Climate Change and Infectious Diseases

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Overview

• Overview of Climate Change
• Green house gases
• Mosquitoes
• Diseases (malaria, dengue fever, zika, chikungunya)
• NZ impact
• US impact
2016: The hottest year

SA drought not broken after driest year in history

The drought in South Africa is set to continue after the lowest rainfall year ever recorded, and amidst scientific predictions that there is no guarantee there will be sufficient rain during the coming season.

21 Feb 2017: Australia

Peak Land Surface Temperature (°C)

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India's extreme heat wave. Asphalt melting in New Delhi. 1,400 deaths

Karachi Heat Wave Pictures 2015: Death Toll Rises As Pakistan Recovers From Power Cuts [PHOTOS]

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3) “Calling CO2 a pollutant is doing a disservice the country, and I believe a disservice to the world.” Ex-Governor Rick Perry (R-TX), $977,624 from oil and gas for his 2012 Presidential Campaign.
Greenhouse gases

- Carbon dioxide (lasts thousands of yrs!)
- Oxides of nitrogen
- Methane
- Chlorinated hydrocarbons (CFCs)

- Fossil fuels (oil, coal, natural gas)
  - Energy generation accounts for approx. 25% GHGs
- Destruction of forests (15-20%), agriculture, industry and transportation

Methane

- U.S. Methane Emissions, By Source
- Cattle methane emissions

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CO2 levels

• Last 420,000 years = 180-280 ppm in troposphere
  • Vostok ice core Antarctica
  • Measure of 400,000 years
• Now: 360 ppm!!

Weather Extremes

• Warming of land surface intensifies monsoons
  • Associated with mosquito and water borne diseases in Bangladesh and India
• Flooding
  •Increases in mosquito breeding sites
  • Water borne diseases eg cryptosporidium
  • Increase in algal blooms (bad for birds, fish and mammals)
The Costs of Climate Change

• Present day
  • $1.2 trillion/year
  • 1.6% global GDP

• By 2030
  • 3.2% global GDP
  • Poorest countries = 11% GDP

Estimated deaths

• Between 2030-2050: increased 250,000 deaths/yr
• Malnutrition, malaria, diarrhea, heat stress
• Low – middle income countries most affected
  • Food and water insecurity
  • Population displacement
  • Increased diseases-vector borne, diarrheal, respiratory
Climate in Numbers

• **1.1°C** global warming
• **2.0°C** maximum warming Paris Climate Deal (Dec 2015)
• **2020** when annual emissions must peak for us to hit only 2°C
• **3.6°C** likely warming on current government pledges

New Diseases since 1975

• WHO reports > 30 new diseases
• HIV
• Ebola
• Lyme disease
• Legionnaires disease
• Toxic E coli
• Hanta virus
Resurgence of old diseases

- Malaria
- Cholera

Mosquito Borne Diseases

- Protozoa eg malaria
- Viral eg dengue, chikungunya, zika, yellow fever
- Nematode eg filariasis
Malaria and climate change

- Warmer temps increase mosquito reproduction and biting
- Anopheles survives in temps > 16°C
- Increase rate of pathogen maturation
  - 20°C: Falciparum takes 26 days to incubate
  - 25°C: takes 13 days
- Anopheles survive for approx. 3 weeks -> parasites mature quicker, transferred to host

Mosquito life cycle

Mosquitoes undergo complete metamorphosis (egg → larva → pupa → adult)
Anophelene mosquito

Spread of Anopheles

- Anopheles in N America
  - 1980s: transmission only in California
  - 1990s: new outbreaks in Texas, Florida, New York, Toronto

- Anopheles elsewhere causing malaria
  - S Korea, southern Europe, S Africa
  - Highland urban areas eg Nairobi
  - Rural highland areas eg PNG

- Not in NZ...yet!

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Impact of malaria

• Today: 50% world’s population exposed
• Impact of doubling of CO2: 60% exposed

• Other factors
  • Land clearing
  • Population movement
  • Drug and pesticide resistance

Dengue Fever and Yellow fever

• Aedes aegypti mosquito survives > 10°C
• Freezing kills
• Warmer winters and warmer nights -> greater survival
• Aedes limited by temp to 1,000m in elevation
• Now found at 1,100m in Mexico and 2,200m in Colombian Andes
Aedes aegypti and albopictus

- Eggs withstand dessication (drying) for months
- Very difficult to eradicate
- Survive without water for several months
- Hatch once exposed to water-rainfall in wet season
- Humans provide great breeding sites

• A aegypti in Australia
• A albopictus-Australia free….but has been detected at airports, ie Sydney!!
• Aedes not in NZ...yet
Dengue Fever

- **Most common** arthropod borne viral diseases worldwide
- Endemic in > 100 countries
  - Africa, eastern Mediterranean, Americas, Asia, western Pacific, **northern Australia**
- Main vectors Aedes widely spread in Asia and Pacific
- In last 50 years estimated 30 fold increase in DF cases!
- 100 million clinically apparent cases/ year
- Mortality 25,000/year
Dengue haemorrhagic fever

- Epidemics DHF
- Causes deaths, usually kids
- Supportive care
- Epidemics of DF in Pacific in 1970s, associated with epidemics of DHF
Dengue in northern Queensland

- Outbreaks in Townsville and above since 1990s
- Some deaths
- Research into prevention of dengue
  - Vaccination trials
  - Infecting mosquitoes with Wolbachia bacteria

Zika Virus: Re-emerging Disease

- 1st picked up during Dengue surveillance in Uganda 1947
- Later spread to India and SE Asia
- Subsequent outbreaks
  - Yap Is (Pacific) 2007
  - French Polynesia 2013
  - Brazil 2015
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World Map of Areas with Risk of Zika

Domestic areas
State Reporting Zika: 
No Known Zika:

International areas
Zika Travel Recommendation:
Low elevation
High elevation
No Known Zika:

Yap Is

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Zika transmission

• Via Aedes mosquitoes
• Modes of transmission
  • Sex, even if asymptomatic at time-virus persists in semen for months
  • Blood transfusion (Brazil)
  • To fetus in pregnancy
• Not transmitted via breast feeding
• Australia 2016: approx. 100 cases
• New Zealand: reported person to person/sexual transmission

Symptoms

• Usually mild illness
• ¾ cases asymptomatic
• Several days to a week
• Viraemia for 1 week
• Similar symptoms to dengue and chikungunya
Complications of Zika

- Guillain-Barre syndrome
- Congenital Zika Syndrome
Congenital Zika

- Microcephaly
- Virus crosses blood brain barrier during 1st trimester
- Decreases normal replication of neurons and astroglial cells
- Small no. get abnormal limb development (arthrogryposis)

Chikungunya: Re-emerging disease

- 1952- 1st identified virus
- Outbreaks in southern Tanzania, Makonde plateau
- Derived from Makonde or Swahili word = “that which bends up”
Chikungunya: Re-emerging disease

- Virus, circulates between mosquitoes and non-human primates
- Aedes aegypti and albopictus
- Thought to have originated in Africa
- 1954: 1st reported in Philippines
- Before 2000: occasional outbreaks in Africa
- Since 2000: increasing outbreaks
- Spread to Asia via shipping

Subsequent Outbreaks

- 2004: epidemic in Kenya
- 2005-2006: outbreak in India
- Oct 2013: in Saint Martin Island (Asian genotype)
- Then transmission throughout Caribbean
- Since Aug 2016: spread to Americas
  - > 1 million suspected cases
St Martin Is and Caribbean

Chikungunya Distribution

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Symptoms

- Usually self-limiting 7-10 days
- Severe joint pain/swelling—any joints, especially small joints
- Myalgias
- Fever
- Rash (up to 90%)
- Some get prolonged disability—joint symptoms for 3 years!

Arthritis and rash
Complications

- Outbreaks in last 15 years seem to be associated with more severe disease
- Myocarditis
- Fulminant hepatitis
- Encephalitis—seizures and paralysis
- Fetal transmission
  - Baby gets encephalopathy
  - Microcephaly
  - Cerebral palsy
- Deaths < 1/1000

Treatment

- Supportive care
- No specific treatment
- No vaccine
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Guidelines for Travellers

- Cover up
- Insect repellents-containing DEET, picaridin, oil of lemon eucalyptus (OLE), and others
  - Safe if pregnant
  - Most can use on kids > 2 months old
  - OLE Not kids < 3 years old
  - Take enough for trip!
- Permethrin treated clothing and gear
- Mosquito net (especially if outdoors)
- Screened rooms or air conditioning if possible

New Zealand Impact?

- Increased extreme weather events
- June 2015: flooding south Dunedin
- 2017: Edgecumbe floods
- 2017: Christchurch fires

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NZ Impact: extreme temperatures

- Above 25°C for 20-40 days/year
- 2100: With warming predicted to increase to 80 days

- Heat related death rate when Temp > 20°C = 14 (ages over 65 yrs)
- Predicted death rate with increase by 1°C = 28

NZ Impact: Marine

- Increased algal blooms (cyanobacteria)
- Toxins
- Effect on human health-contact or ingestion
- Effect on commercial fishing and marine habitat
- 1998: warm water, algal blooms along east coast
NZ Impact: Fresh Water

- Microbial contamination
- Salmonella and E coli in streams
- Leptospirosis
- Norovirus
- Contamination of groundwater wells
- Aug 2016: Campylobacter outbreak Havelock North

Emergence of new diseases in North America

- Hanta virus
- West Nile Virus

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Hanta Pulmonary Syndrome (HPS)

- Decreased predators (owls, eagles, falcons, hawks etc), coyotes, snakes
- Increased rodent population
- 1993: intense rains-increase food for rodents (grasshoppers and pinon nuts)
- Emergence of rodent borne HPS

- Now in Latin America

West Nile Virus (WNV) transmission

In nature, West Nile virus cycles between mosquitoes (especially Culex species) and birds. Some infected birds, can develop high levels of the virus in their bloodstream and mosquitoes can become infected by biting these infected birds. After about a week, infected mosquitoes can pass the virus to more birds when they bite.

Mosquitoes with West Nile virus also bite and infect people, horses and other mammals. However, humans, horses and other mammals are ‘dead end’ hosts. This means that they do not develop high levels of virus in their bloodstream, and cannot pass the virus on to other biting mosquitoes.
West Nile Virus

• Sept 1999: small outbreak in New York city
• Warmer winters, followed by summer drought
• Increased cycling of WNV among birds, mossies-Culex pipiens (urban)
• Encephalitis in humans
• Mortality in birds

Take Home messages

• Interplay between climate, environmental changes, population of humans and our impact on environment
• Increasing outbreaks of serious illness across globe
  • Malaria
  • Arthropod borne disease-dengue, zika, chikungunya
• Limited or no treatment for some illnesses
• New Zealand not immune
• Need to act urgently
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