DOWNLOAD PDF CLIMATE CHANGE, EXTREME WEATHER EVENTS, AND FUNGAL DISEASE EMERGENCE AND SPREAD

Chapter 1 : Chapter 4: Extreme Events | Climate and Health Assessment

1 Climate Change, Extreme Weather Events, and Fungal Disease Emergence and Spread. Compton J. Tucker, Karina Yager*, Assaf Anyamba*@, and Kenneth J. Linthicum#.*

This chapter examines such interactions from several perspectives: Their consequences throughout the aquatic-marine food web, which defines ecological relationships for water-dwelling animals In patterns of distribution and transmission dynamics of individual infectious diseases cholera, Rift Valley fever, chikungunya, and plague Their effects on the dynamics of plant diseases, and their effects on agriculture and natural ecosystems As manifested in the public health challenges posed by climate change to human populations in the Arctic Research on the effects of climate variation on infectious disease incidence and geographic range in these diverse contexts is providing the basis for developing climate-based early warning systems for disease risk. Such studies also represent a necessary first step toward anticipating how climate change may alter infectious disease dynamics in various ecological frameworks. In her workshop presentation, Leslie Dierauf, director of the U. Ecological connections among these environments are illustrated in Figure SA-8 , which depicts the marine food web. Dierauf also emphasized the physical connectedness of aquatic and marine environments, which makes it possible for infectious diseases of fish and wildlife to move from freshwater sources to intertidal zones to marine environments, affecting species that may not have encountered these disease agents before. Salmon, for example, hatch in small freshwater streams, travel hundreds of kilometers downstream to the ocean where they live for several years, only to return to the same streams where they hatched to spawn and die shortly thereafter. Following the flow of water from inland streams to estuaries and into the open ocean, Dierauf considered the possible impacts of climate change in each of the three main elements of the aquatic continuum and how these changes may affect the health of their animal inhabitants. In freshwater ecosystems, extreme weather events that produce flooding can trigger overwhelming influxes of nutrients into ecosystems. Storms can cause a range of environmental disturbances; Dierauf described the release of Nile tilapia into Mississippi streams from aquaculture facilities damaged by Hurricane Katrina. Several emerging diseases of inland aquatic animals, described and depicted in Box SA-2 in the Summary and Assessment, may also be influenced by climate change. Intertidal areas, such as salt marshes and estuaries, are essential for maintaining a delicate balance among many complex and interactive variables such as temperature, light, salinity, wave action, sea level rise, erosion, and sediment deposition that characterize the transition from freshwater to saltwater environments, Dierauf explained. Storms, such as hurricanes, greatly affect intertidal zones. Heavy inland rainfall increases the speed and volume of the run-off that reaches estuaries, while marine storms drive saltwater and its contents past the intertidal buffer, affecting inland ecosystem health. Climate change is expected to produce a range of important effects on oceans as well as on large, deep-water lakes such as the Great Lakes , according to Dierauf. These include increased wave intensity, increased nutrient turnover, changes in nutrients, and changes in the food web. In addition, she noted, higher concentrations of atmospheric carbon dioxide are dramatically increasing the acidity of ocean waters, which in turn is weakening the carbonate shells and skeletons of many marine species that comprise coral reef systems. She also noted the effects of harmful algal blooms HABs , which are thought to result from nutrient influxes to the ocean see Summary and Assessment. HABs appear to be increasing in both frequency and size as the climate warms, she said; this could result from increased upwelling of nutrients within the ocean or changes in ocean currents, as well as from the effects of extreme weather events inland. Ocean warming, which is reducing the availability of food and sea ice for marine mammals, may also be compromising their resistance to infectious disease, Dierauf said. Faced with shortages of food in their native waters, some marine mammals move to new territories where they both encounter and introduce novel disease agents see Summary and Assessment. The incidence and distribution of cholera are controlled by water temperature, precipitation patterns, and water salinityâ€”all of which are influenced by global climateâ€”and conducted through a complex web of ecological relationships. Sanitation and infrastructure also play a role in the incidence and distribution of cholera. Rift Valley fever RVF and chikungunya fever. Chikungunya fever caused a series of outbreaks along the Kenyan coast in , from which it apparently spread to several western Indian Ocean islands and India, resulting in the largest chikungunya fever epidemic on record Chretien et al. Chretien and coauthors discuss several possible, nonexclusive mechanisms connecting the epidemic with the drought, some of which may have also have influenced the first appearance of chikungunya fever in Europe in Throughout recorded history, the various forms of plague, caused by the bacterium Yersinia pestis and transmitted by fleas among a wide range of hosts, are known to have caused both endemic and epidemic disease. Stenseth examines the dynamic ecology and epidemiology of plague in its ancient reservoir in Central Asia, and compares these patterns with local climate variation over the course of decades as recorded in regular measurements of temperature and rainfall and centuries as reflected in tree-ring data for the past 1, years. Using data collected twice annually between and in Kazakhstan, a focal region for plague where human cases are regularly reported, Stenseth and colleagues determined that Y. Rodent populations also tend to increase under these conditions and, along with them, the possibility that plague will be transmitted to humans. Analyses of historical climate variation, as reflected in tree-ring patterns, suggest that similar warm, wet conditions existed in Central Asia during the onset of the Black Death in the fourteenth century, as well as in the years preceding a mid-nineteenth-century plague pandemic. However, she adds, these well-established models will need to be adapted based on sound science to account for climate change, as will plant disease management policies that flow from climate-based forecasts. In her contribution to this chapter, Garrett establishes a framework for this critical effort. She describes standard methods for managing plant disease, reviews observed effects of climate variation on plant diseases and their implications given projected future climatic conditions, and discusses research and policy needs for plant disease management in response to climate change. In considering the consequences of climate change for plant health, Garrett emphasizes threshold effects: Examples of such thresholds include longer growing seasons; pathogen introductions and range shifts; pathogen overwintering; and the removal of constraints on pathogen reproduction at a critical population size. Temperatures in this region have increased at nearly twice the global average over the past century, causing widespread melting of land and sea ice see Figure SA ; Borgerson, ; IPCC, Parkinson describes the observed and projected effects of climate change in the Arctic environment, discusses the direct effects of higher ambient temperatures on the health of Arctic inhabitants, and catalogs the many ways in which climate change may increase the risk of infectious disease for Arctic residents. Indeed, Parkinson observes, infectious disease risks are already increasing in the Arctic through the indirect influence of climate change on the populations and ranges of disease vector species e. Flooding and the loss of permafrost are also damaging the sanitation infrastructure of Arctic communities, thereby increasing the risk of water-borne infectious diseases, respiratory diseases, and skin infections. Meanwhile, increasing mean ambient temperatures raise the risk of food-borne diseases, particularly for Arctic residents who rely on traditional methods of subsistence and food preservation e. In the face of these public health challenges, Parkinson recommends a range of public health responses, including monitoring of high-risk, climate-sensitive infectious diseases with potentially large public health impacts e. He also encourages the creation of infectious disease monitoring networks to connect typically small, isolated Arctic communities and link them to regional, national, and international health organizations. Such networks would encourage the standardization of monitoring methods, the sharing of data, and the detection of infectious disease trends over a larger geographic area. Thus, we employ gene probes, environmental measurements ground truth , and other precise techniques for pathogen detection, but at the same time, we take a holistic approach that integrates information from the atomic to the atmosphericâ€”and perhaps, in some cases, even the cosmicâ€”in order to build a predictive model for cholera outbreaks. Cholera is a significant, global public health problem, as shown in Table Annually, it results in approximately , hospitalizations and approximately 10, deaths, varying from year to year. A few cases of cholera appear each year in the United States, usually associated with seafood harvested from closed beds near sewage outfalls in the Gulf of Mexico. This area is known as the home of cholera due to spring and fall epidemics, of varying but predictable intensity, that have recurred there for hundreds of years see Figure During the monsoon season, flooding rains wash nutrients down from the Himalayas, while winds drive water from the Bay of Bengal up into the Ganges and its tributaries, creating ideal conditions discussed later for cholera outbreaks. The fall epidemic, which followed massive flooding, was catastrophic. The Center for Diarrheal Disease Research in Dacca admitted about a thousand new cases per day for almost 30 days and had to use temporary space to house cholera victims. We are working to create predictive models to provide advance warning of conditions that produce severe epidemics in this region of the world. Printed with permission from Google. Currently, we are sequencing approximately 50 different strains of Vibrio cholerae, the causative agent of cholera collected from many geographic locations to examine their genetic relationships. Preliminary sequencing studies of V. The Ecology of Cholera My laboratory accomplished the first isolation of Vibrio cholerae from the Chesapeake Bay more than two decades ago, and we now know that this bacterium is found in estuaries of similar salinity, ca. Other species of Vibrio, including V. One of my current graduate students, Brad Haley, has just returned from Iceland, where he was able to isolate V. Clearly, water temperature is critical to the growth of this pathogen. Vibrio cholerae also has a dormant state, which it assumes between epidemics and during which it cannot be cultured but can be detected with probes fluorescent antibodies and gene signature sequences. Only during the peak of the zooplankton bloom, in the spring and the fall, is V. We were able to show that by adding nalidixic acid and nutrient yeast extract to water containing the quiescent bacterium, we can stimulate cell elongation and metabolism. Another important discovery was that cholera is transmitted by plankton. Thus, it is not enough to say that its growth correlates with sea surface temperature and salinity; it is important to recognize the ecological interactions that produce these correlations. There is a commensal relationshipâ€"which may prove to be symbiosisâ€"between Vibrio bacteria and zooplankton. Vibrios are chitinolytic i. We are discovering that interactions between V. All of this leads to the conclusion that V. The Epidemiology of Cholera We have determined in earlier studies that between 10, and 50, Vibrio cholerae bacteria may be attached to an individual copepod the zooplankton favored by V. A liter of water drawn by a villager from a pond in Bangladesh between epidemics may contain 10 copepods. However, during a zooplankton bloom, that concentration can increase a hundredfold or more per liter, carrying a dose of cholera bacteria sufficient to cause cholera. The severity of the disease is dose dependent: Thus, it has been estimated that only 25 percent of those with cholera end up in hospitals and many more may have been infected Colwell and Huq, Cholera is a disease with rapid onset. Within 24 to 48 hours, the typical patient can lose up to 18 liters of fluid. If that fluid can be replenished quickly, either intravenously or through oral rehydration using a simple mixture of bicarbonate of soda, table salt, and sugar , recovery is fairly rapid. From years of study in Bangladesh, we have determined several factors that interact and are associated with the massive annual biennial spring and fall cholera epidemics, so that we can predict the onset and severity of epidemics. Our recent research focuses on the communities of Mathbaria and Bakerganj, which are located in the barrier islands region of the Ganges delta see Figure Mangrove-based ecosystems are abundant in copepods. In Bakerganj and Mathbaria, copepods comprise the majority of zooplankton species. We now have evidence that the severity of a given local cholera epidemic can be determined by copepod population dynamics, with intense epidemics occurring during times of abundance of those copepod species to which epidemic strains of V. We are currently conducting a seasonal study of zooplankton species in an attempt to determine which species carry V. We are also using our knowledge of cholera epidemiology to help the people of Bangladesh to avoid contracting cholera. In one study, for example, we found that by simply educating women to filter drinking water through several layers of sari cloth, we were able to reduce cholera incidence by 50 percent. This result supported our hypothesis that plankton and particulatesâ€"to which the bacteria are attractedâ€"transmit cholera and when removed by simple filtration, the incidence of the disease is significantly reduced. Predictive Models of Cholera Currently, the spring bloom of phytoplankton in the Bay of Bengal can be measured by satellite sensors that measure chlorophyll intensity and, therefore, the phytoplankton population. Phytoplankton blooms are followed by zooplankton blooms, but the latter cannot yet be measured directly by satellite sensors. However, the zooplankton peak can be inferred using a series of calculations from measurements of the phytoplankton populations that precede the zooplankton population peak. This information taken together with salinity, temperature, and other environmental factors, provides a more complete picture. We have also gathered ground truth data over the past 10 years in the Bakerganj area, including conductivity of the water, presence of inorganic nutrients, temperature, and salinity. With these data, we are able to improve our prediction of the timing and, possibly, the severity of cholera epidemics. In our original work, we were able to use satellite imagery to measure sea surface temperature and sea surface height in the Bay of Bengal. As shown in Figure , the correlation of chlorophyll and temperature data, measured by satellite sensors, provides a predictive capacity for conditions conducive to cholera outbreaks. We are currently working on a predictive model that takes into account ocean currents to monitor the movement of plankton into the Bay of Bengal estuaries from the southern tip of India. This could provide as much as a 3-month warning prior to an impending cholera outbreak. The epidemic more likely resulted from the effect of increased sea surface temperatures on existing plankton and V. Our most sophisticated predictive model for cholera incorporates chlorophyll, sea surface height, temperature, and extensive ground truth data. We are also refining our model, based on the 40 years of data accumulated on cholera in Bangladesh and in India, which we are presently analyzing.

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Chapter 2 : Climate Change, Extreme Weather Events, and Fungal Disease Emergence and Spread - COF

Climate, Extreme Weather Events, & Fungal Disease Emergence and Spread Road Map CO2 & other gases forcing a warmer Earth General Circulation Models indicate a wetter & drier.

Highlight and copy the desired format. Global Climate Change and Infectious Diseases. Emerging Infectious Diseases, 4 3 , Climate change, if it occurs at the level projected by current global circulation models, may have important and far-reaching effects on infectious diseases, especially those transmitted by poikilothermic arthropods such as mosquitoes and ticks. Although most scientists agree that global climate change will influence infectious disease transmission dynamics, the extent of the influence is uncertain. This conference session provided an overview of the issues associated with climate change as it relates to the emergence and spread of infectious diseases Figure 1 Figure 2. Two papers set the stage by reviewing data that support or do not support the conclusion that climate change has already influenced transmission of infectious diseases. Other studies, however, point out that in centuries past, vector-borne diseases such as malaria, dengue, and yellow fever occurred regularly in temperate regions in epidemic form during the summer months. The diseases were eliminated from Europe and North America, and although many areas still have the mosquito vectors, epidemic disease transmission has been prevented by improved living conditions and effective mosquito control. Also, since malaria has historically occurred at elevations of 2, m to 2, m, its current transmission at high altitudes does not necessarily prove that transmission at these high altitudes is the result of climate change. The second set of papers provided current evidence of global climate change and described how climatologic data might be used to understand geographic spread and transmission dynamics of an important emerging infectious disease such as cholera. The speakers concluded that global warming is occurring and that weather events appear to be associated with the emergence and spread of cholera in the Americas between and Speakers then focused on the research that will be required to answer the many questions relating to climate change and infectious diseases. The hypothesis was that ENSO-related changes in precipitation, temperature, and other environmental variables have both direct effects through drought, flood, and extreme weather events and indirect effects through changes in transmission and outbreaks of infectious diseases, particularly diseases transmitted by mosquitoes, rodents, or water on human health. Diseases studied in the ENSO experiment include cholera in Bangladesh and Peru, cryptosporidiosis in the United States, water-borne and water-related diseases in Florida, marine ecologic disturbances in the eastern United States, dengue in different parts of the world, malaria in Africa, domestic arboviral encephalitides in the United States, and hantavirus pulmonary syndrome in the United States. The National Academy of Sciences and Institute of Medicine plan to appoint a committee to review critically the published work on this topic and make recommendations for a national research agenda. A number of U. The final presentation addressed the need for cooperation and partnerships in implementing this research agenda. The government agencies involved have unique expertise and perspectives that can be brought to bear on the problem of climate change. Emphasis must be placed on public health intervention measures that are properly implemented and can mitigate the effect of global climate change on infectious disease incidence and geographic spread. Biological and physical signs of climate change: Bulletin of the American Meteorological Society ;

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Chapter 3 : Chapter 5: Vector-Borne Diseases | Climate and Health Assessment

Continued global warming poses new opportunities for the emergence and spread of fungal disease, as climate systems change at regional and global scales, and as animal and plant species move into new niches.

Page xi Share Cite Suggested Citation: The National Academies Press. The purpose of the Forum is to provide structured opportunities for leaders from government, academia, and industry to regularly meet and examine issues of shared concern regarding research, prevention, detection, and management of emerging, reemerging, and novel infectious diseases in humans, plants, and animals. In pursuing this task, the Forum provides a venue to foster the exchange of information and ideas, identify areas in need of greater attention, clarify policy issues by enhancing knowledge and identifying points of agreement, and inform decision makers about science and policy issues. The Forum seeks to illuminate issues rather than resolve them. For this reason, it does not provide advice or recommendations on any specific policy initiative pending before any agency or organization. Its value derives instead from the diversity of its membership and from the contributions that individual members make throughout the activities of the Forum. The Forum on Microbial Threats and the IOM wish to express their warmest appreciation to the individuals and organizations who gave their valuable time to provide information and advice to the Forum through their participation in the planning and execution of this workshop. A full list of presenters, and their biographical information, may be found in Appendixes B and F, respectively. The Forum is indebted to IOM staff who tirelessly contributed throughout the planning and execution of the workshop and the production of this workshop summary report. On behalf of the Forum, we gratefully acknowledge these efforts led by Dr. Eileen Choffnes, director of the Forum; Dr. We would also like to thank the following IOM staff and consultants for their valuable contributions to this activity: Finally, the Forum wishes to recognize the sponsors that supported this activity. Financial support for this project was provided by the U. Department of Health and Human Services: Department of Defense, Department of the Army: Department of Veterans Affairs; U. Department of Homeland Security; U. The views presented in this workshop summary report are those of the workshop participants and rapporteurs and are not necessarily those of the Forum on Microbial Threats or its sponsors. The responsibility for the published workshop summary rests with the workshop rapporteurs and the institution. Page xiii Share Cite Suggested Citation:

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Chapter 4 : Karina Yager | SoMAS

The health effects of climate change (including changes in climate variables and extreme weather events) on human infectious diseases are imposed through impacts on pathogens, hosts/vectors, and disease transmission.

Page xxii Share Cite Suggested Citation: Understanding the Contributions to Infectious Disease Emergence: The National Academies Press. The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. This project was supported by contracts between the National Academy of Sciences and the U. Department of Health and Human Services: Department of Defense, Department of the Army: Department of Veterans Affairs; U. Department of Homeland Security; U. Any opinions, findings, conclu- sions, or recommendations expressed in this publication are those of the author s and do not necessarily reflect the view of the organizations or agencies that provided support for this project. International Standard Book Number Copyright by the National Academy of Sciences. Printed in the United States of America The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The serpent adopted as a logotype by the Institute of Medicine is a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin. Data processing and analysis: This image was provided by Dr. IOM Institute of Medicine. Global climate change and extreme weather events: Willing is not enough; we must do. The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in , the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Cicerone is president of the National Academy of Sciences. The National Academy of Engineering was established in , under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Vest is president of the National Academy of Engineering. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Fineberg is president of the Institute of Medicine. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the Na- tional Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Vest are chair and vice chair, respectively, of the National Research Council. The responsibil- ity for the published workshop summary rests with the workshop rapporteur s and the institution. The responsibility for the content of the report rests with the authors and the institution. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evi- dence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report: The review of this report was overseen by Dr. Responsibility for the final content of this report rests entirely with the authoring committee and the institution. The purpose of the Forum is to provide structured opportunities for leaders from government, academia, and industry to meet and examine issues of shared concern regarding research, prevention, detection, and management of emerging or reemerging infectious diseases. In pursuing this task, the Forum provides a venue to foster the exchange of information and ideas, to identify areas in need of greater atten- tion, to clarify policy issues by enhancing knowledge and identifying points of agreement, and to inform decision makers about science and policy issues. The Forum seeks to illuminate issues rather than resolve them; for this reason, it does not provide advice or recommendations on any specific policy initiative pending before any agency or organization. Its value derives instead from the diversity of its membership and from the contributions that individual members make throughout the activities of the Forum. Germ theory and its applications to medicine and surgery. Read before the French Academy of Sciences, April 29, Taken from Scientific papers physiology, medicine, surgery, geology. Collier and Son [c]. The Harvard classics v. Modern History Sourcebook; http: As was pointed out in the report Under the Weather: Roman aristocrats retreated to hill resorts each summer to avoid malaria. South Asians learned early that, in high summer, strongly curried foods were less likely to cause diarrhea. PREFACE xiii The heating of the planet is also accelerating the hydrological cycle, increas- ing the likelihood of extreme weather events such as droughts, heavy precipi- tation, heat waves, hurricanes, typhoons, and cyclones. The projected health impacts of climate change and extreme weather events are predominately nega- tive, with the most severe impacts in low-income countries where the capacity to adapt is weakest. Developed countries are also vulnerable to the health effects of extreme temperatures, as was demonstrated in when tens of thousands of Europeans died as a result of record-setting summer heat waves. Through invited presentations and discussions, participants explored a range of topics related to climate change and infectious diseases, including the ecological and environmental contexts of climate and infectious diseases; direct and indirect influences of extreme weather events and climate change on infectious diseases; environmental trends and their influence on the emergence, reemergence, and movement of vector- and non-vector-borne infectious diseases; opportunities and challenges for the surveillance, prediction, and early detection of climate-related outbreaks of infectious diseases; and the international policy implications of the potentially far-reaching health impacts of climate change. A full list of presenters can be found in Appendix A. The Forum is indebted to the IOM staff who contributed during the course of the workshop and the production of this workshop summary. Global climate change and health: Canadian Medical Association Journal 4: Microbial threats to health: Special thanks to the following IOM staff and consultants for their valuable contributions to this activity: Finally, the Forum wishes to recognize the sponsors that supported this activ- ity. Financial support for this project was provided by the U. The views presented in this workshop summary report are those of the workshop participants and rapporteurs and are not neces- sarily those of the Forum on Microbial Threats or its sponsors. Relman, Chair Margaret A.

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Chapter 5 : How Climate Change Is Exacerbating the Spread of Disease

Diseases of Interest. Considering climate change and extreme weather events when analyzing the spread of disease is a fairly new idea. In one of the first papers to call attention to the potential connection, published in , author Alexander Leaf listed immune system depression, health care and sanitation deficiencies, pollution, population shifts, malnutrition, vector shifts, and.

Messenger Half a century ago concerns about climate change, environment vulnerability, population density and the sustainability of earth systems reached a broad audience. This was clear from books like the Silent Spring published in , and The Limits to Growth published 10 years later. These works influenced environmental activism at the time. They also laid the foundations for growing scientific evidence that climate change was happening and was negatively affecting the earth. But one piece of the puzzle has been missing: This changed at the beginning of this century with growing advocacy and gatherings such as the Conference of Parties and the publication of new research. Scientists began writing about the earth moving into a new era called the Anthropocene. This is an era in which ecosystems were increasingly being affected by human behaviour, and in which people were being affected by the changes brought about by their actions. The Anthropocene provided the impetus for renewed attention on health and sustainability for all species. This new understanding led to increasing new research, across disciplines, to new interdisciplinary journals, and to policy documents on the impact of climate change on health. Major new insights began to emerge. These included the fact that changes in weather patterns were affecting the behaviour of mosquitoes. This in turn was affecting our ability to control disease. For example, health scientists came to grasp that they need anthropologists, sociologists and economists for a full understanding of the impact of climate change. The circle of knowledge has, as a result, begun to expand. Parallel to these efforts, artists and advocacy groups have worked to keep climate change on international and national policy agendas. For example, artists have taken inspiration and drawn from scientific research in engineering, chemistry, biology, and the earth sciences to make their art. In a first of its kind on the African continent, these efforts are reflected at a day public and academic programme at the University of the Witwatersrand. The programme enmeshes art and science to provoke new thinking about water and how its politicisation affects public health. Insights from different disciplines Extreme weather events, shifts in temperature variation and precipitation, and higher mean temperatures have dramatically affected human health and well-being. From a health perspective, incremental environmental changes over time have undone decades of investment in the control of infectious diseases. Many of these are water-borne and water-washed diseases, such as dysentery and scabies. They are result of poor personal hygiene because of inadequate water availability. These diseases, common throughout Africa, are often described as neglected diseases of poverty. Scientists have started to explore the various affects in different settings in relation to different diseases. For example, changes in temperature and rainfall have, in turn, changed the behaviour of vectors such as mosquitoes , flies and snails , with other factors complicating the spread of disease for a summary, see. This means the settings that create the conditions for debilitating and potentially fatal diseases such as malaria, zika, and dengue have shifted. For example, mosquitoes have moved to new areas, introducing infection to previously unaffected people and certain animals. Anthropologists have used a different lens to understand the impact. Gender, class and age have also emerged as points of vulnerability for disease and poor health in the context of climate change. Climate change has, most notably, begun to affect weather patterns. Changes in precipitation and quantity, floods and droughts, and water insecurity are increasingly common as the planet warms. Scientists have begun to track how this affects food production and other farming activities. These changes are increasingly being followed not just by climate scientists, but also by academics from disciplines as wide-ranging as economics and politics. This follows the realisation that challenges of ageing infrastructure and water governance, for example, complicate finding solutions to overcoming the challenges posed by global warming. Creative interventions Scientists across disciplines â€" social, biological, and physical sciences as well as the humanities and arts â€" need to continue to work on ways to interrupt disease transmission in the context of global warming. They seek to identify appropriate interventions where climate change affects health â€" and to come up with creative solutions that cut across narrow paths of thinking. Artists and civil society have a key role to play by creating narrative, visual and acoustic forms to support advocacy on issues of climate change, pollution, the ecology and environmental justice.

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Chapter 6 : Climate change, water and the spread of diseases: connecting the dots differently

A number of diseases well known to be climate-sensitive, such as malaria, dengue fever, West Nile virus, cholera and Lyme disease, are expected to worsen as climate change results in higher temperatures and more extreme weather events.

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Like many aspects of climate change, the connection with infectious disease involves controversy. Some scientists argue that improved climate models may give a false impression that climate change is driving a spread in infectious diseases; others point to human activity and other factors as far more important determinants than climate. In one of the first papers to call attention to the potential connection, published in , author Alexander Leaf listed immune system depression, health care and sanitation deficiencies, pollution, population shifts, malnutrition, vector shifts, and contaminated water supplies as factors that could spur a rise in infectious diseases in a warming climate. If we can study what happens to disease in extreme weather events, it gives us a window into the future [where such extremes are expected to become more common]. Warmer winters and high-latitude warmingâ€"occurring twice as fast as overall warming 17 â€"are already contributing to shifts and expansions of vector ranges. But predicting how the interaction of factors will play out is not always straightforward. According to the World Health Organization WHO Scientific Working Group, dengue is the most rapidly spreading vectorborne disease in the world, with the average annual number of reported cases increasing by more than 7. It is clearly both, says Richard S. Water contamination from flooding can cause shortages of clean water that lead to the spread of diarrheal diseases such as cholera as well as enteric diseases such as typhoid. For example, contamination of crops with aflatoxinsâ€"potent mycotoxins produced by Aspergillus flavus fungi that can cause developmental and immune system suppression, cancer, and deathâ€"is linked both to increased rainfall and to drought. A Wakeup Call The U. WNV is a member of the genus Flavivirus relatives include the viruses responsible for yellow fever and malaria. In it caused a total of 1, human disease cases and 57 deaths; in years prior, the number of cases reached as high as 9, and the number of deaths reached As many as 38 states have developed or are developing climate change action plans, according to the Pew Center on Global Climate Change. State and local emergency preparedness and response personnel have been called in to respond to extreme weather situations, and sanitation and water inspectors have helped identify the effects of excessive rainfall, such as stormwater runoff and well contamination that fouls drinking water. Some states do have surveillance and monitoring programs to track types and locations of mosquitoes, some analyze the insects for emerging viruses, and many track the incidence of mosquito- and tickborne diseases. For example, mosquito control agencies in California test insects for WNV and other, potentially newly introduced arboviruses, and for newly introduced mosquito species that may be capable of transmitting pathogens for diseases not currently endemic such as dengue fever and chikungunya 32 , says Gilberto Chavez, deputy director of the Center for Infectious Diseases at the California Department of Public Health. Despite these effortsâ€"and despite the fact that California has the most aggressive climate change mitigation law in the countryâ€"there are no state-level adaptation discussions under way specifically concerning climate change and infectious disease, Chavez says. This situation is not at all unusual, according to George Luber, associate director for climate change at the CDC. The struggling economy and politics make it tough for public health officials to move proactively. It is very difficult to get funding for new initiatives in the current fiscal environment. The indicators provide consistent and standardized methods for comparing public health surveillance and environmental monitoring data across multiple states. They will help public health specialists begin to detect any emerging patterns that connect disease outbreaks with climate events, Luber says. Disentangling the complex relationship between climate change and infectious diseases will require collaborations involving epidemiologists, disease ecologists, climatologists, modelers, geographic information specialists, sociologists, economists, and policy experts, says Rita Colwell, Distinguished University Professor at the University of Maryland at College Park and at Johns Hopkins University Bloomberg School of Public Health. In small steps, this type of collaboration is beginning to take shape. Paxton, staff scientist and head of the APL Atmospheric and Ionospheric Remote Sensing Group, says he initiated GAIA in order to apply the principles of systems engineeringâ€"an interdisciplinary approach to managing each aspect of a large engineering project over its lifetimeâ€"to the impacts of climate change being seen around the world. Like Colwell, Paxton sees climate change as a diverse issue that is best served by interdisciplinary, collaborative efforts. In another step, two postdoctoral students just completed their first year of a CDC-sponsored program to cross-train recent public health graduates. The students have finished up one year at the National Center for Atmospheric Research in Boulder, Colorado, and will spend the next at the CDC studying climate changeâ€"related health effects; one student will focus on vectorborne diseases, Luber says. In order to begin a conversation between health practioners, climatologists, and meteorologistsâ€"so each group can become aware of the knowledge, skills, and needs of the otherâ€"in July the CDC and other agencies cosponsored a Colloquium on Climate and Health on vectorborne diseases. Over the past 2 years, the Harvard Center for Health and the Global Environment has held state-level courses on health and climate change in conjunction with the American Medical Association. Meanwhile, research on the connections between climate and infectious disease continues. Findings from this project should provide more clues about the spread of other vectorborne illnesses, which in turn can help health experts develop disease prevention and control tactics, Thomas says. References and Notes 1. The Fungus That Came to Canada. Kidd SE, et al. A rare genotype of Cryptococcus gattii caused the cryptococcosis outbreak on Vancouver Island British Columbia, Canada. Springer DJ, Chaturvedi V. 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Chapter 7 : Climate Change and Infectious Disease: Is the Future Here?

Climate change has, most notably, begun to affect weather patterns. Changes in precipitation and quantity, floods and droughts, and water insecurity are increasingly common as the planet warms.

The Centers for Disease Control fears that a worst case scenario could mean 1. Ebola can live in animals for years without making them sick; it is transmitted to humans through contact with an infected animal. Once in a human, the disease is spread by direct contact with the bodily fluids of the infected person, and as yet there is no vaccine. EU Humanitarian Aid and Civil Protection Some scientists think that climate change, with its increase in sudden and extreme weather events, plays a role in ebola outbreaks: When fruit is plentiful, bats the suspected carriers of the recent ebola outbreak and apes may gather together to eat, providing opportunities for the disease to jump between species. Humans can contract the disease by eating or handling an infected animal. According to Kris Murray, senior research scientist at EcoHealth Alliance , an organization that researches and educates about the relationships between wildlife, ecosystems and human health, climate change has strong potential to play a role in increasing the risk for ebola. Almost 50 percent of ebola outbreaks have been directly linked to bushmeat consumption and handling the origin of the current outbreak, however, has still not been determined. More and more wild animals, which may have carried diseases without effect for years, are coming into contact with humans, often because of deforestation. Deforestation in Sierra Leone. Guinea, where the ebola outbreak began, has lost 20 percent of its forests since The human activity that drives deforestationâ€"logging, mining, slash and burn agriculture, demand for firewood and road buildingâ€"means more and more people are entering the forest, and thus forcing animals like bats to find new habitats closer to human civilization. Fruit bats in Madagascar. Climate change will also affect infectious disease occurrence. Malaria killed , in alone. As temperatures warm, the Plasmodium parasite in the mosquito that causes malaria reproduces faster and the vector the organism that transmits a disease , i. Rain and humidity also provide favorable conditions for young mosquitoes to develop and adult mosquitoes to survive. Dengue fever infects about million people each year, and is one of the primary causes of illness and death in the tropics and subtropics. The IPCC projects that the rise in temperatures along with projected increases in population could put 5 to 6 billion people at risk of contracting dengue fever in the s. The reproductive, survival and biting rates of the Aedes aegypti mosquitoes that carry dengue and yellow fever are strongly influenced by temperature, precipitation and humidity. In the summer of , Aedes aegypti, usually found in Texas or the southeastern U. The hantavirus broke out in the southwest U. The precipitation allowed plants and animals to grow prolifically, which resulted in an explosion of the deer mice population. The mice may have carried hantavirus for years, but suddenly many more mice were coming into contact with humans. The deer mouse, a hantavirus carrier People became infected through contact with infected mice or their droppings. Hantavirus Pulmonary Syndrome has now been reported in 34 states. Through , cases were reported in the U. In , the West Nile virus, transmitted to humans by mosquitoes, made its first appearance in the Western Hemisphere in New York, after a drought followed by heavy rains. Since then, over 1, people have died of the disease. This month, the number of reported cases of West Nile virusâ€"1, including 87 deathsâ€" is the highest year-to-date total since it arrived in the U. A recent study suggests that in the future, higher temperatures and lower precipitation will lead to a higher probability of West Nile cases in humans, birds and mosquitoes. Extreme weather events can produce a cascade of other effects that influence disease. Heat and droughts create dry conditions, providing fuel for forest fires that end up fragmenting forests and driving wildlife closer to humans. Droughts and floods affect crop yield, sometimes resulting in malnutrition, which makes people more vulnerable to disease while forcing them to find other food sources. Flooding can provide breeding grounds for insects and cause water contamination, leading to the spread of diarrheal diseases like cholera. Moreover, extreme weather can disrupt the finely tuned relationships between predators and prey, and competitors that keep pathogen-carrying pests like mice and mosquitoes in check. It is making high-quality climate data more available to decision makers in

Africa, including those who are dealing with malaria. Some have shifted stocks of diagnostic tools and medicines out of reserves and made them more readily available, explained Thomson. If there are concerns about an impending epidemic, they can also use insecticide spraying. Even for global policy, the time frame is at maximum maybe 10 to 20 years. The shift to warmer temperatures in highland areas, however, is linked to the larger climate system. World Bank Photo collection Scientists recognize that climate is only one factor in the spread of disease. The good news, said Thomson, is that there is a shift in awareness at the global level about the need to understand how climate change is affecting disease, and it is filtering down to local levels.