DAY ONE PROJECT

Preventing the Next Pandemics: An Upstream Approach to Novel National Security Threats

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Summary

COVID-19 is estimated to cost the global economy between $8 to 15 trillion USD[1], but it is not the first such outbreak, nor will it be the last. Since the 1970's, 70% of emerging infectious diseases (EIDs) have been at the human-wildlife boundary[2], with new infectious diseases emerging at a faster rate than ever before. Further, a common, defining feature of emerging infectious diseases is that they are triggered by anthropogenic changes to the environment. As natural environments degrade (specifically, due to climate change, loss of biodiversity and fragmentation of habitats, or invasive species), they are more likely to harbor infectious diseases and their vectors (animals or plants that transmit a pathogen)[3].

This memo proposes a series of actions to shift the focus of our existing EID strategies from merely reacting to disease outbreaks – which is economically devastating – to detecting, addressing, and mitigating the major **upstream** factors that contribute to the emergence of such diseases prior to an outbreak, and would come at orders of magnitude lower cost. Recent analysis of the exponentially rising economic damages from increasing rates of zoonotic disease emergence suggests that strategies to mitigate pandemics would provide a 250:1 to 700:1 return on investment. Even small reductions in the estimated costs of a future pandemic would be substantial. This approach would have greater success at a much lower cost in reducing the impacts of EIDs.

The next administration should (1) launch a strategy aimed at strengthening biosurveillance systems at home and abroad through a **global viral weather system for spillover**, including harnessing technology and data science to create predictive risk systems; (2) eliminate existing barriers in international development and foreign policy between food security, global health, and environmental sustainability by establishing a coordinator for planetary health; (3) address and alter the incentive structures that facilitate spillover, and create new incentives for investments to reduce the risk for spillover through institutions like the Development Finance Corporation; and (4) through creating the world's first climate & biodiversity neutral development agency, to ensure that our development investments aren't facilitating spillover risks.

Challenge and Opportunity

COVID-19

The COVID-19 pandemic represents the greatest global public health crisis of this generation and, potentially, since the pandemic influenza outbreak of 1918. But it is not the only new pathogen to have threatened humanity in that time, nor will it be the last. Scores of infectious

[1] Dobson, A. P., Pimm, S. L., Hannah, L., Kaufman, L., Ahumada, J. A., Ando, A. W., ... & Kinnaird, M. F. (2020). Ecology and economics for pandemic prevention. Science, 369(6502), 379-381.

[2] Wolfe, N. D., Daszak, P., Kilpatrick, A. M., & Burke, D. S. (2005). Bushmeat hunting, deforestation, and prediction of zoonotic disease. Emerging infectious diseases, 11(12), 1822.

[3] Wolfe et al. 2005.

diseases threaten humankind: both familiar ones like malaria, tuberculosis, and neglected tropical diseases, and emerging viruses, fungal, and bacterial infections like Ebola, H5N1 avian flu, Zika, severe acute respiratory syndrome and Middle East Respiratory Syndrome. Increasingly, emerging infectious diseases (EIDs) are zoonotic: 60% are shared between wildlife and humans[4]. Today, the frequency of epidemics is increasing, driven by surging populations, our degradation debt owed to the planet and climate, wildlife trafficking, and globalized trade and travel.

As we have seen with COVID-19, in a thoroughly interconnected world, those of us in developed economies cannot afford to ignore the developing world if we are concerned about disease outbreaks. The failure to address Covid-19 everywhere affects our ability to address it anywhere. Not enough is known about the trajectory of the transmission of COVID-19 in the Global South. Many developing countries, especially in rural communities, are limited in their ability to test and isolate patients due to under-funded healthcare systems that lack medical staff, training, laboratories, reagents, equipment, and trained personnel. They lack the resources and biosurveillance capacity to identify spillover events, and outbreaks even with large mortality may go undiagnosed when their symptoms mimic other diseases.[5] Moreover, EIDs can exacerbate chaos in failed and failing states, and failed states make ready homes for pandemics.[6] COVID-19 in fact may have moved between 88-115 million people back into extreme poverty, and potentially 150 million by 2021, setting back efforts to end extreme poverty by 3 years.[7] This is why the response to COVID-19, and the next pandemics, are not just health problems, but need be framed within a larger development and conservation context that requires investments in restructuring how we address the wicked problems facing our country and our planet.

Accordingly, as we respond to this outbreak, it is even more important to think about how we prevent the next one. The U.S. has invested significant resources to prepare for, monitor, and respond to outbreaks of existing infectious diseases. Although this investment has been insufficient as we have seen in COVID-19, there is a bigger issue: How do we avoid the next 10 pandemics? These "downstream" responses fail to address the origination of novel emerging infectious diseases, i.e. how such diseases initially arise, or the factors that accelerate their spread. We need to focus on factors that greatly contribute to disease emergence: our food systems & supply chains, environmental degradation, climate change, and the movement and trade of wildlife and wildlife products.

Much of the world's population lives in close proximity to animals and natural environments; such proximity translates into greater disease risks. More than half of the 1,407 recognized

[4] Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. Nature, 451(7181), 990-993.
[5] Dobson et al. 2020.
[6] Stewart Patrick. 2006. Weak States and Global Threats: Assessing Evidence of "Spillovers", Center for Global Development Working Paper Number 73 (January 2006).
[7] World Bank. 2020. Poverty and Shared Prosperity 2020: Reversals of Fortune. Washington, DC: World Bank. doi:10.1596/978-1-4648-1602-4.

infectious diseases are shared between humans and wildlife ("zoonotic"); such zoonotic pathogens are twice as likely to be emerging or reemerging, than are nonzoonotic pathogens. Since the 1970's, 75% of EIDs have been at the human-wildlife boundary, with new infectious diseases emerging at a faster rate than ever before.[8] Further, a common, defining feature of emerging infectious diseases is that they are triggered by anthropogenic changes to the environment. As natural environments degrade (specifically, due to climate change, loss of biodiversity and fragmentation of habitats, or invasive species), they are more likely to harbor infectious diseases and their vectors (animals or plants that transmit a pathogen). Understanding and addressing how such environmental changes may affect the spread of disease allows us to mitigate or even prevent outbreaks in the future.

It would be substantially more cost effective, efficient, and safer to prevent these diseases from initial emergence and spread. According to Dobson *et al*, the estimated cost difference of prevention would be $22.0 to $31.2 billion, compared to the expected costs of COVID-19 of $8.1 to $15.8 trillion, ranging from a 250:1 to 700:1 difference of costs. There are additional ancillary benefits to these upstream approaches, which include ecosystem services and reduced CO2 emissions.

COVID-19 presents us with an unprecedented opportunity to create a world where we anticipate, plan for, and mitigate pandemics before they happen, and even prevent them from emergence. We can address the challenge of EIDs by building the capacity and infrastructure needed to prevent future outbreaks and through addressing the root causes of EIDs. This requires us eliminate the barriers that separate global health programming from investments that address the root causes of environmental degradation, food insecurity, public health, and economic insecurity. It is also an extraordinary opportunity to take a problem-oriented approach to solving conservation & development problems, rather than a disciplinary one, and think about how we create new pathways for industrialization that meet the exigencies of climate change and sustainability.

Climate Change

Climate change expands the range and impact of pathogens, facilitating the spread of EIDs. Warmer temperatures enable pathogens and their vectors to survive and sometimes thrive in habitats previously outside of their tolerance range. It also serves to change weather patterns (like storms or rainfall) that lead to more standing water, and increase the population of mosquitos or other vectors. Climate change may also alter the range and fitness of host predators or competitors that would have limited spread of vectors under previous conditions. Vectors may also be active for longer periods of time during the day (e.g., mosquitos may have more opportunities to transmit a disease because they have more times to bite). Tropical diseases such as malaria, cholera, yellow fever, now reach previously unexposed human

[8] Wolfe, N. D., Daszak, P., Kilpatrick, A. M., & Burke, D. S. (2005). Bushmeat hunting, deforestation, and prediction of zoonotic disease. Emerging infectious diseases, 11(12), 1822.

populations in South America, Central Africa, and Asia due to the spread of their vectors to new regions. Dengue is expected to reach New York and Washington DC by 2080.[9]

Environmental Degradation and Disease Risk

The destruction and degradation of natural habitats and the stress and defaunation of species communities within them, facilitates the emergence of infectious diseases by increasing the opportunities for disease spread and spillover.

First, reduced species diversity increases the relative commonness of those species that incubate, carry, and help spread a pathogen ("reservoirs"), increasing disease prevalence. Further, predators are the first to disappear after habitat degradation; the lack of a "regulatory" agent leads to an increase in reservoirs, increasing opportunities for transmission as with Lyme disease in the Eastern U.S. Lower resources could mean less competitors, another regulatory agent. Environmental degradation may also increase shedding rates by stressing animals, encouraging the spread of the disease. Deforestation and degradation of habitats may also facilitate the spread of infectious disease by increasing habitat that favors disease vectors, such as mosquitos (rice paddies around forest edges), or edge habitat that favors invasions by invasive species.

Finally, changes in landscape geometry and makeup, coupled with changes in density in domesticated and wild species, may draw together formerly isolated populations, increasing spillover risks to humans and domesticated animals from wildlife populations, and vice versa. Tropical forest edges create spillover opportunities for novel human viruses, as humans and their livestock are more likely to come into contact with wildlife when more than 25% of the original forest cover is lost.[10] Environmental degradation, driven by forestry, mining, and agriculture, increases opportunities for hunting wildlife, and the potential for spillover.

Invasive Species, Wildlife Trade, Pet Trade, and Food Systems

The invasion of foreign species (pathogens, vectors, and reservoirs) into novel habitats also spreads infectious disease. Such introductions may happen due to increasing globalization of industry, trade, and tourism; through the pet trade (as what happened with the U.S. outbreak of Monkeypox), through legal or illegal trade in wildlife and wildlife products; or through habitat changes that facilitate invasions by alien plants or animals. Invasive alien species may carry disease into populations previously unexposed to those pathogens. Invasive species may also destroy native species or their food supplies, creating an unbalanced ecosystem more vulnerable to disease. As SARS-COV-2 has shown us, wildlife trade is especially prone to spillover, as the capture, handling, slaughter, and ingestion of wildlife can lead to the transfer of a pathogen from wildlife to humans. Ebola is thought to have arisen due to bushmeat

[9] Messina, J. P., Brady, O. J., Golding, N., Kraemer, M. U., Wint, G. W., Ray, S. E., ... & Marczak, L. B. (2019). The current and future global distribution and population at risk of dengue. Nature microbiology, 4(9), 1508-1515.

[10] Faust, C. L., McCallum, H. I., Bloomfield, L. S., Gottdenker, N. L., Gillespie, T. R., Torney, C. J., ... & Plowright, R. K. (2018). Pathogen spillover during land conversion. Ecology letters, 21(4), 471-483.

hunting of bats and nonhuman primates; HIV is thought to have arisen due to bushmeat hunting of chimpanzees; MERS is thought to have arisen due to animal husbandry (camels).

Plan of Action

Currently, U.S. policies to combat and address EIDs are focused on costly responses to individual outbreaks, rather than reducing the chance for an outbreak to occur. Artificial barriers between public health responses, food security, animal health, biodiversity conservation, and national security also exacerbate the problem. On the international level, there is a total failure to standardize disease data, link it with environmental change, and assess risks despite scientific evidence linking disease emergence and environmental change. Confronting EIDs more effectively and efficiently requires a multifaceted and multidisciplinary approach. To better understand and address the threat posed by EIDs and develop more effective responses to this threat, this memo recommends the following steps:

1. Establish a biosurveillance system in the most biodiverse places

A first line of defense against emerging zoonotic viruses is dependent on countries having adequate capacities for monitoring and reducing spillover of viruses from wildlife to people (either directly or through intermediate animals such as livestock). Existing biosurveillance efforts are typically not sufficiently robust, as evidenced most-recently by the spillover of SARS-CoV-2 from animals to people in Wuhan, China.

Through massively better biosurveillance of targeted pathogens through new technologies, including low cost molecular testing to be able to understand opportunities for spillover in the United States, as well as in the Amazon Basin, Wallacea, and the Congo Basin, we can establish a global, integrated monitoring network that forms the basis of an actionable biosurveillance system. Key will be increasing world class lab capacity in the places where spillover is more likely to happen and development of new low cost technologies that can help identify new pathogens, and their reservoirs in situ. With this networked of networked devices, patterns of emergence and spread can also be monitored in near real-time, producing transformative data on the epidemiological and ecological progression of novel pathogens. However, this will require setting up a modern surveillance network in partnership with other health organizations with a large foot print on the ground. These include the CDC, FHI360, WCS, Veterinarians without Borders, and the World Health Organization. It will also require the US to create a Field ParaVets Program, a rapid training program for rapid response and paraveterinarian specialists that would be focused on one-health surveillance and outbreak detection.

Utilizing big data, machine learning, and models from epidemiology, ecology, and evolution, we can begin to develop the integrated frameworks and analytical capacity that will enable a global forecasting system for future pandemics and EIDs. Much like the Global Weather Services enterprise, we can create a system that provides information and services to front-line actors, governments, health agencies, civil society, and front-line communities that enables them to

anticipate and respond to the emergence of new diseases. Furthermore, because of the integrated nature of such a Global Biosurveillance System, capitalizing on the ecological and evolutionary understanding described above, we can create actionable insights that will allow conservationists, public health officials, food system agents, and others to move upstream from the emergence of these novel pathogens to turn off the underlying drivers.

Implementation Steps

i. Creating a Global Viral Intelligence Service for Predicting Pathogen Spillovers. We need a global surveillance network for emerging infectious diseases to gather information on the incidence of disease in populations of wildlife, humans, and domesticated animals, and agriculture, at every stage of the trade supply chain beginning with free-ranging populations and extending to wildlife farms, confiscated animals being smuggled, and animals legally being shipped at points of export, and create adaptive "weather" maps of the risks of disease transmission. This service, would be based within the NIH, and work closely with the Centers for Disease Control, the Defense Threat Reduction Agency, the Armed Forces Health Surveillance Branch, and the USGS National Wildlife Health Center.

ii. Improving Monitoring and Prevention Internationally. The US must take a leadership role to strengthen efforts by UN Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE), UNDP, UNEP, and the World Health Organization, to develop a systematic approach for early detection and rapid response to identify and control emerging infectious disease of human, wildlife, and domesticated animals, including delineating risks from wildlife trade, environmental degradation, and climate change. Through USAID, in partnership with the Defense Threat Reduction Agency, and the Navy Medical Research Centers in Egypt, Lima, and Singapore, the US would develop new funding and technical assistant programs for building disease monitoring lab activity and personnel, building on USAID's IDENTIFY program, previous programs including PREDICT, PREVENT, IDENTIFY, RESPOND, and DTRA's Cooperative Biological Engagement Program.

iii. Expansion of Existing Authorities to Defend our Borders. The new administration should expand the mission of APHIS to address not only disease issues that affect agricultural animals but also those associated with zoonotic and wildlife diseases, and increased focus on disease prevention, preparedness, detection, and early response activities. We may give CDC the authority to use pre-import screening, such as a process that assesses disease risk by species and country and determines allowable imports on the basis of that assessment. We may also amend the Lacey Act to strengthen the USFWS's ability to identify, designate and stop injurious species, including dangerous pathogens from entering the United States, and from moving in interstate commerce if and when they arrive here.

2. Breaking down barriers between food security, global health, and sustainability

It is clear that how we may address pandemics requires us to break down the barriers – such as the health accounts in USAID – that limit opportunities to take a transdisciplinary approach to how we may address pandemics. Emerging pathogens are not limited to human health or wildlife, but cross over into the disruptive pests and pathogens that address the crops we grow, the food we store, and ecosystems we value. Our solutions to EIDs require us to think more broadly than global health, but think about health systems, food safety and security, wildlife trade, and environmental change.

Implementation Steps

i. Address the Drivers of Pandemic Emergence. Work with Congress to allow for greater multisectoral programming within USAID to address the underlying drivers of extinction. Proactive efforts that minimize risk of emerging diseases are less costly than the economic and mortality costs of responding to these pathogens once they have emerged. Harnessing intelligence from the Global Viral Intelligence Service, the US should also fund programs to mitigate the underlying factors that facilitate disease emergence, including addressing food systems and global production of feed, food, materials, and their supply chains, and environmental degradation. This includes looking at how we may reduce risk through (1) protecting habitats, conserving biodiversity, reducing deforestation, restoring degraded habitat; (2) prioritizing international transdisciplinary research collaborations under the Ecohealth, OneHealth, and Planetary Health Frameworks; and (3) using ecological interventions to reduce human disease burdens and pandemic risk through experimental management and conservation.

ii. Encourage a whole of government approach through the leadership of the National Security Council. The National Security Council should coordinate both international and domestic approaches to take a multi-disciplinary approach to addressing the upstream factors of pandemics, working in consultation with PCAST, NSTC, CEQ, OSTP, and OMB, and through an interagency process with representation from State, USAID, DFC, DOD, Treasury, HHS, NOAA, NASA, USGS, ODNI, and other relevant federal agencies, through an interagency working group.

3. Changing the incentives that drive spillover

Regardless of the exact determinants of the origin of COVID-19, this pandemic is primarily due to human behavior. Wildlife wet markets bring together an array of wild animals, in stressful and confined conditions, that would not normally occur. This creates an environment conducive to the spread of disease. Consumption of these wild animals (such as bats, pangolins, and even primates) puts human health at risk by providing an opportunity for the virus to potentially spillover from non-human animals to humans. We need to change the incentives for human behavior, and facilitate that change through modernization of the food system, animal husbandry, and supply chains, and increasing the sustainability of systems to reduce the demand for wildlife products that produce pandemics and decimate wild populations.

Creating new technological systems to better protect the forests tied to direct payments for conservation systems & monitoring (whose value is based on spillover risks & biodiversity value) to change behavior for those at greatest risk of spillover, and who have few other economic choices. Some early attempts exist to change behavior around wildlife trade, such as campaigns in China to reduce the consumption of shark fin soup, that can serve as models for ways to leverage new technologies and behavioral science approaches (gamification, peer networks, positive and negative reinforcement, etc.) to reduce demand for wildlife products. This, coupled with market signals that incentivize proper behavior could produce significant benefit.

Implementation Steps

i. End Implicit and Explicit Subsidies that Drive Spillover at home and abroad. Many threats to planetary health, including emerging infectious diseases, are unwittingly subsidized and facilitated by the government. These subsidies include those in water use, energy, agriculture, transportation, fisheries, land management, and trade. Ending subsidies domestically may not only support planetary health, but free up revenue to the program. Internationally, subsidies violate the underlying principles of global trade through the World Trade Organization and allow for countervailing measures. Further, parties to the WTO may implement trade related measures at protecting the environment. These would serve to benefit the sustainability of US industry and make our domestic and better regulated products more competitive.

ii. Create new Financial Innovations & Encouraging Investment for Preventing Pandemics. Financial innovations are a powerful class of behavioral incentives. We should consider innovations such as Advanced Market Commitments, Direct Payments for Conservation, Social Impact Bonds & Direct Payments, Franchise Models, and Nutrient and Carbon Trading, coupled with mechanisms such as the Development Credit Authority within the new Development Finance Institution which guarantees up to 50% of "first loss" of an investment to encourage the development of new capital to support Planetary Health and addressing emerging infectious diseases. The SEC could also require companies to report measures on their environmental sustainability, and potential risk from environmental degradation, climate change or pollution on their operations.

4. Creating a climate & biodiversity neutral development agency

Climate change and biodiversity degradation will be a major driver of the spread of EIDs. To mitigate what is an increasing threat to human security, USAID needs to ensure that its entire portfolio of activities, do not on average, worsen climate change or undermine biodiversity loss. This requires us to think beyond just funding sporadic climate and conservation programs, but thinking about the systematic impact of the Agency's activities on climate change, and ensuring that US development investments are generating a net impact of zero emissions of the greenhouse gases that cause global warming, and are not driving species defaunation and extinction. Such an approach supports the SDGs, and will allow for countries to find new pathways to industrialization and development. It will enable the Agency to stop contributing

to the very problems it is trying to solve such as weather-related humanitarian crises, livelihood re-engineering due to decreasing water levels, and conflict over arable land.

Climate & biodiversity neutrality does not detract from other development goals, such as economic growth. While the United States should invest heavily in encouraging sustainable economic growth –and it is in the environment's interest to do so -- it is imperative that we act in a way that does not worsen the effects of climate change or the extinction crisis. Future economic growth must work to reduce rather than expand emissions of greenhouse gases. Working towards climate & biodiversity neutrality would benefit the people assisted by USAID, as well as the environment. Certain USAID programs are inherently emissions-intensive, such as responding to disasters or building roads. Achieving climate & biodiversity neutrality across the entire basket of USAID foreign assistance activities allows development activities in one country that reduce emissions (such as forestry, biodiversity conservation, and renewable energy) to balance activities in other countries that increase emissions (humanitarian aid missions, road-building). USAID can become, once again, the most forward-thinking development agency, shining as an innovative example among other donor organizations throughout the world.

Implementation Steps

i. Create an annual estimate, through the annual budget process, of the approximate carbon impact of USAID programs, and create an office within the Policy Bureau to carry out this analysis. This office will lead a Climate Neutral Task Force (CNTF), with representatives from each Washington Bureau and, initially, those Missions that choose to participate in a comprehensive assessment of both their programs and operations. Bureaus will be represented by environment officers and experts in the key sectors -- infrastructure & engineering, energy, agriculture, water, and natural resources, and our own operational management. One year appears a reasonable estimate for how long it would take for the CNTF to accomplish the work described in the proposal. We recommend undertaking the emissions assessment process in several self-selected, pilot Missions, in the first year, and then expand to the whole Agency in the next year.

About the Author

Dr. Dehgan is the CEO and co-founder of Conservation X Labs, an innovation and technology startup focused on conservation. Conservation X Labs both builds new technologies for addressing the underlying drivers of extinction, and harnesses open innovation & mass collaboration to attract new solvers and new solutions. Alex raised over $15 million of funding, and built a team of 30 people working across both coasts. Alex is also a Professor of the Practice of Sustainability and the Global Futures Fellow at Arizona State University.

Alex previously served as the Chief Scientist at the U.S. Agency for International Development (USAID), with rank of Assistant Administrator. Alex found and led the Office of Science and Technology (OST), and creating the vision for and helped stand up the Global Development Lab, the Agency's DARPA for Development. Alex was also part of the founding team of USAID's Policy Bureau. Prior to USAID, Alex worked in multiple positions at the Dept. of State, including on the Policy Planning Staff and through overseas service under the Coalition Provisional Authority in Iraq, using science to support bilateral diplomacy, including Arab-Israeli relations, engagement with Iran, through leading the science aspects of President Obama's Cairo Initiative.

Alex was the founding country director of the Wildlife Conservation Society Afghanistan Program and helped create Afghanistan's first national park. Alex is the author of the book, *The Snow Leopard Project*, which describes the effort, which was selected by the journal *Nature*'s book editor as one of the top five science books of 2019. Alex holds a Ph.D in Evolutionary Biology from The University of Chicago and a J.D. from the University of California, Hastings College of the Law. Alex has won multiple awards from the Departments of State and Defense, as well as being named an Icon of Science, the World Technology Award, and in 2020, being given the University of Chicago's Medical and Biological Alumni Association's highest honor.

About the Day One Project

The Day One Project is dedicated to democratizing the policymaking process by working with new and expert voices across the science and technology community, helping to develop actionable policies that can improve the lives of all Americans, and readying them for Day One of a future presidential term. For more about the Day One Project, visit dayoneproject.org.