

Predict and Prevent

Identify "hot spots" and enable rapid response to emerging threats

Introduction

The world is experiencing unprecedented change. Rapid ecological and social shifts are increasing the number of emerging threats, ranging from devastating disease outbreaks to extreme weather events. Invariably it is the world's poor who are least equipped to withstand such shocks and suffer the greatest hardship.

- In February and March of 2000, severe floods devastated Mozambique. Approximately 800 people died, 20,000 head of cattle went missing and 113,000 small farming households suffered the destruction of their grazing and cultivated land.¹
- Drought in Ethiopia in 2002 reduced maize and sorghum yields by 70%, threatening the food supply of an estimated 13.2 million people.²
- By 2005, SARS infected around 8000 people, killing 800, spreading from a single country across oceans in merely a few months. Resultant economic losses in East Asia alone reached nearly \$18 billion.³

Could these crises have been averted?

Anticipating disasters before they strike buys precious time for the adoption of measures to enhance preparedness and reduce vulnerability. The hazards and global environmental change communities use modeling to predict future stresses or shocks, to understand regional sensitivities to these stresses, and to assess the ability of societies or ecosystems to respond.⁴ However, not all sectors use this proactive approach - and even where employed, the technology and information available often remains limited in scope and effectiveness.

Google.org will work to strengthen the science, technology, and capacity to predict shocks and prevent subsequent crises. We will begin our efforts with a focus on emerging infectious diseases.

Why Emerging Infectious Disease?

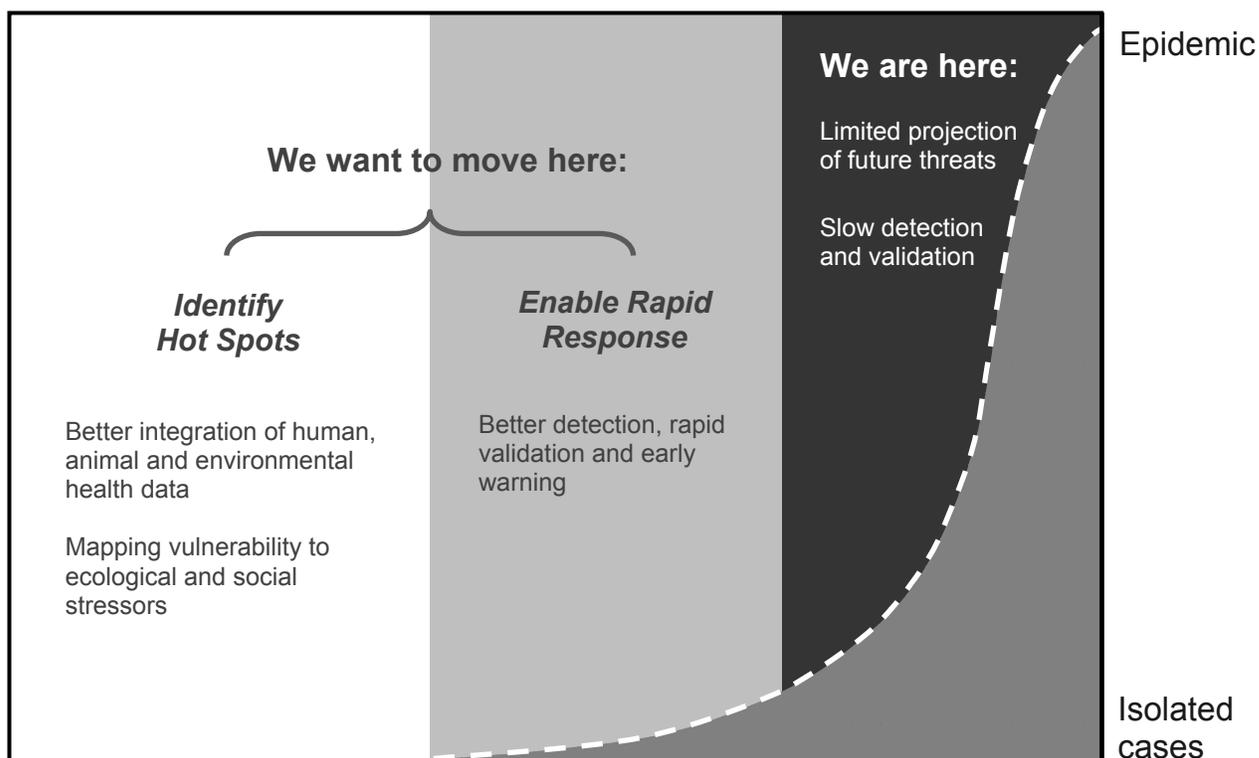
Despite advances in medical treatment and vaccine technology, emerging infectious diseases are on the rise worldwide. What do we mean by emerging infectious diseases? Over the last three decades, the World Health Organization (WHO) has reported more than 30 brand-new infectious diseases, including killers like HIV/AIDS, Ebola, and SARS.⁵ In addition, known diseases are expanding in geographic distribution and even shifting entire continents to affect new populations. For example, in the summer of 2007, health workers were shocked to diagnose chikungunya fever in Ravenna, Italy, a mosquito-borne disease normally confined to the tropics.⁶ In 1999, another mosquito-borne infection, West Nile Virus, jumped continents to appear in New York. Within three years it became endemic throughout the United States.⁷ Finally, as a result of drug resistance, other diseases have essentially transformed into new threats. For example, extensively drug-resistant tuberculosis (XDR-TB) is a new strain of an old bug that is resistant to a combination of standard and reserve treatment medications.^{8,9}

Why are we seeing so many emerging diseases now? Vastly expanded international travel and trade allow disease-causing agents to move around the globe at accelerated speeds. Additionally, as humans and animals come into closer contact because of deforestation, environmental degradation, and greater demand for animal products, diseases are increasingly moving from animals to humans. In fact, the majority of newly-identified infectious threats – upwards of 70 percent – are zoonoses, or diseases that originate in animals and jump to humans.¹⁰ As the growing world population continues to change its environment in unsustainable ways, this trend is likely to continue.

While everyone faces increasing risk from emerging infectious diseases, the world's poor stand to suffer most as they have minimal or no access to health care. Furthermore, the lives and livelihoods of the rural poor are often tied to their animals – more than 70 percent depend on livestock for income.¹¹ They are not only vulnerable to severe or fatal infection due to close contact with infected animals and animal products, but they also bear the economic brunt of livestock losses due to animal disease or disease control programs.

Initiative Goals

Predict and Prevent aims to strengthen traditional disease surveillance and response, but we also hope to foster thinking about what we can do to predict threats before they occur and focus on prevention. In partnership with others, we will enable a rapid and effective response to emerging threats by improving detection and validation, and establishing better systems for early warning. At the same time the initiative will build the science, technology, and capacity in the developing world to map regions vulnerable to future outbreaks. The result of this will be to shift the point of response down the outbreak curve thereby shifting the nature of response from reactive to proactive.



Predict and Prevent Initiative Goal

The goal of the Predict & Prevent Initiative is two fold. First, to move down the epidemic curve to the earliest point of detection and rapid response (gray zones). Second, to move ahead of the curve to a better understanding of the complex factors that lead to emergence of diseases in the first place (white zone). Our strategies therefore will focus on two parallel but highly integrated pathways to identify hotspots and enable a rapid response.

Initiative Strategy

The Predict and Prevent initiative will support two inter-related pathways toward the prediction and prevention of emerging infectious diseases: identifying "hot spots" and enabling a rapid response.

Identify Hot Spots

No model can predict precisely when or where a new infectious disease will emerge or how it will spread. An understanding of the complex drivers that lead to disease emergence and transmission, however, can help communities to anticipate potential outbreaks and enhance preparedness. For example, the Millennium Ecosystem Assessment¹² highlights the important role that healthy ecosystems play in regulating the transmission of many infectious diseases. By contrast, environmental degradation and ecosystem change are increasingly recognized as factors that contribute to the emergence and reemergence of infectious disease, leading to rising concern about the risks posed by climate change and deforestation.¹³ These biophysical stresses are compounded by the impact of rapidly changing social contexts – poverty, inequity, and social unrest all contribute to the risk of epidemic outbreaks.¹⁴

Predicting "hot spots" of disease emergence requires an integrated understanding of the multiple factors that create vulnerabilities. Building this understanding necessitates sharing knowledge and experience across and beyond disciplines.

Through this initiative Google.org will support work that:

- Builds and shares knowledge across human, animal, and environmental health sectors
- Improves data collection, sharing and analysis for enhanced vulnerability modeling and mapping
- Contributes to the enhanced resilience of communities to withstand threats and adapt to changes

Enable a Rapid Response

To provide effective early warning of an emerging disease threat, a community first has to detect the threat and confirm the infectious agent. Google.org will support better detection, rapid validation, and early warning mechanisms to enable a timely and appropriate response. The success of these efforts will depend on having basic epidemiology and laboratory capacity throughout the world and the willingness to openly share important data for disease control and prevention.

Through better detection we aim to identify emerging infections wherever they occur. Within the initial target countries that invite our involvement this will include collection of environmental, human, and animal health data. We will work with key partners to develop innovative mechanisms for community-based and cross-sector reporting. In addition, we will support efforts to better understand the viruses circulating and evolving at the interfaces of humans and animals. For example, we will build upon early efforts to collect blood samples among hunters in Africa and the animals with which they have contact. Similarly, we may explore ways to collect similar data in mosquito vectors to better understand "viral chatter." Additionally, we will explore and build upon data-mining efforts that monitor news feeds and other online resources to identify early signals of potential disease threats and to improve the speed of reporting threats to the appropriate responders.

Once a threat is detected it must be validated. Google.org will look to invest in diagnostic technologies that allow for more rapid identification of a detected threat, and will support improved field investigation by partnering to build laboratory capacity and epidemiology training programs.

Acting on the information gathered to this stage, we will facilitate early warning systems through real-time data sharing. Support to our partners may even extend beyond funding in cases where there are opportunities to build on existing Google tools and resources.

In short, Google.org will focus on:

- Using innovative methods to quickly find threats wherever they occur
- Confirming outbreaks and identifying their cause
- Engaging key stakeholders, from villagers to global health authorities

Regions of Focus

The Predict and Prevent initiative will initially focus on Southeast Asia and sub-Saharan Africa as these two regions have been recent “hot spots” of emerging and re-emerging threats and together bear the biggest infectious disease burden.¹⁵ In Southeast Asia - the center of the emergence of both avian flu (H5N1) and severe acute respiratory syndrome (SARS) - infectious diseases cause about 40 percent of annual deaths.¹⁶ The disease threat is heightened in this region as it has the most intense animal-human coexistence in the world, which hastens the exchange and spread of new and re-emerging infections.¹⁷ Sub-Saharan Africa bears the greatest infectious disease burden and has the weakest public health infrastructure in the world.¹⁸ More than half of the African population lacks access to health facilities and 40 percent lacks access to safe drinking water and sanitation, leaving the populace even more vulnerable to the emergence and outbreaks of new and re-emerging infectious diseases.¹⁹ Poverty and poor infrastructure in both regions heighten vulnerability.

Summary

The world is indeed small and highly interconnected. We must work together to understand the complex factors that lead to emerging threats. We hope to build knowledge, bring technology where it is most needed, and increase access to and sharing of information. In this manner, we hope to help improve the world's capacity to predict and prevent emerging threats.

¹ From Africa Recovery, Vol.14#3 (October 2000), page 13 (part of Mozambique: Country in Focus) at <http://www.un.org/ecosocdev/geninfo/afrec/subjindx/143moz2.htm>

² USAID Fact Sheet for Ethiopia at http://www.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/countries/ethiopia/fy2003/Ethiopia_DR_FS17_09-30-2003.pdf and <http://www.fao.org/english/newsroom/news/2003/18548-en.html>

³ Cooper, S and Coxe, D (2005) An Investor's Guide to Avian Flu. Special Report. BMO Nesbitt Burns Research. Fan, E (2003) SARS: Economic Impacts and Implications, ERD Policy Brief No. 15 . Manila: Asian Development Bank, Economic Research Department.

⁴ IPCC Fourth Assessment Report (AR4), 2007. Available from <http://www.ipcc.ch/#>; Kasperson, J.X., Kasperson, R.E., Turner II, B.L., Schiller, A., Hsieh, W.-H., 2003. Vulnerability to global environmental change. In: Diekmann, A., Dietz, T., Jaeger, C., Rosa, E.S. (Eds.), The Human Dimensions of Global Environmental Change. MIT, Cambridge.

⁵ WHO see http://www.searo.who.int/EN/Section980/Section1162/Section1167/Section1171_4750.htm and NIH see <http://www.niaid.nih.gov/publications/dateline/0997/introsto.htm>

⁶ World Health Organization Regional Office for Europe (2007) Communicable Disease Surveillance and Response Update: 16 September 2007, Chikungunya in Emilia Romagna Region, Italy. http://www.euro.who.int/surveillance/outbreaks/20070904_1

⁷ Nash, D, Mostashari, F, Fine, A et al (2001) The Outbreak of West Nile Virus Infection in the New York City Area in 1999. *New England Journal of Medicine* 344(24): 1807-1814.

⁸ Brownlie, J., Peckham, C., Waage, J., Woolhouse, M., Lyall, C., Meagher, L., Tait, J., Baylis, M. and Nicoll, A. (2006). Foresight Infectious Diseases: preparing for the future. Future Threats. Office of Science and Innovation, London.

⁹ CDC. Revised definition of extensively drug-resistant tuberculosis. *MMWR* 2006; 55: 1176.

¹⁰ Ibid, and Chomel BB, Belotto A, Meslin F-X. Wildlife, exotic pets, and emerging zoonoses. *Emerg Infect Dis* [serial on the Internet]. 2007 Jan. Available from <http://www.cdc.gov/ncidod/EID/13/1/6.htm>

¹¹ Livestock in Development. "Livestock in poverty focused development." Crewkerne, Somerset. (1999)

¹² www.millenniumassessment.org

¹³ Eisenberg et al. 2006: Morse SS (1995) *Emerg Infect Dis* 1:7–15; Patz JA, Graczyk TK, Geller N, Vittor AY (2000) *Int J Parasitol* 30:1395–1405; Colwell RR, Epstein PR, Gubler D, Maynard N, McMichael AJ, Patz JA, Sack RB, Shope R (1998) *Science* 279:968–969.

¹⁴ Smolinski, M., M.A. Hamburg, J. Lederberg, 2001. Microbial Threats to Health; Emergence, Detection, and Response.

¹⁵ Global Health Council, Infectious Diseases, p. 2, http://www.globalhealth.org/view_top.php?id=228

¹⁶ WHO Combating Emerging Infections, Regional Office for Southeast Asia, p. 4

¹⁷ WHO Combating Emerging Infections, Regional Office for Southeast Asia, p. 11

¹⁸ IOM, Emerging Infectious Diseases from the Global to the Local Perspective: Workshop Summary, 2001, pg. 52

¹⁹ Health Care in Africa: Challenges, Opportunities and an Emerging Model for Improvement, Dan Kaseje, MD, PhD, 2006.