occurring decades apart, but for some time scientists have been warning of a growing risk.[3] About 60 percent of emerging infectious diseases are zoonotic (that is, caused by pathogens that "spill over" from animals to people) and the majority originate in wildlife.[4] Alarmingly, in recent decades, several other zoonotic diseases have reached or neared pandemic proportions: HIV (the viruses which cause AIDS), SARS-CoV-1 (another coronavirus like Covid-19), H1N1 (a deadly strain of avian influenza) and the Zika virus.

The threat has deepened because of how our economies and societies are developing. These factors include the intensifying use of land and animals to meet the demands of a growing and more wealthy global population, including human encroachment into natural areas; increasing urbanization, which makes it easier for disease to spread; and the →

Climate change is not the only driver

There are seven main anthropogenic drivers of zoonotic disease emergence, many of which now occur in the same places, amplifying their impact.



SOURCE: UNEP AND ILRI (2020). PREVENTING THE NEXT PANDEMIC

COVER PHOTO: GETTYIMAGES / CHRIS CLOR

accelerated movement of people and goods, which, as seen with Covid-19, can rapidly turn a localized outbreak into a global crisis.

KEY DRIVERS

But as climate change increasingly disrupts and reshapes both the natural and human world, it is itself emerging as a key driver[5] of the risk that more viruses and other pathogens will make the leap from animals into largely defenseless human hosts, with potentially catastrophic consequences.

Bacteria, fungi and other organisms can invade the human body and cause disease. But viruses are the pathogens most likely to cause future pandemics.[6] A recent study estimated the number of unknown animal viruses at 1.67 million. Of those, between 631,000 and 827,000 could potentially infect humans.[7]

For example, bats are reservoirs for coronaviruses (similar to SARS-CoV-2, the virus that causes Covid-19), Nipah virus, and the pathogens behind Ebola and rabies; rodents carry hantaviruses and those that cause Lassa hemorrhagic fever; primates host retroviruses, the virus family that includes HIV; and wild birds maintain a deep pool of influenza viruses whose genetic material can contribute to new strains. Domestic animals from which pathogens can spill over include chickens, pigs, cattle, horses, sheep and goats.

As with Covid-19, the most likely mode of disease transmission in future pandemics is airborne virus particles shed by infected people, though vectors such as mosquitoes, ticks or rodents and sexual transmission are other important ways that zoonotic diseases have been able to spread widely.[8]

ACTION NEEDED NOW

Decisive action is needed now to limit global warming and cut the risk. But the world must also invest in research that helps us understand the emergence of these diseases in a changing climate. Efforts to prevent pandemics must take into consideration how shifts in climate increasingly have an impact on key factors including the pool of pathogens circulating among animals; how those animals come into contact with people; and how easily a new zoonosis can spread across a country, a region, or the whole world. Also essential are "One Health" policies that consider the well-being of people, animals and ecosystems together. ←

CLIMATE CHANGE AND THE EMERGENCE OF DISEASE

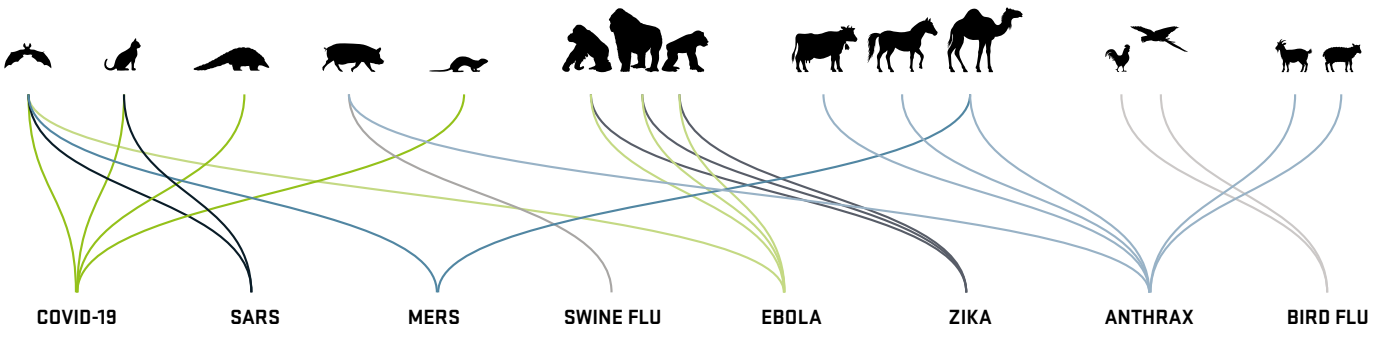
CLIMATE CHANGE, together with other human impacts on the environment, is increasing the danger that more zoonotic diseases capable of causing a deadly pandemic will emerge. Below are some of the key mechanisms that are driving up this risk.

THE REMAKING OF ECOSYSTEMS AND THE IMPACT OF MIGRATION

Climate change is shaping the nature of human-wildlife interactions by setting millions of species – of pathogens as well as of wildlife – on the move. All over the →

From animals to humans

More than 70% of emerging infectious diseases come from wildlife.



globe, species are moving in response to food availability, the presence of predators, and their preferred habitat and climatic conditions. In a 2017 study, about half of the 4,000 species examined were changing their range.[9]

This vast remaking of ecosystems and migration patterns creates a myriad of new opportunities for species to interact, share viruses and create pathways for spillover.[10] Studies have suggested, for instance, that the risk of Ebola in Africa will rise as climate change shifts the range of virus-carrying bats.[11] A forthcoming study projects that by 2070 mammals, including "hyper-reservoirs" like rodents, bats and large carnivores, will aggregate at high elevations, in biodiversity hotspots, and in densely populated areas of Africa and Asia, sharing thousands of novel viruses.[12] As with other impacts of climate change, this will fall more heavily on the poor than on the rich.

However, the developed world will also be affected. Shifts in climate and in climate variability also alter the distribution and abundance of vectors for future as well as existing zoonoses. For example, an additional 4.7 billion people could be at risk of malaria and dengue fever by 2070 as warming helps to expand the range of the mosquitoes that transmit them.[13] Mild winters have already led to more infections of tick-borne encephalitis and other zoonoses in Northern Europe.[14]

"We are penetrating the planet's last natural ecosystems and being exposed to new pathogens; and new pathogens may be coming to us because of how species and ecosystems are shifting in response to climate change."

PROFESSOR HANS-OTTO PÖRTNER, SENIOR SCIENTIST, OTTO WEGENER INSTITUTE; CO-CHAIR, IPCC WORKING GROUP II

LAND-USE CHANGE

The clearance and degradation of forests and other natural ecosystems for agriculture, mining, settlements and other human use has been closely associated with disease emergence in recent decades.[15] Land-use change disrupts ecosystems, creating new opportunities for pathogens to spread, change and find new hosts. It also typically brings more people (and their livestock) into contact with previously undisturbed populations of wild mammals and vectors.[16]

Climate change can magnify this risk by reducing the productivity of existing agriculture land in some regions, especially in low latitudes.[17] This will increase the need to convert even more forests and wetlands to cropland and pasture in order to feed growing populations – and bring new risks of disease spillover.

INTENSIFYING AGRICULTURE

Climate change will profoundly affect farming practices, with implications for disease ecosystems, including zoonoses.

For example, the redistribution of fresh water with dams, reservoirs and irrigation channels can spread the hosts and vectors of human pathogens, such as mosquitoes and malaria.[18] Climate change has altered rainfall patterns, which will spur demand for irrigation in many regions, with knock-on impacts for pathogens, the creatures that carry them, and the ways they interact with people.

Changes in temperature and rainfall will also influence the type of farming practiced. For instance, intensive livestock farming, already considered a risk for the spillover of zoonoses, is likely to expand to meet growing demand for protein, especially in developing countries. Climate change may further accelerate this shift, and see →

PHOTO: GETTYIMAGES / BUENA VISTA IMAGES

production move closer to urban centers,[19] where pathogens could infect large numbers of people. By endangering food and water security and submerging low-lying areas, climate change could also displace tens of millions more people,[20] potentially forcing them into unsanitary living conditions where zoonoses could more easily spread.[21]

BIODIVERSITY LOSS

Climatic stress, land-use change and farming systems contribute to another impact that heightens the risk of zoonoses: the overall loss of biodiversity. There is growing evidence that declines in the abundance and richness of wild species increases the transmission of disease because the species most resilient to habitat destruction and degradation – for example, rodents and bats – and which may thrive in a modified or simplified ecosystem, may also be the ones that amplify pathogen transmission.[22, 23]

MICROBES IN A WARMER WORLD

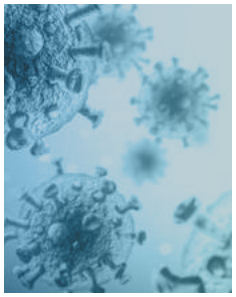
Climate change also affects pathogens more directly, by changing the parameters under which they survive and remain transmissible outside of host animals. Some zoonoses may thrive in warmer, wetter and more disaster-prone future climates.[24] For example, there is evidence that Covid-19 can survive on surfaces for up to five days at temperatures and humidity levels typical of air-conditioned buildings, including hospitals[25] – indoor conditions that could become more common in a hotter world. There is even concern that microbes that evolve to cope with higher temperatures will acquire the ability to infect mammals including humans, whose high body temperatures previously acted as a successful defence mechanism.[26]

THAWING PERMAFROST

Climate change raises the specter of deadly prehistoric pathogens being released from thawing ground in polar and sub-polar regions. As well as vast amounts of carbon and methane that will further warm the atmosphere, the thawing of permafrost that has been frozen for tens of thousands of years could liberate unknown viruses or antibiotic-resistant bacteria as well as more familiar threats like anthrax and smallpox.[27] Scientists have already revived several ancient viruses from permafrost and warned that the expansion of mining in the far north raises the risk that unearthed microbes could come into contact with people.[28, 29]

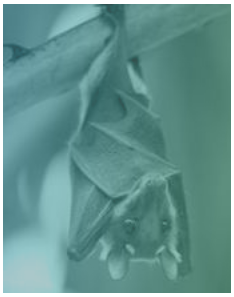
The human-animal disease interface in numbers

As a global community, we need to become more aware of how our relationship with and proximity to animals can affect our health.



4.6 M

Covid-19 **deaths** (by September 2021)



631-827 K

Number of **animal viruses** that could infect humans*

50%

Share of **wildlife species** shifting their range**

> 30 B

Number of **domestic animals** living close to people***

4.7 B

People at risk from spread of malaria/ dengue-carrying **mosquitoes**

SOURCES:
* IMF, 2021. WORLD ECONOMIC OUTLOOK: MANAGING DIVERGENT RECOVERIES
** PECL ET AL., 2017
*** 2017 DATA FROM FAOSTAT

PREVENTING PANDEMICS WITH PLANETARY HEALTH

THE COMPLEX INTERACTION of human and natural systems in the emergence and spread of zoonotic disease, and our limited understanding of the mechanisms at play, mean that integrated approaches and targeted research are essential in reducing the risk of future pandemics.

Regarding the role of climate change, three important areas for action are mitigating and adapting to climate change in ways that reduce the risk of zoonotic disease emergence; research into how wildlife and their pathogens, as well as human-wildlife interactions, are evolving in a changing climate; and "One Health" approaches, which mean considering the health of the planet alongside the health of ecosystems, animals and people.

1 ACTION FOR CLIMATE AND BIODIVERSITY

The links between climate change and zoonotic disease show how addressing the climate and biodiversity crises together will substantially reduce pandemic risk. This adds to the urgency of radical action to decarbonize our economies and divorce future prosperity from the unsustainable use of Earth's natural resources.[30]

Transformative change is needed, for example, to halt deforestation and the destruction of other wildlife habitats, which are key drivers of the emergence of zoonotic disease, as well as the second-largest source of greenhouse gas emissions after the burning of fossil fuels. Innovations to boost both the productivity and biosecurity of food systems are vital.

Measures to mitigate or adapt to climate change that could inadvertently increase zoonotic disease risk – including reforestation and tree plantations, for example to supply biofuel – require careful management.[31]

Key actions that can be taken now include:

- More countries, regions, cities, investors and companies should move now to achieve net-zero emissions so that the Paris Agreement goal of limiting global warming to 1.5°C is met.
- Governments should protect at least 30 percent of Earth's land and oceans to conserve biodiversity and allow it to adapt to the climate change that we cannot avoid.
- Governments, industries and consumers should learn about, promote and make sustainable choices to end deforestation and the degradation of ecosystems that provide humans with key benefits, including the regulation of disease.

"These large-scale issues are so intertwined that we best approach them in a holistic manner. A One Health approach – or planetary health approach, as I understand it – is needed."

PROFESSOR HANS-OTTO PÖRTNER, SENIOR SCIENTIST, OTTO WEGENER INSTITUTE; CO-CHAIR, IPCC WORKING GROUP II

PHOTO: GETTYIMAGES / THOMAS BARWICK

2 RESEARCH INTO DISEASE EMERGENCE

Against the background of the UN Sustainable Development Goals, scientists and policy-makers are already grappling with the challenge of ensuring that action to combat climate change also halts biodiversity loss while fostering human development, especially in developing countries. Covid-19 has underlined that, to protect human health, we must also consider the risk of zoonotic disease emergence. More funding and support for research is needed to inform strategies to prevent as well as respond to new diseases in a changing climate.

Promising research areas include:

- The evolution of ecosystems and their capacity to regulate disease under different climate scenarios, to inform assessments of future spillover risk, including in ecosystems under restoration.[32]
- The identification of pathogens with the potential to cause human pandemics and project how they, their host species and/or vectors will respond to climate change.[33]
- Mapping zoonotic disease emergence hotspots[34] and the use of artificial intelligence to model potential future outbreaks while factoring in the impact of climate change on both people and nature.

"The spillover of novel pathogens is accelerating, just like the impacts of climate change. For both issues, there is an optimal time to initiate new global policies for prevention … the optimal time is now."

REPORT BY A PANEL OF 22 EXPERTS ON BIODIVERSITY AND PANDEMICS CONVENED BY THE INTERGOVERNMENTAL PLATFORM ON BIODIVERSITY AND ECOSYSTEM SERVICES (39)

3 ONE HEALTH POLICIES

Human, animal and environmental health are so intertwined that policies to address any one aspect of health must consider the others. One Health policies that embrace this approach offer our best hope of preventing future pandemics.[35]

To reflect the importance of climate change, One Health efforts should include:

- Surveillance and early warning systems designed to detect zoonotic disease outbreaks in areas including tropical regions with rich biodiversity threatened by climate change and human activities.
- The promotion of healthy diets. Reduced meat consumption would lessen pandemic risk by slowing the rise of intensive livestock farming where disease can more easily spill over and spread, and curb deforestation in the tropics to make space for cattle ranching and the cultivation of fodder crops like soy. Both measures would also cut greenhouse gas emissions and biodiversity loss.[36]
- Increased support for One Health approaches in all countries, especially in the developing world, in order to pool expertise; strengthen communication, collaboration and coordination; and reach out to all members of society, from policy-makers and law enforcement professionals to farmers and pet owners.[37, 38]

PHOTO: GETTYIMAGES / D3SIGN

ABOUT FII INSTITUTE

FII INSTITUTE is a new global nonprofit foundation with an investment arm and one agenda: Impact on Humanity. Committed to Environmental, Social and Governance (ESG) principles, we foster the brightest minds and transform ideas into real-world solutions in five focus areas: AI and Robotics, Education, Healthcare and Sustainability.

We are in the right place at the right time – when decision makers, investors and an engaged generation of youth come together in aspiration, energized and ready for change. We harness that energy into three pillars – THINK, XCHANGE, ACT – and invest in the innovations that make a difference to lives globally.

Join us to own, co-create and actualize a brighter, more sustainable future for humanity.

This paper is part of our Sustainability Series, where the Institute's approach to addressing issues within this field emanates from our focus on SDG 13, SDG 14 and SDG 15. To drive results, the FII Institute's attention will initially focus on ecosystem preservation in both land and sea capacities, before moving onto sustainable marine and land exploitation and carbon-capture solutions in 2022. We will tackle this in a sequential manner, in which inhibitors to progress are identified, potential solutions are mapped out, and organizations and individuals to partner with are approached.

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