Global Climate Change and Emerging Infectious Disease

Universidad Andres Bello

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Global climate change. Global climate variation has profoundly influenced humans from the dawn of civilization to the current day. However, only within the last 100 years or so, has human activity exerted a powerful influence that may drastically change the global climate. A report by the U.S. National Academy of Sciences in 2010 noted "…climate change is occurring, is caused largely by human activities, and poses significant risks for — and in many cases is already affecting a broad range of human and natural systems."

This course will discuss the science and data of climate change, the models used to predict likely future impacts of a changing climate, and uncertainties associated with those data and models. A special emphasis will be focused on the likely effects that global climate change will have on ecology, human and animal health, and the spread of disease.

Ecological impact of global climate change. The altered patterns of climate and weather that accompany global climate change can substantially alter the ecology and physiology of marine and terrestrial plant and animal life. Changes in CO_2 concentration causes stress on key ecosystems such as coral reefs. Global climate change can also alter drought, flooding, and other extreme weather conditions. Global warming is predicted to cause sea level rise, leading to coastal area flooding and erosion, loss of wetlands, and the penetration of seawater into important reservoirs of freshwater. These stresses could prompt widespread shifts in the natural habitats of animals and plants and make it difficult for organisms to survive in the regions they now inhabit. In addition to larger organisms, climate change also affects the microbes that determine the health and disease of animals, humans, and the environment. Understanding these processes will allow us to develop optimal mitigation strategies.

Climate change influences the emergence and spread of many infectious diseases. For example, changes in weather patterns can influence the population of rodents and other animal hosts that can spread disease to humans. Changes in rainfall can influence the availability of clean water and food supplies, thereby increasing the incidence of diseases transmitted via human and animal wastes. Changes in temperature and rainfall also influence the incidence of vector borne diseases, including diseases spread by mosquitoes such as malaria, dengue, and yellow fever.

Changes in temperature and rainfall can also have profound impact on agricultural practices and human demographics. Plants and animals that had been adapted for a particular environment may not thrive in a changed climate, resulting in shifts in agricultural practice. In addition, such changes can impact the food storage and shipping capability, thereby influencing the severity of regional famine and human demographics.

Approaches for studying the impact of environmental change. New molecular methods such as metagenomics coupled with computational analysis, are providing insights into the impact of environmental change on the distribution and transmission of pathogens in the environment, in domestic and wild animal populations (a major source of human disease), and in humans. Metagenomics provides a simple, exquisitely sensitive approach for sampling any environment for DNA signatures that describe the biology of that environment, and the impact of environmental disturbances.

In addition to new approaches for detecting pathogens, other new approaches allow the effective analysis of the environment. Geospacial modeling provides valuable insights into changes in weather patterns, algal blooms, and other large-scale phenomena that are perturbed by global climate change. Conversely, satellites have provided the ability to precisely pinpoint a sampling site by GPS from a mobile phone, and advances in mobile phone technology can be used to record many aspects of the environment and rapidly relay that information to other scientists. This provides abundant meta-data that allows insights into physical and chemical changes in the environment that can be coupled with ecological observations that describe the impact of these changes.

Most current approaches to intervention are primarily therapeutic responses to disease outbreaks, treating the disease after the fact. However, computational analysis of the regional patterns of disease transmission can be used to understand the factors that promote disease transmission. The correlation between certain climate conditions and disease can be used to develop mathematical models that predict when and where major epidemics are likely to occur, the severity of disease outbreaks, and provide insight into how we can develop upstream interventions.

Course Overview:

This international course will include lectures by the instructors and guest speakers from San Diego State University and the Universidad Andres Bello, directed readings from recent publications, and group discussions.

Daily schedule:

9:00	-	10:00	AM	Lecture
10:15	-	10:15	AM	Break
10:15	-	11:15	AM	Lecture
11:15	-	11:30	AM	Break
11:30	-	13:00	AM	Discuss papers

Topics:

Day 1:

Global Climate Change (Sweedler)

Basic science of climate change.
Global changes in average temperature
Effect of oceans on climate change
Difference between weather and climate: Global weather changes (rainfall, etc)
Seasonal variation and major weather events (El Niño, La Niña, etc)
What are the causes of global climate change: Greenhouse gases

Impact of Global Climate Change on the Health of Ecosystems (Maloy)

Microbes and climate change
Marine ecosystems [temperature, pH, salinity, sea level rise, runoff, etc]
Terrestrial ecosystems [water availability, temperature, CO_2]

Day 2:

Quantitative Assessment and Prediction of Climate Change (Sweedler)

How do we know?
Surface air temperature [data measured by thermometers since 1851]
Sea surface temperature [data since 1900]
Proxy temperature data [from last 1000 years]
Use climate models to project the future climate
How solid are the data?
Predicting the future: Climate models

Day 3:

Impact on Animal and Human Disease (Maloy)

Vector-borne diseases
Water and food-borne diseases
Zoonotic diseases

Impact on Plant Disease (Maloy)

Agriculture
- Temperature impacts on growing period
- Elevated CO_2 impact on plants
- Impact on pests
- Impact on plant disease
- New reservoirs of human pathogens

Food storage, shipment, and safety

Day 4:

Impact of Human Demographics (Sweedler

Population, energy use, and climate change
Economic development, and climate change
International travel

How should we respond? (Sweedler and Maloy)

Possible futures
Convergence of science, politics, and economics
Reduction of greenhouse gas emissions
Geoengineering
One Health: Development of upstream interventions

Day 5:

Controversy or confusion? (Maloy)

Why is it essential to inform the public about science?
Why do scientists often fail to convey their point when talking with the media?
How to successfully communicate complex ideas to the public and policy makers