Climate Change and Health

Training Modules

World Health Organization
Western Pacific Region

World Health Organization
Regional Office for South-East Asia

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

SEA/EH/585

Climate Change and Health

Training Modules

Printed in India

Contents

Acronyms

The following is a list of acronyms from the health and climate change field:

ACS	American Cancer Society
AIDS	Acquired Immunodeficiency Syndrome
APF	Adaptation Policy Framework
AVHRR	Advanced Very High Resolution Radiometer
AWG-LCA	Ad Hoc Working Group on Long-Term Cooperative Action
BoD	Burden of disease
BSE	Bovine Spongiform Encephalopathy
BTV	Bluetongue virus
CBD	Convention on Biological Diversity
CC	Climate change
CDC	Centers for Disease Control and Prevention
CDM	Clean Development Mechanism
CER	Certified emission reduction
CH4	Methane
CIESIN	Center for International Earth Science Information Network
CO	Carbon monoxide
CO2	Carbon dioxide
COP	Conference of Parties
COSMIC	Country Specific Model for Intertemporal Climate - Computer Software
CVD	Cardiovascular disease
DALY	Disability adjusted life year
DHF	Dengue hemorrhagic fever
ENSO	El Nino-Southern Oscillation
ESM	Earth System Model
FAO	Food and Agricultural Organization
GBD	Global burden of disease
GCM	General Circulation Model
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIS	Geographic Information System
GLOF	Glacial lake outburst flood
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
HPAI	Highly pathogenic avian influenza
ICD-10	International Classification of Diseases – 10th Edition

ICESCR	International Covenant on Economic, Social and Cultural Rights
ICIMOD	International Centre for Integrated Mountain Development
IFPRI	International Food Policy Research Institute
IFRC	International Federation of the Red Cross
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
JE	Japanese encephalitis
LAP	Length of growing period
MARA/ARMA	Mapping malarial risk in Africa
MDGs	Millennium Development Goals
MEA	Multilateral environmental agreement
MIASMA	Modeling Framework for the Health Impact Assessment of Man-Induced Atmospheric Changes
MPH	Miles per hour
NAO	North Atlantic Oscillation
NAPA	National Adaptation Program of Action
NCAR	National Center for Atmospheric Research
NCD	Noncommunicable disease
NDVI	Normalized Difference Vegetative Index
NO2	Nitrogen dioxide
NOx	Nitrous oxides
NWP	Nairobi Work Program
NYC	New York City
O2	Oxygen
O3	Ozone
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
PAR	Population at risk
Pb	Lead
PDSI	Palmer Drought Severity Index
PM	Particulate matter
ppb	Parts-per-billion
ppm	Parts-per-million
PTSD	Post-Traumatic Stress Disorder
RVF	Rift Valley Fever
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SEA	South-East Asia
SEARO	South-East Asia Regional Office
SIDS	Small island developing states
SO2	Sulfur dioxide

SOI	Southern Oscillation Index
SRES	Standardized Reference Emission Scenarios
SST	Sea surface temperature
UKMO	United Kingdom Meteorological Office
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-OHCHR	United Nations Office of the High Commissioner for Human Rights
UVR	Ultraviolet radiation
VBD	Vector-borne disease
VBZ	Vector-borne zoonose
VOC	Volatile organic compound
WHA	World Health Assembly
WHD	World Health Day
WHO	World Health Organization
WMO	World Meteorological Organization
WNV	West Nile Virus
YLL	Years of life lost

Bibliography

Module 1: Introduction to weather, climate and climate change

- TeddyTV for NRK. 2012. *Walk the Dog*. https://youtube.com/watch?v=e0vj-0imOLw.
- Climate Reality Project. 2011. *Climate 101 with Bill Nye*. https://www.youtube.com/watch?v=3v-w8Cyfoq8.
- Arctic Climate Impact Assessment. 2008. http://www.acia.uaf.edu/.
- Alley, RB. 2000. *The Two Mile Time Machine*.
- Climate Central. 2014. http://www.climatecentral.org/
- Stott PA et al. 2010. *Detection and attribution of climate change: a regional perspective*. WIREs Climate Change; 1:192-211.
- IPCC. 2013. http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.
- Yusuf and Fransico. 2009. *Climate Change Vulnerability Mapping for Southeast Asia*
- IPCC. 2014. Working Group II Assessment Report 5. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers*. http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf
- McIver et al. (unpublished)
- Ebi, KL. 2009. *Public health responses to the risks of climate variability and change in the United States*. Journal of Occupational and Environmental Medicine 2009; 51:4-12
- Government of Tokelau. 2014. http://tokelau.org.nz/Tokelau+Government/Government+Departments/Department+of+Economic+Development+Natural+Resources++Environment.html.

Module 2: Population health and climate change

- IPCC. 2007. *Assessment Report 4*.
- IPCC. 2013. *Assessment Report 5. Chapter 11 - Human Health*.
- WMO/WHO. 2012. *Atlas of Health and Climate*.
- IPCC. 2013. *Assessment Report 5, Asia Report*.
- Bhattacharya et al. 2006. Climate change and malaria in India

- Hales et al. 2002. *Potential effect of population and climate changes on global distribution of dengue fever: an empirical model.*
- World Health Organization. 2008. *Public Health Information and Geographical Information Systems*.
- McMichael et al. 2012. *An Ill Wind? Climate Change, Migration, and Health*
- McMichael et al. 2003. McMichael et al. 2003. . *Climate change and human health: Risks and responses.*
- *BMJ 2008;336:191, McMichael, Global environmental change and health: impacts, inequalities, and the health sector*
- G. Albrecht. 2005. *Solastalgia, a new concept in human health and identity*, Philosophy Activism Nature 3:41-44.

Module 3: Policy and practice of mitigation and adaptation – Relevance for health

- Climate Council. 2014. *Really. Important. Science. Announcement* video. https://www.youtube.com/watch?feature=player_embedded&v=HOD52WeFVms.
- Renew Economy. 2014. http://reneweconomy.com.au/2014/history-carbon-dioxide-emissions-83588.
- IPCC. Year unknown. https://player.vimeo.com/video/89725715.
- United Nations Foundation. 2014. *UN Climate Solutions Report in Numbers*. http://www.climasphere.org/
- Climate Commission. 2012. *The Critical Decade*.
- Lee, Shiroma, Lobelo, Puska, Blair, and Katzmarzyk. 2012. *Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy*. The Lancet 21 July 2012 (Volume 380 Issue 9838 Pages 219-229.
- UK Climate Impacts Program. 2006. *Risk management: UK Climate Program*.
- IPCC. 2014. *Climate Change 2014: Fifth Assessment Report*.
- Hii et al. (2012) Forecast of dengue incidence using temperature and rainfall.
- WMO/WHO. 2012. *Atlas of Health and Climate*.

Module 4: Assessment and prediction of the health impacts of climate change

- Allen BJ, 2002. *Birthweight and environment at Tari. PNG Med J 2002;45(1-2):88-98*
- Hashizume et al. (2010) : *Hashizume M, Faruque AS, Wagatsuma Y, Hayashi T, Armstrong B. Cholera in Bangladesh: climatic components of seasonal variation. Epidemiology. 2010 Sep;21(5):706-10. doi: 10.1097/EDE.0b013e3181e5b053*.
- Hales, Weinstein, Woodward (1996)*: Dengue fever epidemics in the South Pacific: driven by El Nino Southern Oscillation? Lancet 1996;348(9042):1664-1665*

- Hales et al. 6 August 2002. Lancet (online). http://image.thelancet.com/extras/01art11175web.pdf.
- Cheong, HK. 2015. (*These figures were drawn by Cheong based on the climate data from Korea Meteorological Agency and daily mortality data from Statistics Korea*)
- Friel et al. 2011. *Friel S, Bowen K, Campbell-Lendrum D, Frumkin H, McMichael AJ, Rasanathan K. Climate Change, Noncommunicable Diseases, and Development: The Relationships and Common Policy Opportunities. Annu Rev Public Health 2010;32: 133-147.*
- IPCC 5th assessment report , 2013
- Woodruff et al. 2005. Climate change health impacts by 2100.
- Caminade et al. 2014. *Impact of climate change on global malaria distribution. Proc Natl Acad Sci U S A. 2014;111(9):3286-91. doi: 10.1073/pnas.1302089111.*

Module 5: Thermal extremes

- IPCC. 2007.*Technical Summary. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*
- International Federation of Red Cross and Red Crescent Societies. 2003. *Indian heat wave claims almost 2,000 lives.* ReliefWeb. http://reliefweb.int/report/bangladesh/indian-heat-wave-claims-almost-2000-lives.
- IPCC SREX. 2012. *Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*
- Li et al. 2014. *Association between high temperature and mortality in metropolitan areas of four cities in various climate zones in China: a time series*. Environmental Health 2014; 13:65. http://www.ehjournal.net/content/13/1/65.
- EM-DAT - Emergency Disaster Database 2008. *The International Disaster Database.* http://www.emdat.be/
- Guo et al. 2012. *Effects of temperature on mortality in Chiang Mai city, Thailand: a time series study*. Environmental Health 2012; 11:36. http://www.ehjournal.net/content/11/1/36.
- US EPA. 2006. *US EPA 2006. Excessive Heat Events Guidebook*.
- http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf
- NASA. 2008. *Southern Asia Heat*, http://earthobservatory.nasa.gov/IOTD/view.php?id=5603
- NASA 2008. *Heat wave in southern India*
- http://earthobservatory.nasa.gov/IOTD/view.php?id=3522&eocn=image&eoci=related_image

- Kalkstein, L. 2002. Personal communication with the author.
- Diffenbaugh, NS and Giorgi, F. 2012. *Climate change hotspots in the CMIP5 global climate model ensemble*. Climatic Change 2012. DOI 10.1007/s10584-012-0570-x.
- Murari et al. 2014. *Intensification of future severe heat waves in India and their effect on heat stress and mortality*. Reg Environ Change 2014. DOI 10.1007/s10113-014-0660-6.
- Dunne et al. 2013. *Reductions in labor capacity from heat stress under climate warming*. Nature Climate Change 2013; 3:563-566. DOI: 10.1038/NCLIMATE1827.

Module 6: Extreme weather

- Munchener Ruckversicherungs-Gesellschaft. 2014. *2013 Natural Catastrophe Year in Review*
- Centre for Research on the Epidemiology of Disasters. 2012. EM-DAT database.
- IPCC. 2012. *Special Report on Extreme Events*.
- Centre for Research on the Epidemiology of Disasters. 2012. EM-DAT database.
- Cash et al. 2013. *Reducing the health effect of natural hazards in Bangladesh*
- Doocy et al. 2013. *The Human Impact of Tropical Cyclones: a Historical Review of Events 1980-*
- *2009 and Systematic Literature Review*
- WHO. 1996. *Climate Change and Human Health, A.J. McMichael et al., eds. Figure 7.3, p. 155.*

Module 7: Vector-borne diseases and climate change

- Hill, C.A., F.C. Kafatos, S.K. Stansfield, and F.H. Collins. 2005 Arthropod-borne diseases: Vector control in the genomics era. *Nature Reviews Microbiology* 3:262−268.
- Greer, A., V. Ng, and D. Fisman. 2008. Climate change and infectious diseases in North America: The road ahead. *CMAJ* 178(6):715722.
- Gubler, D.J., P. Reiter, K.L. Ebi, W. Yap, R. Nasci, and J.A. Patz. 2001. Climate variability and change in the United States: Potential impacts on vector- and rodent-borne diseases. *Environmental Health Perspectives* 109(Supplement 2):223-233.
- Ogden N.H., M. Bigras-Poulin, C.J. O'Callaghan, I.K. Barker, L.R. Lindsay, A. Maarouf, K.E. Smoyer-Tomic, D. Walter-Toews, and D. Charron. 2005. A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick *Ixodes scapularis*. *International Journal for Parasitology* 35:375-389.

- Vail, S.G. and G. Smith. 1998. Air temperature and relative humidity effects on behavioral activity of blacklegged tick (Acari: Ixodidae) nymphs in New Jersey. *Journal of Medical Entomology* 35(6):1025-1028.
- Rogers, D.J. and S.E. Randolph. 2003. Studying the global distribution of infectious diseases using GIS and RS. *Nature Reviews Microbiology* 1(3):231-237.
- IPCC. 2014. *Assessment 5 Report*.
- Kenya Division of Malaria Control. 2009. Malaria Background Info. Available: http://www.nmcp.or.ke/section.asp?ID=3
- Yang G.J., P. Vounatsou, X.N. Zhou, M. Tanner, and J. Utzinger. 2005. A potential impact of climate change and water resource development on the transmission of *Schistosoma japonicum* in China. *Parassitologia* 47:127-134
- WHO, 2014. World Malaria Report 2014
- Macdonald, G. 1957. *The Epidemiology and Control of Malaria*. Oxford University Press, London, UK.
- Khasnis, A.A. and M.D. Nettleman. 2005. Global warming and infectious disease. *Archives of Medical Research* 36:689−696.
- Patz, J.A. and S.H. Olson. 2006. Malaria risk and temperature: Influences from global climate change and local land use practices. *PNAS* 103(15):5635-5636.
- Haines A. and J.A. Patz. 2004. Health effects of climate change. *JAMA* 291(1):99−103.
- Yang et al. Malaria Journal 2012 , *Malaria surveillance-response strategies in different transmission zones of the People's Republic of China: preparing for climate change*
- Hugo Ahlenius, UNEP/GRID-Arendal. 2005. From collection of Environment and Poverty Times #4: MDG issue
- Vezzani D., S.M. Velazquez, and N. Schweigmann. 2004. Seasonal pattern of abundance of *Aedes aegypti* (Diptera: Culicidae) in Buenos Aires city, Argentina. *Memoria do Instituto Oswaldo Cruz* 99:351-356.
- Watts, D.M., D.S. Burke, B.A. Harrison, R.E. Whitmire, and A. Nisalak. 1987. Effect of temperature on the vector efficiency of *Aedes aegypti* for Dengue 2 virus. *The American Journal of Tropical Medicine and Hygiene* 36(1):143-152
- Patz, J.A. and S.H. Olson. 2006. Malaria risk and temperature: Influences from global climate change and local land use practices. *PNAS* 103(15):5635-5636.
- Patz, J.A., W.J. Martens, D.A. Focks, and T.H. Jetten. 1998. Dengue fever epidemic potential as projected by general circulation models of global climate change. *Environmental Health Perspectives* 106:147-153.
- Hales S., P. Weinstein, Y. Souares, and A. Woodward. 1999. El Nino and the dynamics of vectorborne disease transmission. *Environmental Health Perspectives* 107(2):99−102.

- Mathuros Tipayamongkholgul, Chi-Tai Fang, Suratsawadee Klinchan, Chung-Ming Liu, and Chwan-Chuen King, 2009. Effects of the El Niño-Southern Oscillation on dengue epidemics in Thailand, 1996-2005
- Kuno G. 1995. Review of the factors modulating Dengue transmission. *Epidemiologic Reviews* 17(2):321−335.

Module 8: Water-borne diseases and climate change

- Prüss-Üstün et al. 2008. *Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, p.7.*
- IPCC. 2007. *IPCC fourth assessment report, Working Group II: Impacts, Adaptation and Vulnerability*
- World Health Organization, 2009. *Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, 2008, p.11.*
- Mead et al. 1999. *Food-related illness and death in the United States. Emerg Infect Dis 5(5):607–625*
- IPCC AR5 (2014)
- Kovats and Lloyd, WHO. 2014. *Drawn from Table 4.7, Kovats S, Lloyd S. Diarrhoeal disease In: Hales S, Kovats S, Lloyd S, Campbell-Lendrum D, eds. Quantitative risk assessment of the effects of climate change on selected causes of deaths. 2030s and 2050s. World Health Organiozation, 2014, p. 48.*
- Patel et al. 2013. *Global seasonality of rotavirus disease. Pediatr Infect Dis J 2013;32(4):e134-e147.*
- Kovats et al. 2004. *The effect of temperature on food poisoning: a time-series analysis of salmonellosis in ten European countries. Epidemiol Infect. 2004 Jun; 132(3): 443–453.*
- Hall et al. 2002. *Foodborne disease in the new millennium: out of the frying pan and into the fire? Med J Aust 2002; 177 (11): 614-618.*
- Singh RB et al. 2001. *The influence of climate variation and change on diarrheal disease in the Pacific Islands. Environ Health Perspect. 109(2): 155–159.*
- Kim H et al. Climate change and health adaptation strategy in Lao PDR: final report. World Health Organization Western Pacific Regional Office, 2011
- Bennett et al. 2012 Drawn based on the table 4 of Bennett A et al. Effects of the 1997–1998 El Niño Episode on Community Rates of Diarrhea. Am J Public Health. 2012 July; 102(7): e63–e69.
- Curriero FC et al. 2001. *The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994. Am J Public Health. 2001 Aug;91(8):1194-9.*
- Auld et al. 2004. Auld H et al, 2004. *Heavy rainfall and waterborne disease outbreaks: the Walkerton example. J Toxicol Environ Health A. 67(20-22):1879-87.*

- Howard KWF, 2004. Microbial pollution of groundwater in the town of Walkerton, Canada. In: Tellam JH et al. eds. Urban Groundwater management and sustainability. IV Earth and Environmental Sciences Vol 74. NATO Science Series. Dordrecht; Springer
- Das P et al. 2006. *Molecular characterization of Cryptosporidium spp. from children in Kolkata, India. J Clin Microbiol. 44(11):4246-9*
- CRCWQT. 2005. Drought and Water Quality: Background Paper for Workshop, 2nd August 2005 – Brisbane. Report No. DC05119. July. Cooperative Research Centre for Water Quality and Treatment
- Hallegatte et al. 2013. Future flood losses in major coastal cities. Nature Climate Change 2013;3:802-806.
- Lobitz B et al. 2000. *Climate and infectious disease: Use of remote sensing for detection of Vibrio cholerae by indirect measurement. PNAS 2000;97(4):1438-1443.*
- ICIMOD. 2009. *Climate change and its impacts on glaciers and water resource management in the Himalayan Region*
- Gosain AK et al. 2006. Climate change impact assessment on hydrology of Indian river basins

Module 9: Food security and malnutrition

- FAO. 2002 http://www.fao.org/economic/ess/ess-fs/en/
- Black et al. 2008. Maternal and child under nutrition: global and regional exposures and health consequences. Lancet. 2008 Jan 19;371(9608):243-60)
- Onis et al. 2010. Prevalence and trends of stunting among pre-school children, 1990–2020. Public Health Nutrition
- Von Braun. 2008 'High Food Prices: The What, Who and How of Proposed Policy Actions', Washington DC, International Food Policy Research Institute (IFPRI), Policy Brief, http://www.ifpri.org/pubs/ib/foodprices.asp.
- FAO. 2014. Food price and crop yield data from FAO (http://www.fao.org/worldfoodsituation/foodpricesindex and http://faostat.fao.org/) and oil price data from US Department of Energy (EIA). 2014. http://www.eia.gov.
- International Food Policy Research Institute*, website 2014. available from: http://www.ifpri.org/tools/2014-ghi-map*
- FAO. 2002. The State of Food Insecurity in the World 2002
- FAO. 2008. The State of Food Insecurity in the World 2008
- Battisti and Naylor. 2009. Historical warnings of future food insecurity with unprecedented seasonal heat. Science. 2009 Jan 9;323(5911):240-4.
- Naylor R 2005. Losing the Links Between Livestock and Land;

- Gerber, P., Wassenaar, T., Rosales, M., Castel, V. & Steinfeld, H. 2007. Environmental impacts of a changing livestock production: overview and discussion for a comparative
- assessment with other food production sectors
- Fischer G et al. 2005. Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990-2080
- Tubiello, F.N. and G. Fischer. 2007. Reducing climate change impacts on agriculture: Global and regional effects of mitigation, 2000–2080. *Technological Forecasting & Social Change*. 74:1030–1056.
- Fischer, G., M. Shah, H.V. Velthuizen, and F.O. Nachtergaele. 2001. Global Agro-ecological Assessment for Agriculture in the 21st Century. International Institute of Applied Systems Analysis.
- Bell et al. 2013. *Mixed responses of tropical Pacific fisheries and aquaculture to climate change*. Nature Climate Change 2013; 3:591-599.
- IPCC. 2014. Fifth Assessment Report.
- FAO. 2006. *World Agriculture: Towards 2030/2050.* Interim Report, June. Available: http://www.fao.org/ES/esd/AT2050web.pdf.
- McMichael et al. 2008. Food, agriculture, energy, climate change and health. *The Lancet* 370:1253−1263

Module 10: Air quality

- Queensland Government Environmental Protection Agency, 2013. https://www.qld.gov.au/environment/pollution/monitoring/air-pollution/ozone/
- Gillett et al. 2004. *Detecting the effect of climate change on Canadian forest fires*. Geophysical Research Letters 31, L18211, doi:10.1029/2004GL020876.
- Clean Air Initiative for Asian Cities (CAI-Asia) Center. 2010. *Air Quality in Asia: Status and Trends*, 2010 Edition. Pasig City, Philippines.
- WHO Climate Change and Human Health Atlas. 2012. http://who.int/globalchange/publications/atlas/en/
- Climate Central. 2014. http://www.climatecentral.org/.
- Air Better. 2014. http://www.airbetter.org/wp-content/uploads/2014/10/Pollution_effects-620x597.jpg.
- UCLA Institute of the Environment & Sustainability. 2008. http://www.environment.ucla.edu/reportcard/article1700.html.
- Lim et al. 2012. *A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010*. Lancet; December 15:380(9859): 2224–2260. doi:10.1016/S0140-6736(12)61766-8.

- WHO. 2014. http://www.who.int/phe/health_topics/outdoorair/databases/en/
- WHO. 2012. Climate Change and Human Health Atlas 2012. http://www.who.int/globalchange/publications/atlas/en/.
- Fang et al. 2013. *Impacts of 21st century climate change on global air pollution-related premature mortality*. Climatic Change 121:239–253. DOI 10.1007/s10584-013-0847-82013.
- WHO. 2008. http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/.
- WHO. 2014. http://www.who.int/mediacentre/factsheets/fs313/en/.
- West et al. 2013. *Co-bene ts of mitigating global greenhouse gas emissions for future air quality and human health*. Nature Climate Change;3; DOI: 10.1038/NCLIMATE2009.

Module 11: Assessing health vulnerability

- IPCC. 2013. Fifth Assessment Report, Chapter 11.
- Germanwatch 2014. Global Climate Risk Index 2014**.** Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012
- IPCC. 2013. Fifth Assessment Report.
- Woodward, A.J., S. Hales, and P. Weinstein. 1998. Climate change and human health in the Asia-Pacific region: Who will be most vulnerable? *Climate Research* 11:31-38.
- Fukuma, Y. 1993. Objective evaluation of preparedness against typhoon, by typhoon classification. *Journal of Meteorological Research* 45:159–196.
- KNMI. 2009. Effects of El Nino on world weather. Available: http://www.knmi.nl/research/global_climate/enso/effects/
- WHO. 2014. *WHO guidance to protect health from climate change through health adaptation planning*.
- http://www.who.int/globalchange/publications/guidance-health-adaptation-planning/en/.
- WHO. 2014. *Operational framework for building climate-resilient health systems*.

Module 12: Adaptation to climate change

- WHO. 2014. *Protecting Health from Climate Change: Vulnerability and Adaptation Assessments*.
- IPCC. 2013. *Fifth Assessment Report, Chapter 11*.
- UK Climate Impacts Programme. 2006. UKCIP Experience: NCSP Workshop on Vulnerability and Adaptation Assessment under the Second NatioNational Communications Meeting.

- WHO. 2013 Protecting Health from Climate Change: Vulnerability and Adaptation Assessments. http://www.who.int/globalchange/publications/Final_Climate_Change.pdf. Slide 17
- McMichael A.J., D. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga, and A. Woodward (eds.). 2003a. Climate change and human health: Risks and responses. WHO/WMO/UNEP.
- WHO. 2015 *Case Study: Climate Resilient Health Facilities. A Public Tertiary Health Facility in Surat, Western India responds to the Challenge of Floods. Slide 34*
- WHO.2015. *Case Study: Climate Based Early Warning System. Sea Surface Temperature in the South Atlantic helps predict Malaria Outbreaks in distant India. Slide 35*
- United Nations Environment Program. 2014. *Adaptation Technologies Mongolia, Disaster Warning Systems*. http://www.unep.org/roap/Portals/96/Compendium%20Report_Mongolia_Final.pdf.
- UK Climate Impacts Programme. 2006. UKCIP Experience: NCSP Workshop on Vulnerability and Adaptation Assessment under the Second National Communications Meeting.

Module 13: Mitigation and co-benefits

- IPCC. 2013. Assessment Report Five, Working Group III.
- Patz J A, Gibbs H K, Foley J A, Rogers J V, Smith K R. 2007. *Climate change and global health: quantifying a growing ethical crisis*. EcoHealth 4 397.
- Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations, National Research Council. 2011. *Climate Stabilization Targets:* Emissions, Concentrations, and Impacts over Decades to Millennia. http://www.nap.edu/catalog/12877/climate-stabilization-targets-emissions-concentrations-and-impacts-over-decades-to.

Module 14: Health and the UNFCCC

- United Nations Framework Convention on Climate Change. 2014. www.unfccc.int.
- Intergovernmental Panel on Climate Change. 2014. www.ipcc.ch.
- United Nations Framework Convention on Climate Change. 2014. *Progress made in implementing activities under the Nairobi work programme on impacts, vulnerability and adaptation to climate change*. http://unfccc.int/resource/docs/2014/sbsta/eng/inf07.pdf.
- The Global Environment Facility. 2014. www.thegef.org.
- The Global Environment Facility. 2014. *How to access LDCF resources*. http://thegef.org/gef/node/4433.
- Accessing Resources under the Special Climate Change Fund. 2014. http://thegef.org/gef/sites/thegef.org/files/publication/23470_SCCF.pdf.

- Green Climate Fund. 2014. http://news.gcfund.org/.
- IPCC, 2007, Summary for policy makers, 4th Assessment report
- Haines A, McMichael AJ, Smith KR, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. Lancet 2009; 374:2104-14.

Module 15: Disaster risk management

- Yumul et al. 2013. *Abnormal weather events in 2009, increased precipitation and disastrous impacts in the Philippines*. Climatic Change 118:715–727 DOI 10.1007/s10584-012-0661-8.
- World Bank. 2010. *Natural hazards, natural disasters: The economics of effective prevention*. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf. Slide 6.
- Keim M. 2006. *Cyclones, tsunamis, and human health: the role of preparedness*. Oceanography 19:2;40-49.
- Yusuf and Francisco. 2009. *Climate Change Vulnerability Mapping for Southeast Asia*. http://web.idrc.ca/uploads/user-S/12324196651Mapping_Report.pdf.
- The World Bank. 2010 *Natural Hazards, Unatural Disasters: The Economics of Effective Prevention*. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf.
- World Bank. 2011. *Jakarta: Urban Challenges in a Changing Climate*. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/10/19/000356161_20111019004946/Rendered/PDF/650180WP0Box360ange0Jakarta0English.pdf.
- Hahm and Fisher. 2010. *Can Jakarta Become Flood-Free: Sustainable Flood Mitigation Measures for a Coastal City. Presentation at Singapore International Water Week, June 28–July 2.*
- The United Nations Office for Disaster Risk Reduction. 2014. *Hyogo Framework for Action*. http://www.unisdr.org/we/coordinate/hfa.
- Gero, A et al. 2011. *How local communities and global development agencies reduce vulnerability to natural disasters and climate change: Examples from the Pacific*. Natural hazards and earth system sciences.
- International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. *Community early warning systems: guiding principles*. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf.
- School of Ocean & Earth Science and Technology Hawaii. 2009. *Pacific ENSO Update. 1st Quarter 1999 - Vol. 5 No. 1*. http://www.soest.hawaii.edu/MET/Enso/peu/update.dir/Update-1stQtr1999/Update-1stQtr1999.html.

- Ebi KL, Schmier JK. 2005. *A stitch in time: improving public health early warning systems for extreme weather events*. Epidemiologic Reviews 2005; 27:115-121.
- Parvin, GA and Shaw R. 2011. *Climate disaster resilience of Shaka City corporation; an empirical assessment at zone level*. Risk, Hazards, and Crisis in Public Policy. 2;2: article 6. DOI: 10.2202/1944-4079.1069.
- Nahar et al. 2014. *Increasing the provision of mental health care for vulnerable, disaster-affected people in Bangladesh*. BMC Public Health 14:708. http://www.biomedcentral.com/1471-2458/14/708.
- International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. *Community early warning systems: guiding principles*. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf.

Module 16: Communicating climate change and health

- Climate Access. 2014. *Communication Tips for Public Health Professionals*. http://climateaccess.org/resource/tip-sheet-communication-tips-public-health-professionals.
- Centre for Research on Environmental Decisions, Columbia University. 2009. *Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public*. http://guide.cred.columbia.edu/guide/principles.html.
- Heath, C., and Heath, D. 2007. *Made to stick: Why some ideas survive and others die*. New York. Random House.
- Maibach, Nisbet and Weathers. 2011. *Conveying the Human Implications of Climate Change: A Climate Change Communication Primer for Public Health Professionals*.
- Climate Outreach and Information Network (COIN). 2015. *Talking Climate: The gateway to research on climate change communication.* http://talkingclimate.org/about/.

Action planning activity: Country action planning

Aims of the activity:

- To allow participants to connect with colleagues in their country/region and develop their team work skills
- To allow participants to generate actions for their country that will help prevent some of the negative impacts on health from climate change
- To generate a sense of action, enthusiasm and pride in participants at the culmination of the training.

Required resources:

- Tables and chairs at the back of the training room that groups can sit around, or floor space (if comfortable)
- Flipchart paper
- Coloured markers
- Background music and speakers

Timing: 30 minutes

Delivery notes for this exercise:

Set up the exercise carefully – ensure all participants are in a group that works for them. For example participants from individual Pacific Islands without colleagues from their country present may choose to group together with others for a subregional or regional grouping. Encourage participants to decide together what makes most sense as an action planning scale for them to work on. It is possible for one person to work on a country action plan, as long as they draw in others and rework the action plan with representatives who will need to be involved once they get home.

Allow for independent work – Encouraging participants to work together and decide how they will tackle this exercise helps achieve part of the purpose of this activity, which is to give participants experience in working together effectively as a team – something they will require when implementing the action plan.

Consider the format for the presentations that will follow the exercise – You may want to change the room set up (in the break) or invite external guests to see the presentations, in order to increase the sense of significance given to the action the participants are committing to undertake in their country/region.

Instructions for delivery

1. Ask participants to come to a clear area of the room in a huddle, and introduce the idea of country action planning.

"You've had some time to make a plan for your own work and how as health professionals you can help protect health in your country from climate change. We now want to give you the chance to gather with others from your country or region to decide what you would like to do back in your country to together tackle the health impacts from climate change."

"Please arrange yourself into country groups. If you are the only person from your country here, you could form into a sub-regional or regional grouping, or you could develop a country plan on your own – whatever feels most appropriate for designing a climate change and health action plan that can be implemented. So please move into groups now, and stand with your group mates so I can see that everyone has decided on their grouping, or that they'll work solo."

Watch the group and check in with anyone who looks confused. Move amongst the groups and check everyone is happy, asking if everyone knows who they are working with.

NB: Have a fellow trainer count how many finalised groups there are.

2. Ok, now that you're in your groups, you have the next 25 minutes to create an action plan for protecting health from climate change in your country or region. I'm going to leave it to you to decide as a group how you will go about this, and what format you'll come up with. At the end of the 25 minutes – at **X** pm - you need to be prepared to give a short presentation to the group (*and invited guests – if relevant*) on the action plan you come up with.

   In this room you have flipchart paper and markers, and a whiteboard one or two groups could use. I'll give you some time reminders as you go. Are there any questions before you start? Ok, go for it."

3. Set timer.

   Work out the length the country presentations will be able to be (see the session plan for the total time block for presentations), based on how many groups there are.

4. Give time reminders at:

   – **10 minutes** (15 minutes to go), and tell groups how long they will have for their presentation

   – **18 minutes** (7 minutes to go). Encourage groups to get working on what they will present if they have done already, and ask groups to decide on two representatives to present their action plan; and

   – **22 minutes** (3 minutes to go).

5. At **25 minutes** ask participants to finish their action plans and pack up their materials.

   If a break is scheduled, send people off for some fresh air before they sit through presentations. Otherwise start straight into the presentations, asking for a group to nominate to present first. Remind everyone of the time they have for presentations, and that you'll be giving them a 30 second warning and then a wrap up signal.

Use a timer, '30 seconds to go' sign (if desired – this can be written on a page or coloured post it note) and keep to time to prevent the presentations from spilling over.

Encourage applause at the end of each presentation, and then call for a next country to present. Ideally pages will be stuck up on the wall or a spare whiteboard for display, where they can be photographed one by one.

6. At the end of all presentations acknowledge the action plans and ask for another round of applause. If there is time, call for short reflections from other trainers or invited guests, giving the participants a sense that their action is significant, and that following through on their action plans is highly valued.
7. To document and share the actions that have been generated, have a trainer or photographer photograph all the action plans if possible, and let the group know how these will be documented. Ask each group to decide what they will do with the hardcopy version, and ask a representative to come and get their plan at the end of the session/training (whenever the photographing is completed.)

Glossary

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Adaptation assessment: The practice of identifying options to adapt to **climate change** and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility.

Adaptation Fund: A Fund established under the Kyoto Protocol in 2001 and officially launched in 2007. The Fund finances adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol. Financing comes mainly from sales of Certified Emissions Reductions (CERs) and a share of proceeds amounting to 2% of the value of CERs issued each year for Clean Development Mechanism (CDM) projects. The Adaptation Fund can also receive funds from government, private sector, and individuals.

Adaptation measures: This refer to actual adjustments, or changes in decision environments, which might enhance resilience or reduce vulnerability to observed or expected changes in climate.

Ambient air pollution: Air pollution in the ambient environment, that is, in outdoor air, but able to enter homes.

Air pollution: One or more chemicals or substances in high enough concentrations in the air to harm humans, other animals, vegetation, or materials. Such chemicals or physical conditions (such as excess heat or noise) are called air pollutants.

Air quality guidelines: Value at or under which a pollutant is considered to have no or minimal impact on health.

Anthropogenic: Human made. In the context of greenhouse gases, emissions that are produced as the result of human activities.

Atmosphere: The gaseous envelope surrounding the earth, divided into five layers — the troposphere which contains half of the earth's atmosphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere, which is the outer limit of the atmosphere. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium and radiatively active greenhouse gases (GHGs) such as carbon dioxide (CO2) (0.035% volume mixing ratio) and ozone (O3). In addition, the atmosphere contains the GHG water vapour (H2O), whose amounts are highly variable but typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols.

Atmospheric brown clouds (ABCs): Are regional scale plumes of air pollution that consist of copious amounts of tiny particles of soot, sulphates, nitrates, fly ash and many other pollutants.

Annex I Parties / countries: The group of countries listed in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC). Under Articles 4.2 (a) and 4.2 (b) of the UNFCCC, Annex I Parties were committed to adopting national policies and measures with the non-legally binding aim to return their greenhouse gas (GHG) emissions to 1990 levels by 2000. The group is largely similar to the Annex B Parties to the Kyoto Protocol that also adopted emissions reduction targets for 2008 – 2012. By default, the other countries are referred to as Non-Annex I Parties.

Annex II Parties / countries: The group of countries listed in Annex II to the United Nations Framework Convention on Climate Change (UNFCCC). Under Article 4 of the UNFCCC, these countries have a special obligation to provide financial resources to meet the agreed full incremental costs of implementing measures mentioned under Article 12, paragraph 1. They are also obliged to provide financial resources, including for the transfer of technology, to meet the agreed incremental costs of implementing measures covered by Article 12, paragraph 1 and agreed between developing country Parties and international entities referred to in Article 11 of the UNFCCC. This group of countries shall also assist countries that are particularly vulnerable to the adverse effects of climate change.

Anthropogenic greenhouse emissions: Greenhouse-gas emissions resulting from human activities.

Biological model: a mathematical approach to determine the relationship between environmental variables and an outcome of interest (e.g. the distribution of disease vectors) using biological associations between the environment and aspects of population dynamics (e.g. how insect development rates change with temperature). Unlike **statistical models**, this approach requires detailed understanding of disease population dynamics.

Carbon dioxide: A colorless, odorless, nonpoisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion. Although carbon dioxide does not directly impair human health, it is a greenhouse gas that traps terrestrial (i.e., infrared) radiation and contributes to the potential for global warming.

Carbon monoxide: Colorless, odourless, toxic gas produced by incomplete combustion of carbon containing materials.

Capacity-building: In the context of climate change, the process of developing the technical skills and institutional capability in developing countries and economies in transition to enable them to address effectively the causes and results of climate change.

Climate change: Climate change refers to a change in the state of the climate that can be identified (e. g., by using statistical tests) by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Climate prediction: A climate prediction or climate forecast is the result of an attempt to produce a most likely description or estimate of the actual evolution of the climate in the future (e.g., at seasonal, interannual, or long-term time-scales).

Climate projection: A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/concentration/radiative forcing scenario used, which are based on assumptions, concerning, for example, future socioeconomic and technological developments that may or may not be realized, and are therefore subject to substantial uncertainty.

Climate scenario: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships, that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate. A "climate change scenario" is the difference between a climate scenario and the current climate.

Climate-Sensitive Health Outcome is any health outcome whose geographic range, incidence, or intensity of transmission is directly or indirectly associated with weather or climate.

Climate Variability describes variations in the mean state and other statistics (e.g.,standard deviations, the occurrence of extreme events, etc.) of climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system or to variations in natural or anthropogenic external forcing.

Cholera: An intestinal infection, caused by the bacterium *Vibrio cholerae*, which results in frequent watery stools, cramping abdominal pain, and eventual collapse from dehydration. It is thought that **zooplankton** in cold waters may carry large number of cholera vibrios on their bodies. Zooplankton feed by grazing on **phytoplankton** which bloom with sunshine and warm conditions. Thus, a phytoplankton (algal) bloom may lead to an increase in the population of zooplankton which carry the vibrios.

Cobenefits: benefits (often health benefits) associated with reductions in greenhouse gas emissions. For example, reduced emissions of air pollutants can have immediate health benefits. In addition, there can be cobenefits of adaptation measures, such as new surveillance systems that monitor climate-related and nonclimate-related infectious diseases.

Conference of the Parties (COP): The supreme body of the United Nations Framework Convention on Climate Change (UNFCCC), comprising countries with a right to vote that have ratified or acceded to the convention. It currently meets once a year to review the Convention's progress. The word "conference" is not used here in the sense of "meeting" but rather of "association". The "Conference" meets in sessional periods, for example, the "fourth session of the Conference of the Parties."

Dengue/dengue haemorrhagic fever (DHF): An acute febrile syndrome caused by dengue arbovirus type 1–4, commonly transmitted by the mosquitoes *Aedes aegypti* and *Ae. albopictus*, which breed in small water bodies in containers, car tyres, etc. Dengue is often called breakbone fever because it is characterized by severe pain in joints and back. Subsequent infections of dengue virus may lead to dengue haemorrhagic fever, which can be fatal.

Disability Adjusted Life Year (DALY): An indicator of life expectancy combining mortality and morbidity into one summary measure of population health to account for the number of years lived in less than optimal health. It is a health measure developed for calculating the global burden of disease that is also used by WHO, the World Bank and other organizations to compare the outcomes of different interventions.

Disaster: A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Disaster risk management (DRM): Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development.

Drought: The phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances.

Dysentery: An infection of the gut caused by shigella bacteria. Symptoms include acute bloody diarrhoea, vomiting, stomach pains and fever.

Early warning systems (EWS): A system consisting of **Mathematical models** and **surveillance** measures designed for the early detection, prevention and control of an **epidemic** of infectious disease or other abnormal event (e.g., famine or heat waves).

El Niño Southern Oscillation (ENSO): El Niño, in its original sense, is a warm water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the intertropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño Southern Oscillation, or ENSO. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world. The opposite of an El Niño event is called La Niña. The accepted definition is a warming or cooling of at least 0.5 °C (0.9 °F) averaged over the east-central tropical Pacific Ocean. Typically, this anomaly happens at irregular intervals of 2–7 years and lasts nine months to two years. The average period length is 5 years. When this warming or cooling occurs for only seven to nine months, it is classified as El Niño/La Niña "conditions"; when it occurs for more than that period, it is classified as El Niño/La Niña "episodes".

Extreme weather event: An extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place. An extreme climate event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season).

Global warming (GW): usually: the warming trend over the past century or so; also: any period in which the temperature of the Earth's atmosphere increases; also the theory of such changes.

Emissions: Releases of gases to the atmosphere (e.g., the release of carbon dioxide during fuel combustion). Emissions can be either intended or unintended releases.

Exposure: Amount of a factor to which a group or individual was exposed; sometimes contrasted with dose (the amount that enters or interacts with the organism). Exposures may be either beneficial or harmful.

Fecal-oral transmission: is a route of transmission of a disease, when pathogens in fecal particles passing from one host are introduced into the oral cavity of another host.

Fifth Assessment Report (AR5): The Fifth Assessment Report of the Intergovernmental Panel on Climate Change, released in 2014.

Food security: A situation that exists when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life. *Food insecurity* may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level.

Flood: Temporary partial or complete inundation of normally dry areas caused by rapid runoff or overflow from lakes, rivers, or tidal waters.

Fossil fuels: Carbon-based fuels from fossil hydrocarbon deposits, including coal, peat, oil, and natural gas.

Gastroenteritis: Inflammation of the stomach and the intestines. Gastroenteritis can cause nausea, vomiting, and diarrhea. Gastroenteritis has numerous causes, including infections (viruses, bacteria, and parasites), food poisoning, and stress.

Glacial lake outburst flood (GLOF): Flood associated with outburst of glacial lake. Glacial lake outburst floods are typically a result of cumulative developments and occur (i) only once (e.g., full breach failure of moraine-dammed lakes), (ii) for the first time (e.g., new formation and outburst of glacial lakes), and/or (iii) repeatedly (e.g., ice-dammed lakes with drainage cycles, or ice fall).

Global Environment Facility (GEF): The Global Environment Facility, established in 1991, helps developing countries fund projects and programmes that protect the global environment. GEF grants support projects related to biodiversity, climate change, international waters, land degradation, the ozone (O3) layer, and persistent organic pollutants.

Global climate model, also **General Circulation Model** or **GCM** - a computer model of the world's climate system, including the atmosphere and oceans.

Global mean surface temperature: An estimate of the global mean surface air temperature. However, for changes over time, only anomalies, as departures from a climatology, are used, most commonly based on the area-weighted global average of the sea surface temperature anomaly and land surface air temperature anomaly.

Global surface temperature: The global surface temperature is the area-weighted global average of the sea surface temperature over the oceans (i.e., the subsurface bulk temperature in the first few metres of the ocean), and the surface air temperature over land at 1.5 m above the ground.

Global warming: Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions.

Green Climate Fund (GCF): The Green Climate Fund was established by the 16th Session of the Conference of the Parties (COP) in 2010 as an operating entity of the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC), in accordance with Article 11 of the Convention, to support projects, programmes and policies and other activities in developing country Parties. The Fund is governed by a Board and will receive guidance of the COP. The Fund is headquartered in Songdo, Republic of Korea.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary GHGs in the earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and brominecontaining substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). For a list of well-mixed GHGs, see WGI AR5 Table 2.A.1.

Greenhouse effect: The effect created by the band of greenhouse gases that blanket the Earth. The greenhouse effect keeps the Earth's surface within a temperature range that makes life on Earth (as we know it) possible.

Health: A state of complete physical, mental and social well being, and not merely the absence of disease or infirmity.

Health impact assessment (HIA): A combination of procedures, methods and tools by which a policy, project or hazard may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.

Health Systems: Comprises all the organizations, institutions, and resources that are devoted to producing actions principally aimed at improving, maintaining, or restoring health. (World Health Organization. 2007)

Health system strengthening: Defined by the WHO in reference to its current framework as, "improving the six building blocks and managing their interactions in ways that achieve more equitable and sustained improvements across health services and health outcomes, requiring both technical and political knowledge and action." (WHO 2007, 4) The Hyogo Framework for Action (HFA) is the first plan to explain, describe and detail the work that is required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk - governments, international agencies, disaster experts and many others - bringing them into a common system of coordination.

Intergovernmental Panel on Climate Change (IPCC): Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. The IPCC is independent of the Convention.

Kyoto Protocol: The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most Organisation for Economic Cooperation and Development countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas (GHG) emissions (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6)) by at least 5% below 1990 levels in the commitment period 2008 – 2012. The Kyoto Protocol entered into force on 16 February 2005.

Kyoto mechanisms: Three procedures established under the Kyoto Protocol to increase the flexibility and reduce the costs of making greenhouse-gas emissions cuts. They are the Clean Development Mechanism, Emissions Trading and Joint Implementation.

Land use and land-use change: Land use refers to the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land-use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land-use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have radiative forcing and/or other impacts on climate, locally or globally.

Least-Developed Countries (LDCs): A list of countries designated by the Economic and Social Council of the United Nations (ECOSOC) as meeting three criteria: (1) a low income criterion below a certain threshold of gross national income per capita of between USD 750 and USD 900, (2) a human resource weakness based on indicators of health, education, adult literacy, and (3) an economic vulnerability weakness based on indicators on instability of agricultural production, instability of export of goods and services, economic importance of nontraditional activities, merchandise export concentration, and the handicap of economic smallness. Countries in this category are eligible for a number of programmes focused on assisting countries most in need.

Least-Developed Countries Expert Group (LEG): A panel of 13 experts that provides advice to LDCs on the preparation and implementation of national adaptation programmes of action (NAPAs) – plans for addressing the urgent and immediate needs of those countries to adapt to climate change.

Least-Developed Country Fund (LDCF): The LDCF is a fund established to support a work programme to assist Least-Developed Country Parties to carry out, inter alia, the preparation and implementation of national adaptation programmes of action (NAPAs). The Global Environment Facility, as the entity that operates the financial mechanism of the Convention, has been entrusted to operate this fund.

Loss and damage: At COP 16 in Cancun in 2010, governments established a work programme in order to consider approaches to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change as part of the Cancun Adaptation Framework.

Malaria: Endemic or epidemic parasitic disease caused by four species of the protozoan genus *Plasmodium* that are transmitted to humans by the bite of female *Anopheles* mosquitoes. Disease is characterised by high fever attacks and systemic disorders and is responsible for approximately 2 million deaths every year, 90% of which occur in Sub-Saharan Africa. Malaria is the most serious and common vector-borne disease in the world.

Methane (CH4): One of the six greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol and is the major component of natural gas and associated with all hydrocarbon fuels. Significant emissions occur as a result of animal husbandry and agriculture and their management represents a major mitigation option. See also Global Warming Potential (GWP) and Annex II.9.1 for GWP values.

Millennium Development Goals (MDGs): A set of time-bound and measurable goals for combating poverty, hunger, disease, illiteracy, discrimination against women and environmental degradation, agreed at the UN Millennium Summit in 2000.

Mitigation (of climate change): A human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs). This report also assesses human interventions to reduce the sources of other substances that may contribute directly or indirectly to limiting climate change, including, for example, the reduction of particulate matter (PM) emissions that can directly alter the radiation balance (e. g.,black carbon) or measures that control emissions of carbon monoxide, nitrogen oxides (NOx), volatile organic compounds (VOCs) and other pollutants that can alter the concentration of tropospheric ozone (O3), which has an indirect effect on the climate.

Montreal Protocol: The Montreal Protocol on Substances that Deplete the Ozone Layer, an international agreement adopted in Montreal in 1987.

Morbidity: Rate of occurrence of disease or other health disorder within a population, taking account of the age-specific morbidity rates. Morbidity indicators include chronic disease incidence/ prevalence, rates of hospitalization, primary care consultations, disability-days (i.e., days of absence from work), and prevalence of symptoms.

Mortality: Rate of occurrence of death within a population; calculation of mortality takes account of age-specific death rates, and can thus yield measures of life expectancy and the extent of premature death.

The national adaptation plan (NAP): The NAP process was established under the Cancun Adaptation Framework (CAF). It enables Parties to formulate and implement national adaptation plans (NAPs) as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is a continuous, progressive and iterative process that follows a country-driven, gender-sensitive, participatory and fully transparent approach.

National Adaptation Programmes of Action (NAPAs): Documents prepared by least-developed countries (LDCs) identifying urgent and immediate needs for adapting to climate change.

National communication: A document submitted in accordance with the Convention (and the Protocol) by which a Party informs other Parties of activities undertaken to address climate change. Most developed countries have now submitted their fifth national communications; most developing countries have completed their first national communication and are in the process of preparing their second.

National delegation: One or more officials empowered to represent and negotiate on behalf of a government.

Nitrous oxide (N2O): One of the six greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol. The main anthropogenic source of N2O is agriculture (soil and animal manure management), but important contributions also come from sewage treatment, fossil fuel combustion, and chemical industrial processes. N2O is also produced naturally from a wide variety of biological sources in soil and water, particularly microbial action in wet tropical forests. See also Global Warming Potential (GWP) and Annex II.9.1 for GWP values.

Non-Annex I Parties / countries: Non-Annex I Parties are mostly developing countries. Certain groups of developing countries are recognized by the Convention as being especially vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. Others, such as countries that rely heavily on income from fossil fuel production and commerce, feel more vulnerable to the potential economic impacts of climate change response measures. The Convention emphasizes activities that promise to answer the special needs and concerns of these vulnerable countries, such as investment, insurance, and technology transfer. See also Annex I Parties / countries.

Ozone (O3): Ozone, the triatomic form of oxygen (O3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (smog). Tropospheric O3 acts as a greenhouse gas (GHG). In the stratosphere, it is created by the interaction between solar ultraviolet radiation and molecular oxygen (O2). Stratospheric O3 plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the O3 layer.

Particulate matter (PM): Very small solid particles emitted during the combustion of biomass and fossil fuels. PM may consist of a wide variety of substances. Of greatest concern for health are particulates of diameter less than or equal to 10 nanometres, usually designated as PM10. See also Aerosol.

Pathogen: An infectious agent such as a virus, bacterium, prion, fungus, viroid, or parasite that causes disease in its host. The host may be an animal, a plant, a fungus, or even another microorganism.

Policies (for mitigation of or adaptation to climate change): Policies are a course of action taken and / or mandated by a government, e. g., to enhance mitigation and adaptation. Examples of policies aimed at mitigation are support mechanisms for renewable energy (RE) supplies, carbon or energy taxes, fuel efficiency standards for automobiles. See also Measures.

Precipitation: Rain, hail, mist, sleet, snow or any other moisture that falls to the Earth.

Radiation: Energy emitted in the form of electromagnetic waves. Radiation has differing characteristics depending upon the wavelength. Because the radiation from the Sun is relatively energetic, it has a short wavelength (e.g., ultraviolet, visible, and near infrared) while energy re-radiated from the Earth's surface and the atmosphere has a longer wavelength (e.g., infrared radiation) because the Earth is cooler than the Sun.

Radiative forcing: Radiative forcing is the change in the net, downward minus upward, radiative flux (expressed in W m – 2) at the tropopause or top of atmosphere due to a change in an external driver of climate change, such as, for example, a change in the concentration of carbon dioxide (CO2) or the output of the sun. For the purpose of this report, radiative forcing is further defined as the change relative to the year 1750 and refers to a global and annual average value.

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (Arctic Council, 2013).

Response: The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Risk: (i.e., climate-related risk) is a product of the likelihood of exposure and the consequence(s) of that exposure. It arises from the interaction of a physically defined hazard (e.g., floods and other extreme weather events, increasing temperature) with the properties of the exposed system, its vulnerability (UNDP, 2003). System vulnerability is a critical determinant of the risk a region or subpopulation faces when exposed to a particular hazard. This means that programs to decrease vulnerability will decrease risk.

Rotaviruses: are a leading cause of severe diarrhoeal disease and dehydration in infants and young children throughout the world. Most symptomatic episodes occur in young children between the ages of 3 months and 2 years. The virus spreads rapidly, presumably through person-to-person contact, airborne droplets, or possibly contact with contaminated toys.

Salmonellosis: Bacterial food-poisoning caused by *Salmonella* species, most frequently reported in North America and Europe. Most people become infected by ingesting foods contaminated with significant amounts of *Salmonella* and the poisoning typically occurs in outbreaks in the general population or hospitals, restaurants, etc. Improperly handled or undercooked poultry and eggs are the foods which most frequently cause Salmonella food poisoning. Chickens are a major carrier of *Salmonella* bacteria, which accounts for its prominence in poultry products.

Sea level change/sea level rise: Sea level can change, both globally and locally, due to changes in the shape of the ocean basins, changes in the total mass of water and changes in water density. Factors leading to sea-level rise under global warming include both increases in the total mass of water from the melting of land-based snow and ice, and changes in water density from an increase in ocean water temperatures and salinity changes. Relative sea level rise occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence.

Sensitivity: describes an individual's or subpopulation increased responsiveness, primarily for biological reasons, to a particular exposure. Biological sensitivity may be related to developmental stage, preexisting medical conditions, acquired factors (such as immunity), and genetic factors (Balbus and Malina 2009). Socioeconomic factors also play a critical role in altering vulnerability and sensitivity, by interacting with biological factors that mediate risk (such as nutritional status) and/or lead to differences in the ability to adapt or respond to exposures or early phases of illness and injury.

Seasonality/seasonal variation: Seasonal fluctuations in disease **incidence** or **prevalence** or other phenomena (e.g. abundance of **vectors**). Shigellosis is an acute invasive enteric infection caused by bacteria belonging to the genus *Shigella*; it is clinically manifested by diarrhoea that is frequently bloody.

Special Climate Change Fund (SCCF): The SCCF was established to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification. This fund should complement other funding mechanisms for the implementation of the Convention. The Global Environment Facility (GEF), as the entity that operates the financial mechanism of the Convention, has been entrusted to operate this fund.

Stratosphere: Second layer of the atmosphere, extending from about 19 to 48 kilometers (12 to 30 miles) above the earth's surface. It contains small amounts of gaseous ozone (O3), which filters out about 99 percent of the incoming harmful ultraviolet (UV) radiation. Most commercial airline flights operate at a cruising altitude in the lower stratosphere.

Subsidiary Body for Implementation (SBI): The SBI makes recommendations on policy and implementation issues to the COP and, if requested, to other bodies.

Subsidiary Body for Scientific and Technological Advice (SBSTA): The SBSTA serves as a link between information and assessments provided by expert sources (such as the IPCC) and the COP, which focuses on setting policy.

Sulfur dioxide (SO2): A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain).

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Surveillance: Continuous analysis, interpretation and feedback of systematically collected data for the detection of trends in the occurrence or spread of a disease, based on practical and standardized methods of notification or registration. Sources of data may be related directly to disease or factors influencing disease.

Time-series analysis: Statistical methods used to describe events that are measured in an ordered sequence at equally-spaced time intervals, and often to analyse their variations as functions of other variables (e.g. analyses of daily records of daily **mortality** rates, as a function of concurrent variation in temperature).

Transmission cycle: The transmission of pathogens from current to future host follows a repeating cycle. This cycle can be simple, with a direct transmission from current to future host, or complex, where transmission occurs through (multiple) intermediate hosts or vectors. Typhoid fever is a bacterial disease, caused by *Salmonella typhi*. It is transmitted through the ingestion of food or drink contaminated by the faeces or urine of infected people.

United Nations Framework Convention on Climate Change (UNFCCC): The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. It contains commitments for all Parties under the principle of 'common but differentiated responsibilities'. Under the Convention, Parties included in Annex I aimed to return greenhouse gas (GHG) emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention entered in force in March 1994. In 1997, the UNFCCC adopted the Kyoto Protocol.

Uncertainty: An expression of the degree to which a value is unknown. This can result from lack of information or disagreement about what is known. Uncertainty can be represented by **quantitative** measures (e.g. a range of values calculated by mathematical models) or **qualitative** statements (e.g. reflecting the judgement of a team of experts).

Undernutrition: Is defined as the outcome of insufficient food intake and repeated infectious diseases. It includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition).

Vector: An organism that acts as an essential **intermediate** host or definite host for a human pathogen and that plays an active role in its transmission; for example, *Anopheles* mosquitoes are vectors of **malaria**. This definition excludes mechanical carriers of infective materials (such as houseflies and cockroaches), strictly passive intermediate hosts (e.g. the snail hosts of **schistosomiasis**) and reservoir species (e.g. foxes carrying rabies).

Vector-borne diseases: Range of infectious diseases that are transmitted between hosts by **vectors** such as mosquitoes or ticks (e.g. **malaria, dengue fever, Lyme disease**).

Vibrio species: are natural inhabitants of marine aquatic environments in both temperate and tropical regions.

Volatile Organic Compounds (VOCs): Important class of organic chemical air pollutants that are volatile at ambient air conditions. Other terms used to represent VOCs are hydrocarbons (HCs), reactive organic gases (ROGs) and non-methane volatile organic compounds (NMVOCs). NMVOCs are major contributors — together with nitrogen oxides (NO_X), and carbon monoxide (CO) — to the formation of photochemical oxidants such as ozone (O_3).

Volatile organic compounds (VOCs): Organic compounds that evaporate readily into the atmosphere at normal temperatures. VOCs contribute significantly to photochemical smog production and certain health problems.

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Weather: Atmospheric condition at any given time or place. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard).

Water-related diseases: those caused by micro-organisms and chemicals in water people drink; diseases like schistosomiasis which have part of their lifecycle in water; diseases like malaria with water-related vectors; drowning and some injuries; and others such as legionellosis carried by aerosols containing certain micro-organisms.

Zoonosis: An infectious disease of vertebrate animals, such as rabies, which can be transmitted to humans.

Zoonotic disease: A disease that can be passed between animals and humans. Zoonotic diseases can be caused by viruses, bacteria, parasites, and fungi.

Revision activity: Graffiti wall

Purpose of the activity:

This revision exercise allows participants to revise their learning from each of the modules covered during training. It also brings in creativity methodology and a group approach, helping participants unlock their past experience and be reminded of what was covered in the training by their colleagues.

Preparation:

Using flipchart paper and large marker pens, create one page for each of the modules covered during training, writing a large label in the middle of each sheet. Have these ready and in the previous Module or a break before running this exercise, fix them in chronological order to the walls around the back of the training room. Ensure pages are placed at a height that all participants can easily write at. Place marker pens on the floor near the wall, or on hand on a nearby table. Allow enough space near the walls for the whole group to congregate near all the pages.

NB: Make sure that the pages used are thick enough or the ink of the marker pens light enough that participants drawing on the pages won't go through and mark the walls of the training venue! Double thicknesses of paper can be used if necessary, or pages can be placed on tables spaced around the room, although this is less visually effective.

Required resources:

- List of all training modules
- One or two flipchart pages per module covered during training (allowing enough space for all participants to write comments on each module topic)
- Marker pens (2 – 3 of different colours per participant)
- Blu tak / tape to affix pages safely to walls
- Clear walls (or tables)
- Background music and speakers

Learning environment:

Back of the training room, cleared of chairs and tables with participants standing in the centre.

Timing – 30 minutes

2 mins	Introduce the activity, lay out the chronology of modules around the room, and give instructions.
15 mins	Participants write or draw the learnings they remember from each module on each page, moving around the room. Encourage rotation.
5 mins	Ask participants to revolve pages, looking at other participant's notes, ticking, emphasizing or adding to what others have written, & being reminded of learning they'd forgotten about.
3 mins	Wrap up, recognizing all that's been captured & learnt. Ask participants to take a step back from pages & reflect on which modules have been their learning areas of most value.

Instructions for delivery

Introduce the activity – 2 minutes

After a busy five days of training, we've come to the point of looking back over everything we've covered in the training process. It's been a busy week, hasn't it?!

To help remind you of what we've covered, I've written up each of the modules we covered on a page around the room. (Walk to first page). Here you can see we started with An introduction to weather and climate … (read off each module as you move or gesture around the room so participants know where each is located, and have a verbal reminder of what was covered), ending with the Communicating climate change and health module.

You now have the chance to do something you probably don't get very often in your work – to graffiti over these walls – well actually pages – with the learning you're taking away from each module.

This is a chance to get creative! So in a minute please grab a few of your favourite coloured markers from the middle of the room, and spend the next 10 minutes revolving around the back of the room. Write phrases, sentences or words, or draw or doodle what we covered, big learning outcomes for you, or phrases you remember.

You can move in any direction, going to pages where there's not a whole huddle of people, but please make sure you leave at least one mark on every page. Go for it – have fun making your graffiti!

Play background music to help people focus on the activity and discourage conversation.

Graffiti process – 10 minutes

Stay central in the space, watching the participants as they move around the space, helping hold the focus for the group. Ideally participants should work individually in this process so if more than small side conversations bubble up, encourage participants to keep moving through the process, giving occasional time reminders throughout the 10 minutes of how much longer they have remaining and encouraging them to make sure they get to every page.

Learning from each other – 5 minutes

Thanks people for their beautiful colourful graffiti, and how much has gone up on the wall.

Ask participants to now go back to every page, looking at other participant's notes, ticking, emphasizing or adding to what others have written, and being reminded of learning they'd forgotten about. Ask them to visit every page again over the next 5 minutes, aiming to make at least another mark on every page.

Give time reminders to keep everyone moving around the room. Move around the pages from afar so you can pick up some of the learnings that are shared by a majority of participants.

Summary – 3 minutes

Give participants a 2 and 1 minute count down.

Bring participants back together and encourage them to gather around you, looking on to the grafittied pages. Thank the participants and recognize all that they have captured of their shared learnings from the 5 days. Provide some reflection of some of the major learning themes that you've seen emerging on the pages.

Ask participants to take a step back from pages so they can just see the titles, and reflect on which modules have been their standout learning areas of most value. Ask them to pick their top three as they look at the spread of pages, and hold those in their mind. This will come in handy as they move into the evaluation coming soon.

Introductory activity: Human Map

Aims:

- To allow participants to learn each other's names and get to know each other at an introductory level
- To put participants at ease with sharing ideas and opinions with the group
- To create a safe, relaxed and productive learning environment

Required resources:

Large open space at the back of the training room

Timing: 15 minutes

Instructions for delivery

1. Explain to the participants that to begin the training we are going to do a few exercises to help everyone to get to know each other. First off, we're going to create a map of where we all come from.
2. Designate a point at the centre of the space to represent the training venue. Stand at this point, saying "I'm standing here on the map, representing where we are at the university." Ask someone to point out North with their arm, and then show which way was is East, South and West.
3. Ask the participants to position themselves around the space based on where they live, relative to where you're standing. For example, if a person usually lives in a country north but close to the training venue, they will be standing a way away from you but on the north axis. Someone who lives in the same city will stand close to you. Tell participants that they will have to talk to each other to find out what their place on the map should be in relation to each other (which is the point of the exercise) and then when they find their place on the map, stand still.
4. Watch the group and check everyone has found their place on the map, giving an encouragement to the last people to find their place if necessary.
5. "Let's now hear who and where we have on this map. I'm going to ask each of you to introduce yourself by telling the group your name, where you live, and where you work." Start this process by introducing yourself, and then invite a person near you on the map to go next, followed by the person nearest to them. Make sure that people can be heard by the rest of the group, especially those further away, and ask them to speak up if necessary.

Try to verbally acknowledge input from each participant – either with a simple "Thank you *Name*", or by thanking them for being at the training. Repeating names and responding positively to all contributions during this activity will make participants feel more comfortable expressing ideas and opinions later on in the training, and help them to learn each other's names more quickly.

NB: *This exercise if followed immediately by the introductory exercise 'Reasons for being here', so don't allow participants to move out of their map positions – start straight into the next exercise from where people are standing.*

Action planning activity: Individual action planning

Aims of the activity:

- To allow participants to reflect on the possible actions they came up with in each module
- To help participants refine their brainstormed actions and decide on concrete steps they will take back in their workplaces
- To give participants time to focus on their own workplace before generating actions for their country (to follow)

Required resources:

- Tables and chairs at the back of the training room (see 'Preparation' for instructions)
- Blank A4 paper that has been hole punched to fit the handout folder (enough for 4 per participant)
- Coloured markers
- Background music and speakers

Timing: 25 minutes

1 minute	Instructions
14 minutes	Participants read over action notes from Modules 3 – 16 in their handout folders and record on loose A4 pages those actions that seem most important.
3 minutes	Participants review shortlisted actions, removing any areas of double up or redrafting actions so they can be achieved by them individually.
7 minutes	Participants create an action plan for all shortlisted actions, allocating timeframes, required resources or input, and who they will need to work with.

Preparation

In the afternoon tea break get other trainers to help you set up tables at the back of the training room at random angles (not in rows). Chairs should be placed around them (enough for each participant) at enough distance apart that each participant can sit down without being too close to another person, so as to minimize distraction. The space should resemble a café, where participants can chose where they'd like to sit for their solo action planning activity.

Place piles of blank A4 paper that have been hole punched to fit the handout folder in piles around each table, as well as coloured markers at a number of points on each table, and anything that will make the tables look attractive and 'café-like'.

Instructions for delivery

Part 1 – 15 minutes

1. After the break/opening slides, stand/move to at the back of the room and welcome participants to take a seat anywhere at the tables. They'll need to have their handout folder with them, and a pen.

2. Let participants know that they'll have some time to reflect on their actions coming away from the training now.

   "I'm going to give you some time to go back through your notes in your handout folder. I'd like you to turn to the ending slide from Modules 3 to 16, one by one. Read over the actions that you brainstormed at the time as a result of that module. Which ones really stand out as 1) Important for your country; or 2) Priorities for your work?"

   "The invitation is to take a plain piece of A4 paper from the table and, next to your folder, use pens or markers to record which of these brainstormed actions you want to take back at work. You have 14 sets of notes to go back to, and only **14 minutes**. So you'll be moving fairly quickly, spending about a minute per module. Remember that your action notes start at Module 3, and finish at Module 16. Are there any questions?"

   "Enjoy going back through your action ideas and creating your shortlist of actions you would like to take back in your workplace."

   Play quiet background music to encourage focus. If any conversations emerge, move a bit closer to the participants and, if necessary, check in on how they're going (they may be unsure).

3. Give time reminders at **7 minutes** (halfway), 10 minutes (4 minutes to go) and 13 minutes (1 minute to finish off). Move around the tables at a slight distance to get a sense of the type of action lists/plans that participants are creating.

Part 2 – 3 minutes

4. Congratulate participants on their synthesis of action ideas. "It looks like there are some great synthesized action lists that have been created. However I know that you're not all super human – you have busy workloads and limited time. So close your handout folder now and in a minute, look over everything on your A4 sheets.

   Are there any areas of double up, or actions that could be grouped together? If you've chosen a huge action that's not possible for you on your own or in your team, how could you rewrite that action so that it's realistic for you to achieve? I'll give you **3 minutes** for this."

5. Ask participants to finish up at just before 3 minutes "Ok, please finish off any last adjustments you are making to your condensed action list in the next 20 seconds".

Part 3 – 7 minutes

6. "Great, so you should now have a list of finalized actions that you can take back in your workplace to make a difference on the health impacts of climate change. I'd now like to give you some time to support these actions by coming up with a more structured action plan."

   On another piece of A4 paper please create a table that lists each action, and also the following things.

   - **Any resources or input** that you'll require to achieve this action
   - **Whom** you will need to work with to achieve this; and
   - **Approval needed?** If so, from whom, or by what process?
   - **A timeframe** for when you will complete this action
   - **Anything else** you want to note that will help you achieve this action.

   I'll write these up on the whiteboard so you can refer to them in a minute. Any questions on the activity?

   Ok, you'll have 7 minutes to create your action plan. Go for it!"

   Play quiet background music to encourage focus.

   Give time reminders at 5 minutes (2 minutes to go) and 6 minutes (1 minute to finish off their first version of their action plan).

7. At **7 minutes** stop everyone and thank them for their hard work in generating their action plans – this is a fantastic outcome from the training.

   All A4 pages can now be clipped into each person's folder for safekeeping.

Reflection activity: Key learnings from yesterday

Aims of the activity:

- To allow participants to reflect on their learning from the previous day, increasing their retention and allowing them to build on their existing learning in the coming day.
- To warm people up at the start of the day and allow them to speak to each other and into the group, increasing their trust in the group and enhancing the likelihood of them contributing to group exercises and discussions throughout the day.
- To allow everyone to warm up and become more engaged before they sit through a training module.

Timing: 5 - 10 minutes

Resources required:

Session plan or a list of the modules and key activities (site visits, panel discussion, poster presentation etc.) that were covered yesterday

Instructions for delivery

1. After opening the day and welcoming people back (and perhaps asking about their evenings to warm them up) let them know that you're interested in what their key learnings were from yesterday.

   "We had a busy day yesterday, covering X, Y and Z (list the day themes from yesterday and the modules and key activities that were covered.) What were the key learnings from yesterday for you, which were still with you when you woke up this morning?"

   "I'll get you to turn to the person next to you and share with each other some of your key learnings from the day, or something you learnt that really surprised you."

2. After a few minutes (or when things seem to go quiet), draw everyone back together. "Would some pairs like to share the key learnings that you discussed between you?" Seek out other responses, looking for similar or different learnings. If any group discussion emerges encourage it, contributing where relevant.

3. At 5 – 10 minutes (however much time is available, or at the point the exercise feels complete with the group), wrap up the discussion and thank people. Bring them back to today and the learning theme you'll be focusing on, and the valuable learning that will be building on yesterday on Day X (number).

Variations for this exercise

This exercise can be done:

- Standing (to energize people before sitting down for much of the day), ideally in a circle or horseshoe shape
- Swapping partners for shorter conversations, sharing one learning highlight or new piece of knowledge per conversation (similar to speed dating)
- As a whole group, with individuals speaking into the whole group (on later days in the training when the group is more warmed up, or to save time in a 5-minute learning reflection).

Overview of the WHO Training Course for Public Health Professionals

Objective and aims of the Training Package

This training course's objectives are to improve the knowledge of health professionals on the associations and implications of climate change on human health and to enhance stronger and more efficient participation of the health sector in addressing climate change challenges.

The training course is designed for public health professionals who are actively involved in the management and decision-making process related to health programmes. The course will also give a good foundation for nonmedical professionals involved in addressing the health challenges posed by climate change.

The modules are developed as standalone modules, so that any one module or a combination of a few can be used for different types of audiences.

Upon completion of the course participants should:

(1) Comprehend the principles and basic concepts of global warming and climate change.

(2) Understand how climate change can impact human health and know the major health effects from climate change.

(3) Become aware of the special vulnerability of public health in the South-East Asia Region as a result of climate change.

(4) Better analyse the health sectors' vulnerability to climate change effects.

(5) Have an improved understanding of the epidemiologic methods used to analyse associations between climate change and health outcomes.

(6) Be aware of adaptation and mitigation policies to manage the risks of climate change.

(7) Develop skills in critical thinking for making management decisions to reduce the potential adverse impacts of climate change on health.

(8) Understand the role of the health sector in national, regional and global negotiations and agreements for dealing with climate change mitigation and adaptation.

(9) Identify knowledge gaps and know where to find further sources of information.

(10) Be in a position to help incorporate the health dimensions of climate change in local and national climate change work plans.

(11) Be able to facilitate the training of other health professionals on the basic concepts of climate change and its health effects, as well as on how to carry out mitigation and adaptation in the health sector.

(12) Enhance stronger and more efficient participation of the health sector in addressing climate change challenges.

Outline of the Training Package

The materials for this course were originally developed by Alexander von Hildebrand, Regional Advisor Environmental Health & Climate Change, SEARO who worked in concert with Dr Kristie Ebi of ESS, LLC, Executive Director of the Intergovernmental Panel on Climate Change Working Group II, with David Mills of Stratus Consulting and with Dr Hisashi Ogawa, Regional Advisor WHO Regional Office for Western – Pacific (WPRO). Together they developed the course framework, identified relevant expert authors of the chapters on particular topics and edited the training material. The project had the financial support of SEARO. The training content was reviewed by a number of health experts working mainly in SEARO.

The current version of the training was then further developed under the direction of Payden of WHO/SEARO with funding and technical support of GIZ, Bonn. Modules were revised and developed by four experts as below:

Responsible person	Title
Dr Kristi Ebi University of Washington	Module 1: Introduction to weather climate, climate variability and climate change Module 5: Impact of thermal extremes Module 6: Extreme Weather Events Module 10: Air quality and human health Module 14: UNFCCC Modules 15: Disaster risks management and reduction
Dr Kathryn Bowen Australian National University	Module 2: Population health and CC: Global and regional perspectives Module 3: Policies and practice of mitigation and adaptation – relevance to health Module 11: Assessing health vulnerability (HNAP) Module 12: Adaptation Module 13: Mitigation and co-benefits Module 16: Communication
Dr HK Cheong Sungkyunkwan University School of Medicine	Module 4: Disease burden estimates, modelling health impacts – key concepts Module 8: Water- and food-borne diseases Module 9: Food security and nutritional conditions under changing global climate
Dr Lutfan Lazuardi Gadjah Mada University	Module 7: Vector-borne disease

The original training package was reviewed by a small group consisting of the four experts, Ms Ute Jugert and Ms Ursula Schoch from GIZ, Dr Nasir Hassan and Mr Jung Sub Yeom from WHO/WPRO, Ms Payden from WHO/SEARO and Ms Elena Prats Villalobos from WHO/HQ in a two-day meeting held in Gadjah Mada University, Yogyakarta, Indonesia in June 2014. The work for revising the modules were divided among the four experts and the draft modules were then reviewed in September 2014 in Bangkok, Thailand by the same group. The final draft was rolled out in a biregional workshop held in Gadjah Mada University in January 2015. Final feedback was then incorporated. Dr David Sutherland and Ms Kati Thompson contributed in the final review and design of the training package.

The Training Package consists of:

Component	For use on Day/s…	Name and location
Day overview slides	Days 1 – 5, at the beginning of the day and after lunch	*Training slides\Day overview slides*
Introductory slides	Day 1 (morning)	*'Introduction to the training'* in *'Training slides'*
16 training modules, presented on visual PowerPoint slides with text notes, including instructions for the delivery of integrated exercises	Days 1 - 5	Modules 1 – 16 in *'Training slides'*
2 videos	To be played within Module 1	*'Training slides\Videos'*
Guides to exercises (outside of training modules)	For the beginning and end of Days 1, 2 and 5	*'Guides for trainers'*
A 'Trainer Guide' for each module	Days 1 – 5, to guide trainers in how to deliver the content (in addition to notes below each slide)	*'Guides for trainers'*
A glossary, reference list, list of acronyms, and slide handouts for each training module	Days 1 – 5 as a 'Participant's Handbook'	*'Training handouts'*

Training venue and equipment

Hosts of the Climate Change and Health training should consult the Venue, Equipment and Printing Guides contained in the Training Package, under *'Guides for training hosts'*. These set out explicit needs for the training venue that should be selected and booked for the training, and the equipment and printing that will need to be arranged in advance of a training course.

Participants' equipment

Each participant should receive the supplies listed below:

- Training outline (not a print off of the Session Plan for trainers)
- Participant's Handbook in a folder or binding
- Notebook and ballpoint pen
- A bag to keep all the above items.

Session Plan for the training

A draft Session Plan (timetable) has been provided as part of this Training Package. A suggested timetable for a four-day training course is a seven-hour working day, four hours in the morning and three in the afternoon. This may not always be suitable and may have to be modified. The Session Plan can also be adjusted for different lengths of trainings and participant learning needs.

However, in any training outline organizers must allow adequate time for both delivery of elements and the following aspects:

- **Exercises to help participants get to know each other** – Group learning and ongoing working relationships will be one of the most valuable results of the training.
- **Group exercises** – Participants will struggle to learn within long periods of one-way didactic learning, particularly with detailed technical material which is likely new to them. Group exercises break up the delivery mode and help participants interpret and embed learning into their existing knowledge base.
- **Poster sessions** – As well as the information contained in the training slides, participants will bring with them valuable experience and insight into how climate change is affecting health in their own contexts, and what programmes are being designed to respond. Allowing time for sharing between participants at a poster and discussion session will allow for valuable sharing of experience and ongoing relationships.
- **Reflection and action planning exercises** – One of the key goals of the training is to influence the knowledge and practice of health professionals. Time for participants to reflect on how they will apply what they have just learnt in their own context, and make specific plans for action at the individual, organization, region or country level is therefore essential.
- **Pre- and post-testing** – Testing participants before and after the training using the same questions allows for assessment of the change in participants' knowledge as a result of the training. In addition to qualitative evaluation and action planning outcomes, this helps show the outcomes investment in the training programme has resulted in.
- **Evaluation both during and after the course** – In order to improve the training and its delivery, it's important to ask participants for feedback at the end of Day 1 (using the exercise '*Day 1 Evaluation Activity - Post It Wall*'). This allows for short-term changes to the design, delivery and practical logistics of Days 2 – 5 that will benefit both the participants and trainers. Evaluation at the end of the training then allows for assessment of outcomes from the training, as well as gathering ideas for ongoing improvement of the Training Package and trainer delivery.
- **Ample break time**, ideally including fresh air breaks outside – to keep participants energized and refreshed throughout long training days.
- **Extra time for unforeseen situations**, such as getting involved into working groups, delays in transportation to the place of training and so on.
- **Time for further discussion of topics important to the group**, or possible additional action by the participants.

Training style

Accessible – The training's purpose is to help change the knowledge and practice of health professionals regarding climate change. Therefore all concepts presented in the training need to be made accessible to participants so that no one is alienated by technical or academic concepts that they're not familiar with. At all points, but particularly in dense or technical sections of the training package, check in with participants on their understanding. Define terms (using the glossary where needed), explain concepts in simple language, and describe the relevance and significance of the concept for health professionals on the ground. The Trainer Guides have pointers on areas of training modules that may be challenging for participants to comprehend, and ways to make them more accessible.

Practical and real world focused – Where possible, refer academic concepts and models back to real world scenarios and case studies. What effect is this trend having? What have other countries, regions or hospitals done to respond to this? What can these health professionals do? Ensure that enough time is left for all action-oriented activities designed into the Session Plan and training slides to be carried out, as these will help participants to translate their learning into practical action.

Engaging – In order for participants to continue to learn over a multi-day training made up of long days, the style of training used must engage them. Avoid a one-way didactic delivery style where only you as the trainer are heard for the entire Training Module – this will make it almost possible for participants to stay engaged for a full 60 minute session.

Follow notes provided in the training slides and accompanying activity guides to involve participants as much as possible throughout a module, using questions, exercises, humour, case studies, videos, stretch breaks, challenges and stories from your own experience. Remember that our brains can only concentrate for a certain period – ideally no longer than 40 minutes in one stretch without moving, carrying out an activity or having a brief break. It's much more important that you reengage participants with a short stretch or exercise, rather than 'pushing through' to complete a presentation.

Use your body language and voice effectively to help engage people. Move around the room to provide variety, using a slide changer in your hand or pocket so that you can speak from anywhere. Avoid carrying outline notes with you (leave them on a table nearby) so that you can use your hands, arms and body to emphasise your points and provide visual interest. Varying your tone of voice and the volume with which you speak will also keep people engaged.

In the Session Planning process, ensure that training modules are swapped between at least two trainers to provide variety and interest for participants. Ideally few, if any, sequential modules will be delivered in a row by the same trainer. If this is needed due to one trainer having expertise in the subject of sequential modules, schedule a break between modules and encourage the trainer to bring new energy to the second module delivered so that participants don't become disengaged.

Recognizing participants' knowledge and experience – In dividing modules between trainers in the Session Plan, trainers should work to their strengths, opting for modules on topics they have some familiarity with. However, trainers do not need to be total experts on the module topic. Remember that participants bring with them a wide variety of knowledge and experience, whether through formal study, practical work in the field, or a combination of both. Allow regular opportunities for participants to share their experience with the group or with each other directly – in many cases learning from the proven practice of other participants will be of equal or greater value to those attending than the designed training material.

Responsive to participants' needs – A suggested Session Plan has been provided in this Training Package, indicating an order for Modules 1 – 16 that would flow well sequentially. This order is featured in the last slide of each set of training module slides, with a 'Coming next' slide. Activities and interactive sessions such as poster displays and field trips have also been included. However training organisers are welcome to alter the suggested order of training modules, based on available time and participant interest.

Once training has begun, trainers can also get a sense of participant interests in the opening exercise 'Reasons for being here'. Feel free to then steer emphasis towards learning areas that are most common for participants, so that learning goals are achieved.

Trainers should also touch base as a group at the end of each training day to review how things are going and any changes that may help meet participants' needs and interests.

For any questions on the delivery of the Climate Change and Health Training Package, please contact Payden at WHO SEARO: payden@who.int

We wish you all the best in the delivery of the training!

Module	Scope	Length
Day 1		
Module 1: Introduction to weather, climate, climate change and variability	Provides an introduction to definitions of weather, climate, climate variability and climate change; trends and projections in climate; the health risks of climate variability and change; and the role of the health sector nationally and internationally in preparing for, preventing, and coping with the health risks of climate change.	1 hour
Module 2 – Population health and climate change	South-East Asia and the Western Pacific are disaster prone regions; Overview of the main findings most relevant to health from the latest IPCC report, called the AR5; Action the health sector can take to reduce the health impacts of climate change in SE Asia and the Western Pacific.	1 hour
Day 2		
Module 3: Policies and practice of mitigation and adaptation	The basics of adaptation and mitigation, and their relevance to health; The options for mitigation and the cobenefits (or 'win-win') for mitigation and health; Framing mitigation and adaptation as risk management.	1 hour
Module 14: Health and the UNFCCC	Orientation to the United Nations Framework Convention on Climate Change (UNFCCC); Adaptation activities under the UNFCCC; Financial mechanisms for support of country action on health and climate change; Health action within the UNFCCC.	1 hour
Module 13: Mitigation and cobenefits	Introduction to mitigation; Cobenefits of climate change mitigation for the environment and human health.	50 minutes
Module 12: Adaptation to climate change	The theory and practice of adaptation; The process of conducting an adaptation assessment; Examples of adaptation activities in the WP and SEA region.	1 hour
Module 11: Assessing health vulnerability	Defining key terms around health vulnerability; The main causes of vulnerability to disease and injury resulting from climate change; The Health National Action Plan (or HNAP) and Health Impact Assessment (or HIA) approaches to assessing vulnerability.	1 hour

Module	Scope	Length
Day 3		
Module 5: Thermal extremes	Understanding thermal extremes; Identifying thermal extremes; Who is vulnerable to thermal extremes; How to assess the risks and impacts of thermal extremes; Potential impacts of thermal extremes.	1 hour
Module 6: Extreme weather events	How to understand the health risks from extreme weather and climate events; Worldwide trends in hazards; Extreme weather and climate events in Asia and the Pacific; Sources of vulnerability to extreme weather events; Public health risks from extreme events; Disaster risk management.	1 hour
Module 15: Disaster risk management	The multiple sources of vulnerability to extreme weather and climate events and disasters in Southeast Asia and the Pacific; UNISDR Hyogo Framework for Action; Disaster risk management vs. climate change adaptation; Early warning and response systems.	1 hour
Day 4		
Module 4: Assessment and prediction of the health impacts of climate change	Types of analysis of climate-related health effects; Modeling the health impacts of climate change; Uncertainties in analysis and modeling; Changing vulnerability.	70 minutes
Module 7: Vector-borne diseases and climate change	Introduction to vector-borne disease (VBD); Effects of climate change on VBD; Case studies of climate change effects on VBD; Potential for adaptation to minimize health risks and impacts.	1 hour
Module 8: Water-borne diseases and climate change	Water quantity and quality; Burden of diarrhoeal diseases; How climate and weather affects diarrhoeal diseases and water-borne pathogens; Measures to address water-borne diseases.	1 hour
Module 9: Food security and malnutrition	Define terms related to food insecurity and look at its causes; The burden of disease from undernutrition; How climate change is affecting food security; How climate change is likely to affect crop production and food security; Steps that can improve food insecurity.	70 minutes
Day 5		
Module 10: Air pollution	Introduction to air pollutants and their characteristics; Exposures to air pollution; Health impacts of air pollution; Benefits of air quality policies.	1 hour
Module 16: Communicating climate change and health	Why communicate; Communicate with whom; How to communicate; What to communicate; 6 principles for good communication.	1 hour

The modules are designed as standalone modules. One or a combination of few can be taken up separately for different target groups. For eg. Module 1 can be used for advocacy to Policy makers. Module 14 can be used for Health & Environment officials involved in climate change discussions etc.

Appendix 1: Contributing Authors and List of Reviewers

Dr Kristie L. Ebi, University of Washington

Dr Ebi has more than 25 years experience evaluating the health impact of environmental stressors with about 20 years of applied research on the human health impacts of and adaptation to climate change. She was a lead author on the Human Health chapter of the IPCC Fourth Assessment Report, and the Human Health chapter for the U.S. Synthesis and Assessment Product Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems. Dr Ebi was Executive Director of the Intergovernmental Panel on Climate Change Working Group II (Vulnerability, Impacts and Adaptation) Technical Support Unit from 2009-12. Dr Ebi is currently Professor, Department of Global Health, School of Public Health, University of Washington, Seattle, specializing in public health issues related to climate change impacts and adaptation.

Professor Hae-Kwan Cheong, Sungkyunkwan University School of Medicine, Republic of Korea

Professor Cheong is an environmental epidemiologist. His main area of research encompasses the effects of climate change on health including on infectious diseases; environmental burden of disease due to climate change and environmental hazards, air pollution and health; neurotoxicology of metals including manganese, lead and mercury; epidemiology of neurodegenerative disorders; and various issues on environmental and occupational health. He is actively involved in the research in these issues with the Korea Center for Disease Control and Prevention and the Ministry of Environment. Currently, he is co-chairing the Korea Climate Change and Health Forum and he was a former chair of the Korean Society of Environmental Health and Toxicology. He had worked with WHO/EURO on climate change and health programme. Since 2009, he has been working as a consultant for WHO/WPRO on a series of project on climate change and health in vulnerable countries such as Mongolia, Papua New Guinea and Cambodia. He was one of the authors of the synthesis report on climate change and health of the Western Pacific region. Recently he facilitated training on data analysis for health and meteorological data for a team from Bhutan.

Dr Kathryn Bowen, Australian National University

Dr Bowen has a PhD in global health, climate change and governance from the National Centre for Epidemiology and Population Health (NCEPH), Australian National University (ANU), and a MSc (International Health) from Charité Medical Faculty, Berlin. She holds appointments with ANU and the University of Melbourne. Dr Bowen has worked in global health research, practice and policy since 1999, across public, private and university sectors. She is a Research Fellow within the Earth System Governance project, and Fellow of the Adaptation College and the Centre for Sustainability Leadership. Dr Bowen is co-founder of Just Change, a climate change and equity organization, and sits on an environment advisory committee for the City of Melbourne. Dr Bowen's roles have included a number of significant engagements for a variety of funders, including governments, nongovernment organizations, and UN organizations, where she has worked extensively in many developing countries. Dr Bowen has worked in a range of cross-cultural settings and held the responsibility for project coordination and stakeholder engagement across a large programme of sustainability work.

Dr Lutfan Lazuardi, Universitas Gadjah Mada

Dr Lazuardi is the head of Master Program of Public Health Informatics and the vice-head of Public Health Department at the Faculty of Medicine, Universitas Gadjah Mada. He obtained his Medical Doctor from Gadjah Mada University, Indonesia, in 1999 and Master of Public Health in 2002. He earned a PhD from Innsbruck Medical University in 2006. He has been involved in various projects related to public health and health management information system. He was involved in the development of Malaria Elimination Database in Sabang district, and Information and Communication Technology for Disease Surveillance System at several areas in Indonesia.

In 2012, he was involved in a project funded by SIDA (Swedish International Development Cooperation Agency) called "CC-MAP: Climate Change Mitigation and Adaptation Policies in the Health Sector" in collaboration with Umeå University, Sweden. Since that time, the project has been expanding and involving various institutions such as Health Offices in Gunungkidul and Yogyakarta and Västerbotten County Council in Sweden. Currently, he is involved in a multi-year project on the development of early warning system for dengue fever using climate data in Yogyakarta.

List of Reviewers

Regional Office for South-East Asia (SEARO)

- Dr Roderico Ofrin, Coordinator, Emergency and Humanitarian Action
- Ms Payden, Regional Adviser, Water, Sanitation and Health
- Dr David Sutherland, Technical Officer, Water, Sanitation and Health
- Dr Leonard Ortega, Regional Adviser, Malaria
- Ms Vismita Gupta-Smith, Public Information and Advocacy Officer
- Ms Sushera Bunluesin, WHO Thailand
- Mr Sharad Adhikary, Environmental Health Adviser, WHO Indonesia
- Mr Raja Ram Pote, NPO, Climate change and health, WHO Nepal
- Mr Tito de Aquino, NPO, Environmental health, WHO Timor-Leste

Regional Office for Western Pacific (WPRO)

- Dr Nasir Hassan, Coordinator, Health and Environment
- Mr Jung Sub Yeom, Technical Officer, Health and Environment

WHO Headquarters

- Ms Elena Prats Villalobos, Technical Officer, Climate change and health

GIZ Bonn

- Ms Ute Jugert, Head, Global Program Adaptation to Climate Change in the health sector, Health Section
- Ms Ursula Schoch, Advisor, Global Program: Adaptation to climate change in the health sector, Health Section

Others

- Ms Kati Thompson, Training Design and facilitation specialist, Australia
- Dr Nitish Dogra, Principal Public Health Adviser, TARU Leading Edge, India – contributed two case studies

Evaluation activity: Post it wall

Purpose of the activity:

This ‘pulse check’ evaluation exercise allows you to quickly get a sense of how the training is going for participants at the end of Day 1. Participants will often be reticent in sharing what they think about the training set up with organizers directly, so the confidential format can provide valuable ideas that allow you and the training team to make any adjustments to Day 2 (and following days) rather than waiting until Day 5 for evaluation forms to be submitted.

Required resources:

- Post its (enough for 5 per person)
- Whiteboard, drawn up with two wide columns and a ‘smiley’ and ‘frowny’ face

Preparation:

On a whiteboard, draw one dividing vertical line, dividing the board into up two wide columns. At the top of the left column draw a large ‘smiley’ face, and on the right a ‘frowny’ face, with a question mark by its head or in a thought bubble. Place the whiteboard towards the back of the room.

If a whiteboard on wheels is not available, draw each of the faces on flipchart paper and blu tak them next to each other on the back wall, close to the exit.

Place a pile of post it notes of different colours (enough for 5 per participant) on each table, or give them to another trainer to distribute across the tables as you’re introducing the exercise.

Timing – 10 minutes

Instructions for delivery

1. Before the group leaves for the day, tell them that “this training course is designed to be of most use to you as health professionals. This is also the first time we have run this training, and we’d like to make it as valuable for you as we can across the five days.

So before you go, could I ask you to please think about how today has been for you? You might think about the pace of the day, the style of the modules, the breaks and food, the venue, or how the trainers have shared the material with you.

You’ll see in front of you on the table some post its. Please write down on some post its some things you’ve found good about the day. And also – and this is very welcome and encouraged – any suggestions for improvement for tomorrow and the following days.

Please write only one idea per post it.

At the back of the room you’ll see on the whiteboard/wall a smiley face and a frowny face, who’s wondering about possible changes. As you leave, please place your post its under the relevant face. It would be great to get at least a few ideas for each per person.

Thank you very much for your feedback, and have a great evening. We’ll see you all tomorrow morning back here just before 9 am.”

Post-training questions

Now that you have completed the training, please spend the next 15 minutes filling in your responses to the following questions. These results will not be shared, but will be used internally by the WHO SEARO office to evaluate the influence of the training on participant learning.

1. **What is the difference between climate variability and climate change?**

2. **Name three risks to health that occur currently and are predicted to arise in the Western Pacific and South East Asia regions due to climate events:**

   (1)

   (2)

   (3)

3. **What does the concept of 'co-benefits' or 'win-win' strategies mean in relation to climate change and human health?**

4. **Explain the advantages and disadvantages of health modelling**

5. **What impacts do high ambient temperatures have on human health in a changing climate?**

6. **What are some of the extreme weather and climate events that affect Asia and the Pacific?**

7. **Describe the effects of climate change on vector-borne diseases:**

8. **Explain how the amount of rainfall is related with occurrence of water-borne diseases:**

9. **Explain how climate change can affect malnutrition of children in a specific local area: i) Pacific Island countries, OR ii) Mongolian steppes?**

   My area choice (i or ii):

   Effects:

10. **How could a changing climate affect respiratory health?**

11. **Name three causes of vulnerability in the context of climate change:**

    (1)

    (2)

    (3)

12. **What is the main goal of climate change adaptation in the health sector?**

13. **Which economic sector directly emits the largest amount of greenhouse gases?**

14. **Why should health feature strongly in international climate change negotiations?**

15. **What are the two basic approaches for reducing the health risks of the extreme weather and climate events in Asia?**

    (1)

    (2)

16. **Why should we in the health sector communicate widely around climate change and health?**

Pre- and post-training testing question and answers (for WHO marking and evaluation only)

Question 1 (Module 1): What is the difference between climate variability and climate change?

Answer: Climate variability is short-term fluctuations around the average weather, and climate change operates over at least three decades.

Question 2 (Module 2): Name three risks to health that occur currently and are predicted to arise in the Western Pacific and South East Asia regions due to climate events.

Answers from the following options: undernutrition, vector-borne disease, heat-related mortality, water-borne disease.

Question 3 (Module 3): What does the concept of 'cobenefits' or 'win-win' strategies mean in relation to climate change and human health?

Answer: If emissions are reduced (mitigation), health of the human population is improved.

Question 4 (Module 4): Explain the advantages and disadvantages of health modelling.

Answer: Advantages: Provides best explanation or prediction of likely health impacts based on current knowledge

Disadvantages: Cannot predict what will actually happen, due to unexpected changes or other unknown factors

Question 5 (Module 5): What impacts do high ambient temperatures have on human health in a changing climate?

Answers from the following options: Heat stress, heat stroke, hospitalization for cardiovascular and respiratory disease, death

Question 6 (Module 6): What are some of the extreme weather and climate events that affect Asia and the Pacific?

Answers from the following options: Floods, storms, storm surges, cyclones and droughts.

Question 7 (Module 7): Describe the effects of climate change on vector-borne diseases.

Answer (one of):

(1) Climate change may increase the range or abundance of both animal reservoirs and arthropod vectors (e.g. Schistosomiasis in China and malaria in the Kenyan Highlands).

(2) Climate change may prolong the length of the transmission cycles of disease or the transmission season of diseases (e.g. West Nile virus in North America has an amplification cycle involving mosquitoes and avian reservoir hosts).

(3) Climate may increase the likelihood of successful importation of disease vectors and animal host reservoirs (e.g. the global spread of Asian tiger mosquito, Aedes albopictus, which has been linked to the sale of used tires around the world, was linked to an outbreak of Chikungunya virus).

(4) Climate change may increase animal disease risks and are likely to increase the risk of human disease as well.

Question 8 (Module 8): Explain how the amount of rainfall is related with occurrence of water-borne diseases.

Answer:

(1) Heavy rainfall is usually related with increased incidence of water-borne diseases. Heavy rain will bring sewage and contaminants from human excreta into drinking water sources. However, depending on the mode of transmission and biologic characteristics of each pathogen, there can be a delay between rainfall and disease outcome. Diseases with longer incubation periods such as Hepatitis A will have longer delay, including reporting delay. Some diseases that have a natural reservoir, such as Cholera, may also demonstrate a longer lag between rainfall and disease occurrence.

(2) Less rainfall over a long-term period will push the community toward a water stress situation, in which water usage for washing and daily cleaning are less available. Prolonged water shortage may predispose people toward more opportunities to transmit faecal-orally transmitted diseases through person-to-person transmission.

Question 9 (Module 9): Explain possible pathways that climate change can affect malnutrition of children in a specific local area: i) in Pacific Island countries, OR ii) Mongolian steppes?

Answers (hypothetical representations, to be added to with participant understanding of local context)

Pacific Island countries

(1) Sea-level rise will restrict and accelerate salination of the freshwater reserve of the atoll island.

- As the freshwater source dies out, plantations will become less productive and food resources get scarce.
- Decreased food availability can be aggravated by lower food accessibility of the vulnerable population such as children and the poor. Sociocultural and socioeconomic status of the local island can interact with food accessibility in contrasting ways, either worsening or improving access to food.

(2) Higher sea level exposes the atoll, leading to higher susceptibility to storms and tsunami.

- Natural disasters may worsen food availability and distribution issues. Relocation of the population will aggravate the food availability and balance, with deficits in the specific nutrients that are needed for the growth of children.

(3) Depending on food resources, more imported food may distort the nutrient balance, which can drive health toward malnutrition.

OR

Mongolian steppe

(1) Extreme weather events and desertification

(2) Accentuated climate variability may be related with more frequent and more severe extreme weather events such as dzud in winter and flooding in summer. Prolonged drought may facilitate desertification of the steppe near the margin of the Gobi desert.

(3) Desertification and extreme weather events immediately bring about the massive loss of livestock, both a food source and economic basis of the households, predisposing people to undernutrition, especially children. Less money means less milk and weaning food products for the infant and young children. Less livestock means less dairy food material for the growing children.

(4) Acute effects:

– Food availability and accessibility as well as nutritional balance drives undernutrition of children, which is more prominent in younger children and infants, who have more critical need for essential nutrients and calories.

(5) Long-term effects:

– Relocation or migration into periphery areas of a city makes households rely more on the market for food, making nutrition more sensitive to the economic status of the household. Amount and balance of nutrients, especially those for children, can be affected.

Question 10 (Module 10): How could a changing climate affect respiratory health?

Answer: Through changing concentrations of ozone and particulate matter, both of serious concern in Asia and the Pacific.

Question 11 (Module 11): Name three causes of vulnerability in the context of climate change.

Answers from the following options:

- Geographical location
- Socioeconomic status
- Health status
- Governance
- Preparedness
- Physical environment
- Policies

Question 12 (Module 12): What is the main goal of climate change adaptation in the health sector?

Answer: To prepare for, and effectively respond to the health risks of climate change.

Question 13 (Module 13): Which economic sector directly emits the largest amount of greenhouse gases?

Answer: Agriculture, Forestry (and other land use)

Question 14 (Module 14): Why should health feature strongly in international climate change negotiations?

Answer: Health should be central to considerations of adaptation (because people are already being affected) and mitigation (because most energy and environmental decisions have health implications).

Question 15 (Module 15): What are the two basic approaches for reducing the health risks of the extreme weather and climate events in Asia?

Answer: 1) Disaster risk management; and 2) Adaptation.

Question 16 (Module 16): Why should we in the health sector communicate widely around climate change and health?

Answers from the following options (and other possibilities):

- Because climate change is a threat to human health and wellbeing
- The health sector is responsible for doing this; climate change is an intersectoral issue
- Climate change and health still requires further advocacy efforts
- Impacts are already being experienced
- Many people currently have low levels of understanding on the health impacts of climate change
- We need to prepare for the health impacts of climate change
- Everyone needs to be involved in reducing our contribution to climate change.

Pre-training testing

Before beginning the training, please spend the next 15 minutes filling in your responses to the following questions. These results will not be shared, but will be used internally by the WHO SEARO office to evaluate the influence of the training on participant learning.

1. What is the difference between climate variability and climate change?

2. Name three risks to health that occur currently and are predicted to arise in the Western Pacific and South East Asia regions due to climate events:

(1)

(2)

(3)

3. What does the concept of 'cobenefits' or 'win-win' strategies mean in relation to climate change and human health?

4. Explain the advantages and disadvantages of health modelling:

5. What impacts do high ambient temperatures have on human health in a changing climate?

6. What are some of the extreme weather and climate events that affect Asia and the Pacific?

7. Describe the effects of climate change on vector-borne diseases:

8. Explain how the amount of rainfall is related with occurrence of water-borne diseases:

9. **Explain how climate change can affect malnutrition of children in a specific local area: i) Pacific Island countries, OR ii) Mongolian steppes?**

   My area choice (i or ii):

   Effects:

10. **How could a changing climate affect respiratory health?**

11. **Name three causes of vulnerability in the context of climate change:**

    (1)

    (2)

    (3)

12. **What is the main goal of climate change adaptation in the health sector?**

13. **Which economic sector directly emits the largest amount of greenhouse gases?**

14. **Why should health feature strongly in international climate change negotiations?**

15. **What are the two basic approaches for reducing the health risks of the extreme weather and climate events in Asia?**

    (1)

    (2)

16. **Why should we in the health sector communicate widely around climate change and health?**

Introductory activity: Reasons for attending the training

Aims of the activity:

- Understanding participant expectations from the training, gauging the extent to which they match its realities and correcting any misconceptions so that no-one commences the training with unclear or false expectations.
- Providing you with information as trainers on how to tailor training content and examples you provide to help meet the group's learning needs.
- Encouraging a sense of excitement and anticipation in the group about the training.

Resource requirements:

- Large open space at the back of the training room
- Whiteboard, whiteboard markers and scribe to capture two brainstorms/lists

Timing: 15 minutes

Instructions for delivery

***NB:** This activity follows on directly from the Human Map*

1. Participants are standing in the map they created in the first introductory exercise. Acknowledge how far participants have come to be here – as everyone can see on the map, and the time they're taking out of their busy schedules.

   "But you've obviously come here for a reason! I'd like you to turn to a person near you on the map, introduce yourselves, and tell each other **why you've come to the training.** Take turns doing this – you'll have 30 seconds each."

2. Ring a bell at 30 seconds, letting people know to swap over. At 1 minute stop this first round of conversations and ask them to find a new partner, someone from a different country or region from themselves.

   "Ok, thanks for sharing with your first partner. In a minute I'm going to ask you to now cross the map and find someone from an entirely different country and possibly even region from yourself. Again, introduce yourselves, and tell each other **what you're hoping to get out of this training programme.** You'll have a minute each this time – I'll ring a bell to remind you when to swap over."

3. Ring a bell at 1 minute, letting people know to swap over. At 2 minutes stop this second round of conversations and ask them to explore the map and find a third partner, someone from a different country or region from themselves.

   "In this last round of meeting, I'd like you to share in your pair **what you'd like to be able to do back in your work as a result of this training.** So, find your new partner, remembering to introduce yourselves."

4. Ring a bell at 1 minute, letting people know to swap over. At 2 minutes stop this third and final round of conversations by thanking people for exploring the map

and sharing some of the reasons why they've come to the training with their new colleagues.

5. Ask participants to gather around you in a semi-circle, hear a whiteboard. "It sounds like there were some great conversations going on. I'm curious to hear some of the reasons that were discussed."

   "Can I ask you to share some of the reasons you've discussed, and we'll write these up on the whiteboard here?"

Note that you'll have 10 minutes for this section, so keep the responses to the two brainstorms to 5 minutes each.

Visual brainstorm 1 (5 minutes)

"First off, what are **you hoping to get out of this training programme**? Can someone start us off? This can just be an idea or sentence." Summarize ideas that are shared one by one into a single phrase, making sure they're captured by the scribe in a brainstorm or list format. If ideas are mentioned multiple times, encourage the scribe to emphasize that point with a tick or underline. Seek responses from different areas of the semi-circle to get a range of responses from the group with "What about others, what are you hoping to get out of this training?", although in the 15-minute timeframe not everyone will be able to give a response. Do respond to any hopes that will not be covered or achieved by the training, ensuring that any false expectations don't persist.

"Thanks everyone – those are some great hopes you have for what you'll get out of this week. Please keep these in mind as we go through all of the training content, so you stay engaged and motivated in why you're here."

Visual brainstorm 2 (5 minutes)

"What about the last conversation you had - **what would you like to be able to do back in your work as a result of this training**? Would anybody like to share?" Again summarize ideas that are shared one by one into a single phrase, making sure they're captured by the scribe in a second brainstorm or list format on the whiteboard, with common action themes represented. Keep an eye on the time, finishing off before 10 minutes is up.

"Thanks everyone. First off it's good to know that you're in the right place, and have some great things you want to get out of this training. It's also inspiring to see the kinds of action you're interested in taking back in your countries with the support of this training. Let's start into it!"

Ask everyone to return to their seats.

Climate Change and Health Training Package: Training Equipment Guide

Overview

The training package is designed to achieve enhanced learning outcomes and value for participants by running interactive activities, small group exercises, sharing of best practice through poster displays and site visits, and interactive games to let the participants get to know each other.

This style is important not just for achieving learning outcomes, but because training is run over long successive days.

All of the following requirements are therefore important in selecting and booking a training venue for a WHO Climate Change and Health training.

Training equipment requirements: Provided by the training organizer/host

Equipment requirement	Quantity	Reason required
Laptop (ideally a PC) with all trainer presentations and videos loaded, and a recent version of Microsoft PowerPoint and Windows Media Player	1	To show training material
Charging cable for laptop	1	To maintain laptop power
Data projector (if not provided by venue)	1	To project training material
Charging cable for data projector	1	To maintain data projector power
Projector cable for laptop type	1	To connect the laptop to the data projector
Plug in audio speakers, if these are not contained in the projector unit	1	To listen to videos
Internet access		If don't have Windows Media Player, as a back up for playing videos, or showing relevant climate change and health websites
Slide changer and spare batteries	1	So trainers can move around the training space and continue the progress of the presentation
Clock and spare batteries	2 – 1 in training space, 1 in dining space	To keep time when delivering modules so that participants can return after breaks on time
Stopwatch	1	To keep time more accurately during exercises of only 2 – 15 minutes
Bell, chimes or gentle noise maker	1	To get participants' attention at the end of activities
Nametags	1 per participant, reusable	So trainers can call participants by name, and participants get to know each other easily

Equipment requirement	Quantity	Reason required
Whiteboard	1, 2 if possible	For writing up instructions and scribing participant input
Flipchart stand	1	For placing flipchart paper on and writing instructions or scribing participant input
Flipchart paper (large sheets of blank paper that can be stuck up on the wall)	2 – 3 large pads	For participants to use in exercises
Blutak (or removable adhesive)	1 large packet	To stick flipchart pages to the training room walls
Roll of wide tape	1	To stick flipchart pages to whiteboards and other surfaces
Scissors	1	For cutting tape
Markers or felt tip pens	3 per participant, of varied colours	For activities carried out on flipchart paper
Post it notes, or squares of paper that can be stuck to walls with blutak or other adhesive	10 per participant, of at least 2 different types of colours	For activities requiring short written input from individual participants
Pens	Enough for one per participant	In case participants forget to bring their own pen
Paper or blank notepads	Small quantity	In case participants want to take additional notes and don't bring their own notebook

Training equipment requirements: Provided by the trainer

Equipment requirement	Quantity	Reason required
Print off of Trainer Guide for all modules delivered by that trainer	1 per module	To use in preparation for delivery of the module
Print off of PowerPoint notes for all modules delivered by that trainer	1 per module	To consult in the preparation process and have present in the training room in case they need to be referred to
Personal trainer notes	1 per module (not provided)	To provide the trainer with their own overview of the module and actual timings (e.g. 10.20 am end time, rather than 30 minutes). Trainers should ideally not read off the full notes below each slide.

For any questions on these requirements please contact the organiser of the training or your WHO support person.

Climate Change and Health Training Package: Venue Guide

Overview

The success of this Climate Change and Health training relies in large part on our ability to engage health professionals in an engaging learning process that meets their needs. The training package is designed to achieve enhanced learning outcomes and value for participants by running interactive activities, small group exercises, sharing of best practice through poster displays and site visits, and interactive games to let the participants get to know each other.

This style is important not just for achieving learning outcomes, but because training is run over long successive days, requiring participants to stay engaged beyond all usual concentration limits (generally 40 minutes maximum for adults).

For these reasons, we rely heavily on a training venue that supports interactive teaching and learning methods, flexible delivery, and the ability for participants to maintain energy levels and concentration for long periods.

All of the following requirements are therefore important in selecting and booking a training venue for a WHO Climate Change and Health training.

Training venue requirements

Venue requirement	Reason required
Open room with no fixed furniture (not a lecture theatre) Large enough for participants to walk around in easily, and **big enough for two adjoining working spaces to be set up within the same room**, with space between the two sections: 1) **Round tables at the front of the room**, arranged in a semi-circle facing a large white wall or screen for projecting onto. (Square or rectangular tables can also be used). Each table should seat an even number of participants, likely 4 or 6, without restricted view of the screen. Allow 3 – 4 metres of room in front and behind the semicircle of tables for stand-up activities. 2) **Tables** (any shape) **with chairs around them at the back**, for participants to do small group activities at. Note that a room with fixed seating should **not** be used, such as a lecture theatre with rows of fold down seats, as this will not allow for planned interactive activities and exercises.	To be able to run teaching, interactive and small group activities within one space in a time efficient manner. So that participants can move easily around the space and share information between sessions.
Good **natural light** from windows facing directly into the room	To keep participants awake over long days of concentration!
Windows that open, air vents, fans or air conditioning that is adjustable within the room to maintain a high volume of air flow and oxygen	To keep participants awake over long days of concentration!
Close proximity to **toilets**	For participants to access during activities without wasting time
Close to **outdoor access**	For quick access to fresh air breaks, or for activities to be run outside (if appropriate)

Venue requirement	Reason required
Easy security access	So participants can come and go for quick breaks or activities, without needing to have someone waiting on the door
Disability access	So that any student applicant can have access to the training programme
Access to a **nearby kitchen** or dining hall	To keep participant's energy levels up with regular food and drink breaks, without having to travel far
Clear wall space for (carefully) affixing participant work and instructions	To create galleries of participant work in a blank room, to build on learning
Optional: **Internet access**	If Windows Media Player isn't available, as a back up for showing videos, or websites related to climate change and health
Optional: Sustainability features (if possible) such as light wells, double glazing, efficient lighting, tap flow restrictors, dual flush toilets, solar panels etc.	For showcasing to participants as we teach them about initiatives their health care facility can take to reduce their environmental impact.

Venue equipment requirements

Venue equipment requirement	Reason
Data projector	For projecting slides and videos
Whiteboard (at least one but two if possible)	For writing up instructions and scribing participant input
Flipchart stand	For writing instructions and scribing participant input
Chairs, enough for 2 per participant, plus one each for trainers and visitors	For participants to sit on in a semi-circle and around tables, without moving chairs between the two areas
Tables that can be easily collapsed and shifted on wheels	Enough for a maximum of six participants to sit around (at front), plus one for every four participants (at back), plus one for trainer materials

For any questions on these requirements or to compare venues you have access to, please contact the organizer of the training or your WHO support person.

Module 1

Introduction to weather, climate, climate change and variability

Key learning messages in Module 1

- It is important to know that there is a difference between weather, climate, climate variability & climate change
- Climate change is occurring & has a strong anthropogenic (human) influence
- The resulting changing weather patterns can affect human health trends & projections in climate
- Current & future consequences include sea-level rise, extreme weather events, droughts etc.
- The health sector has a role nationally & internationally in preparing for, preventing & coping with the health risks of climate change.

Estimated length: 60 minutes

Structure of Module 1

Section	Slides	Activity (if any)
Key learning messages	2–3	
Module outline	4	
1. Basic definitions of weather, climate, climate variability, climate change	5–7	VIDEO 1 on slide 7 - Walk the Dog video (1 min) Short discussion
2. Trends and projections in climate, including the most vulnerable regions of South East Asia	8–21	EXERCISE on slide 9: How has the weather changed over your lifetime? Groups of 3, 5 minutes VIDEO 2 on slide 10 - Climate 101 with Bill Nye (5 mins)
3. The health risks of climate variability and change	22–30	EXERCISE: All the ways that climate change is affecting health in your country/ countries The department/group that may be responsible for managing this. 10 minutes, groups of 3, list on flipchart paper
4. The role of the health sector nationally and internationally in preparing for, preventing, and coping with the health risks of climate change.	31–35	

Section	Slides	Activity (if any)
Module outline	36	
Learning from Module 1	37–38	
Questions	39	

Required resources

- Data projector and slide changer
- Module 1 slides
- Windows Media Player or Internet
- Speakers/sound system
- Two videos 'Walk the Dog' and 'Climate 101'
- Flipchart paper (2 pieces for every three participants)
- Markers (two for every three participants)
- Tables at the back of the room groups of three participants can sit around
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 1

As the first module of the training, Module 1 is important in ensuring participants feel confident in core concepts related to climate change. Keep in mind that these will be new terms and ideas for some people, and your own knowledge is likely far greater than those in the group you are training. Move slowly through the material, using questions and observations of faces and body language to ensure understanding of all participants before moving on.

The exercise on slides 27 – 28 gives participants time to explore for themselves the likely impacts of climate change. This is also the first interactive small group exercise within the training content. Give this the full 10 minutes or longer if required, so that people warm up to working in groups, and the connections between climate change and health become clearer for everyone.

Module 1 contains two videos:

1. Walk the Dog – played on slide 7
2. Climate 101 – played on slide 10

To play the videos as embedded video files you will need to ensure before you begin the presentation that you have an Internet connection.

If you don't have an Internet connection, open both videos in Windows Media Player and have each one ready to play when you click out of the relevant slide and into Windows Media Player. (The videos are saved in the videos folder of the Training Package, alongside the trainer slides).

Ensure you are connected to speakers before you start the presentation, and that the volume is working and appropriate to be heard at the back of the training venue.

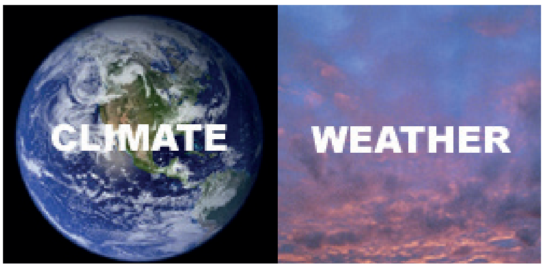
Key terms introduced in Module 1

- Climate
- Weather
- Climate variability
- Climate change
- Health impacts of climate change

References (in order presented)

- TeddyTV for NRK. 2012. *Walk the Dog*. https://youtube.com/watch?v=e0vj-0imOLw.
- Climate Reality Project. 2011. *Climate 101 with Bill Nye*. https://www.youtube.com/watch?v=3v-w8Cyfoq8.
- Arctic Climate Impact Assessment. 2008. http://www.acia.uaf.edu/.
- Alley, RB. 2000. *The Two Mile Time Machine*.
- Climate Central. 2014. http://www.climatecentral.org/
- Stott PA et al. 2010. *Detection and attribution of climate change: a regional perspective*. WIREs Climate Change; 1:192-211.
- IPCC. 2013. http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.
- Yusuf and Fransico. 2009. *Climate Change Vulnerability Mapping for Southeast Asia*
- IPCC. 2014. Working Group II Assessment Report 5. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for Policymakers*. http://ipcc-g2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf
- McIver et al. (unpublished)
- Ebi, KL. 2009. *Public health responses to the risks of climate variability and change in the United States*. Journal of Occupational and Environmental Medicine 2009; 51:4-12
- Government of Tokelau. 2014. http://tokelau.org.nz/Tokelau+Government/Government+Departments/Department+of+Economic+Development+Natural+Resources++Environment.html.

Module 1: Introduction to weather, climate & climate change



In this first module we're going to look at some of the fundamental concepts around weather, climate, climate change and climate variability.

The intention of this module to provide a broad overview on climate variability and change and their associated health risk, and the role of the health sector in climate change in international and national efforts to manage climate change.

For trainer: *Note that this module contains two videos. To play them as embedded video files you will need to ensure before you begin the presentation that you have an Internet connection and are connected to speakers. If you don't have an Internet connection, open both videos in Windows Media Player and have each one ready to play when you click out of the relevant slide and into Windows Media Player. (These are saved in the same folder as this PowerPoint)*

Connected videos (in order):
Walk the Dog – played on slide 7
Climate 101 – played on slide 10

2

Key messages in Module 1

- It is important to know that there is a difference between weather, climate, climate variability & climate change
- Climate change is occurring & has a strong anthropogenic (human) influence
- The resulting changing weather patterns can affect human health trends & projections in climate

Here are the key takeaways from Module 1.

1. CLICK - It's important to know that there is a difference between what we mean by weather, climate, climate variability and climate change. I will be providing you with some useful ways of remembering the difference between these concepts soon.
2. CLICK - Climate change is occurring, and humans are influencing the rate of change that we are witnessing.

3

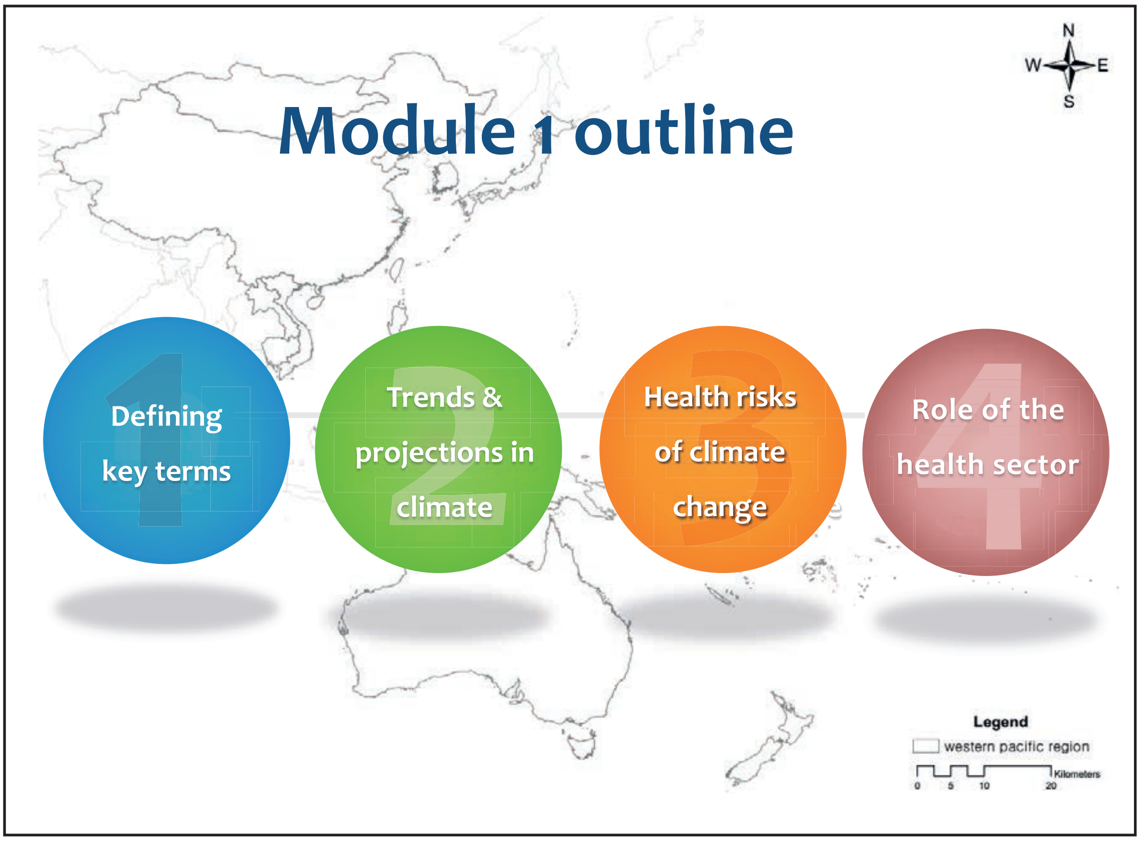
Key messages in Module 1

- Current & future consequences include sea-level rise, extreme weather events, droughts, etc.
- The health sector has a role nationally & internationally in preparing for, preventing & coping with the health risks of climate change

The last two key concepts in this module are:

1. CLICK - There are many current and future consequences of climate change, including sea-level rise, extreme weather events such as floods and cyclones, and droughts. We will see some examples of these and also provide some time where you can discuss what you have seen in your own countries and regions.
2. CLICK - The health sector has a role nationally & internationally in preparing for, preventing & coping with the health risks of climate change.

4



This is what we'll cover in Module 1, focused on weather, climate, climate variability and climate change:

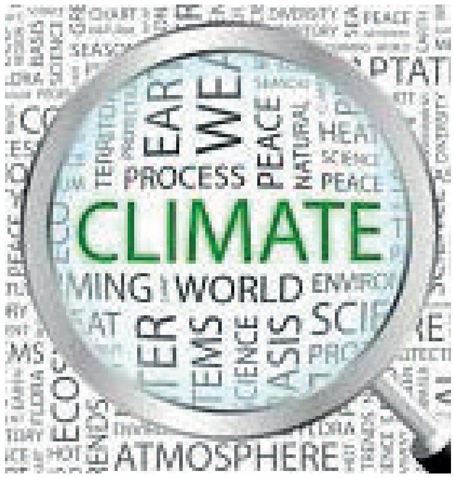
1. Basic definitions of weather, climate, climate variability, climate change
2. Trends and projections in climate, including the most vulnerable regions of South-East Asia
3. The health risks of climate variability and change
4. The role of the health sector nationally and internationally in preparing for, preventing, and coping with the health risks of climate change.

Let's now look at some of the key terms in this topic.

5

1

Defining key climate terms



Let's start off by looking at some definitions of common words used in the climate change field, so we have a good understanding of these.

6

Climate terms

Climate is what we *expect*

Weather is what we *get*

Climate variability
Short-term fluctuations around the average weather

Climate change
Operates over decades or longer
– General circulation models (GCMs)
  • Based on scenarios, not predictions

First, it's really important to understand the difference between weather and climate.

CLICK slide changer to animate each definition

Climate is what you expect, but **weather** is what you actually get on a day-to-day basis. Weather and climate are part of a continuum.

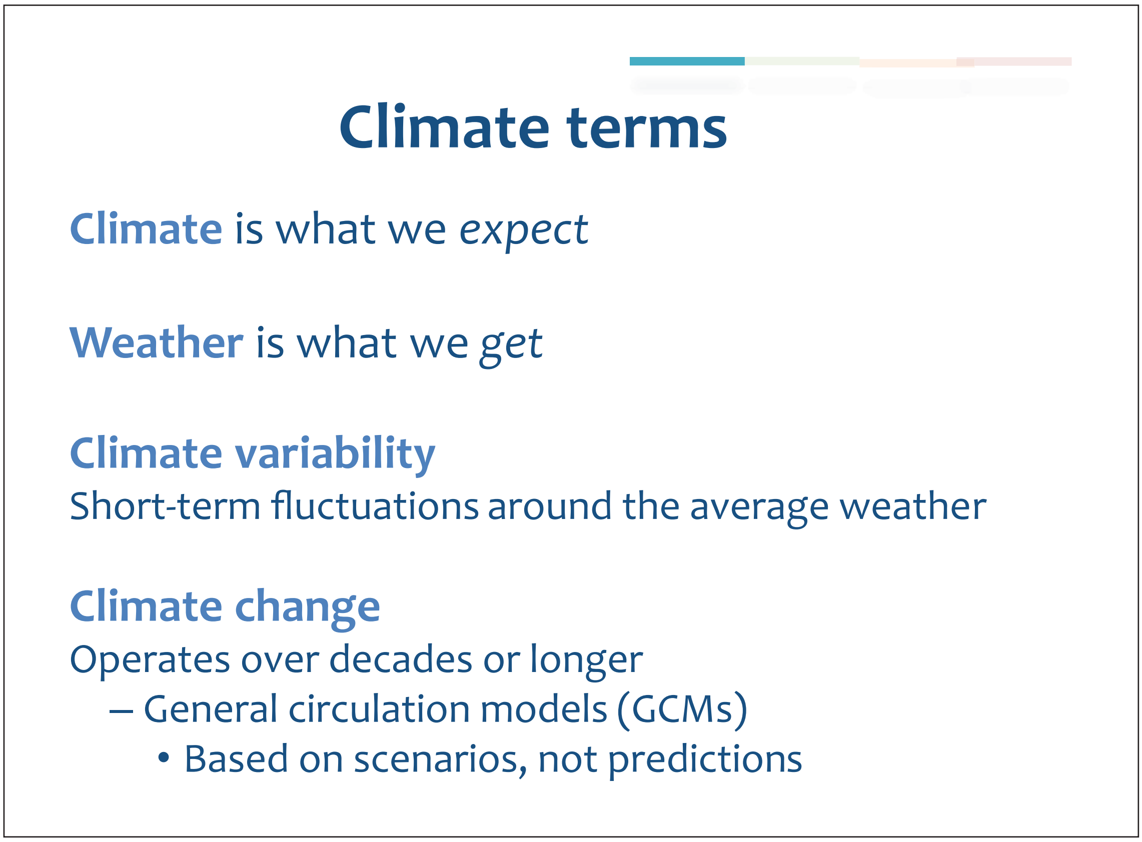
The World Meteorological Organization designates particular weather stations for collecting data on a range of weather variables for determining the "climate normal" or the 30-year average of weather variables in a particular location. Projecting what could happen over a 30-year time periods is, in some ways, less challenging than forecasting what will happen tomorrow or next week. Weather, then, is the day-to-day variability in climate that we experience.

The climate in a particular location is defined as the 30-year averages of weather variables, such as temperature and precipitation. Most of the research on the health impacts of climate variability and change uses the period 1961-1990 as the climate baseline. Climate scientists analyse data against this baseline.

So to summarise again, **weather** can change from minute to minute, hour to hour and day to day. **Climate** is the average of this weather calculated over a 30-year time period.
Q (rhetorical): Does that make sense?

CLICK - **Climate variability** is the term used to describe short-term variations around average weather. El Nino-Southern Oscillation (ENSO) events are particularly important expressions of climate variability for human health. As you will hear in other modules.

6

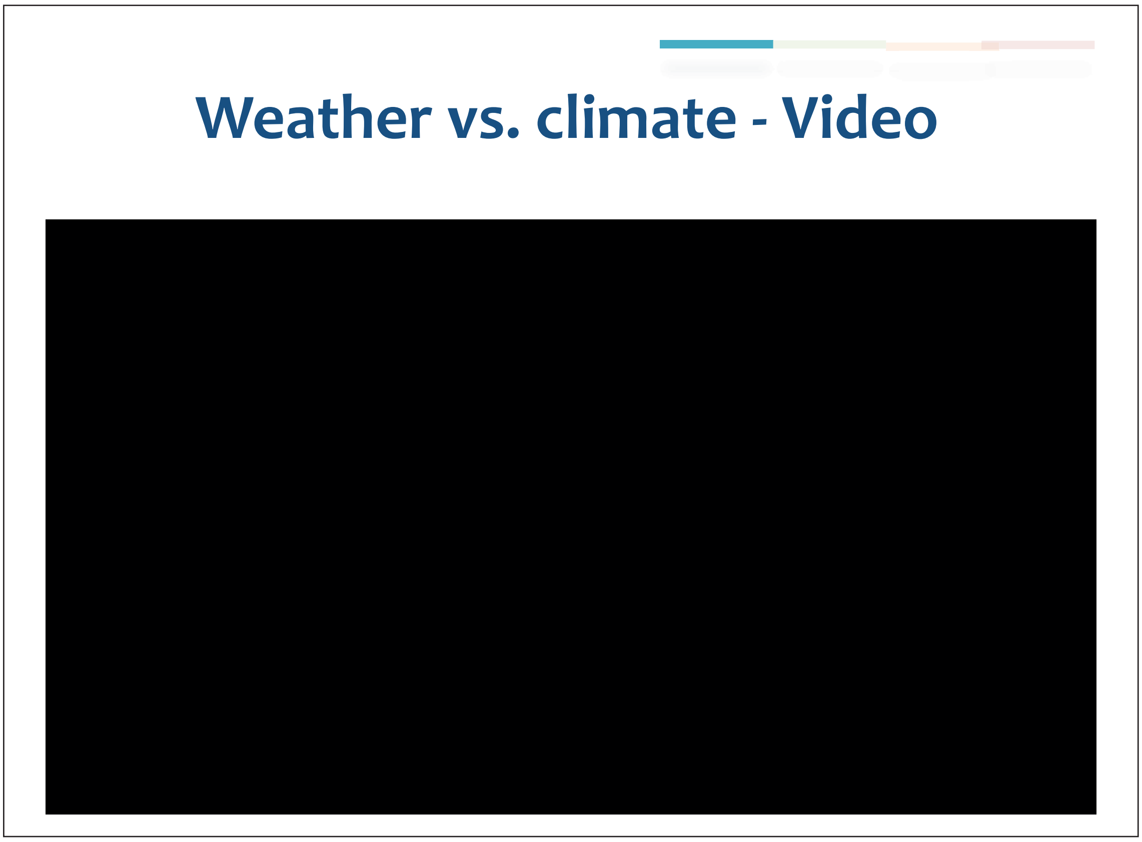


ENSO events are associated with adverse health outcomes in many regions. For example, in some regions of Asia and the Pacific, ENSO events are associated with drought. In other regions, ENSO events are associated with flooding. Both extreme events can cause direct and indirect health impacts.

CLICK - **Climate change** is the change in long-term averages of the daily weather and operates over decades or longer. It is projected using increasingly sophisticated earth system models (ESMs). Climate projections are based on scenarios of drivers of greenhouse gas emissions, including, at a minimum, demographic change (including patterns of change), economic development, and technological development. These scenarios project emissions of greenhouse gases. These emission concentrations are then input into the ESMs to project possible future climate. ESMs do not predict what will occur; they project how temperature and precipitation could change under different assumptions of greenhouse gas emissions. The future is inherently uncertain, so projections are not “predictions”.

Remember that these terms and many others are located in the glossary in your training handout folder.

7



VIDEO 1 - Walk the Dog video: https://youtube.com/watch?v=e0vj-0imOLw

Double click on the black box *and the video should appear with a red start arrow.* Click on this arrow *and the video will play, as long as you are* connected to the Internet. *Note that this doesn't allow a full screen viewing. To view full screen, load up the downloaded version of the video in Windows Media Player before you begin, then click out of the presentation and press play on the Windows Media Player window. Make sure that you've tested sound before you begin the presentation.*

"This animation explains the difference between weather and climate. The dog being the weather, and the owner being the climate. The point of this short video is that although the weather may show short-term changes and be 'all over the place' (like the dog), the more important factor to watch for is the big picture, or the overall long-term trend (the owner). If we look at statistics from too close a viewpoint, the picture can seem confusing, so it is important to take a step back and not focus so much on the details so that we can understand the trend.

Note: The video is embedded, so you should be able to play it by clicking with a mouse on the image, or pressing 'Enter' on the keyboard.

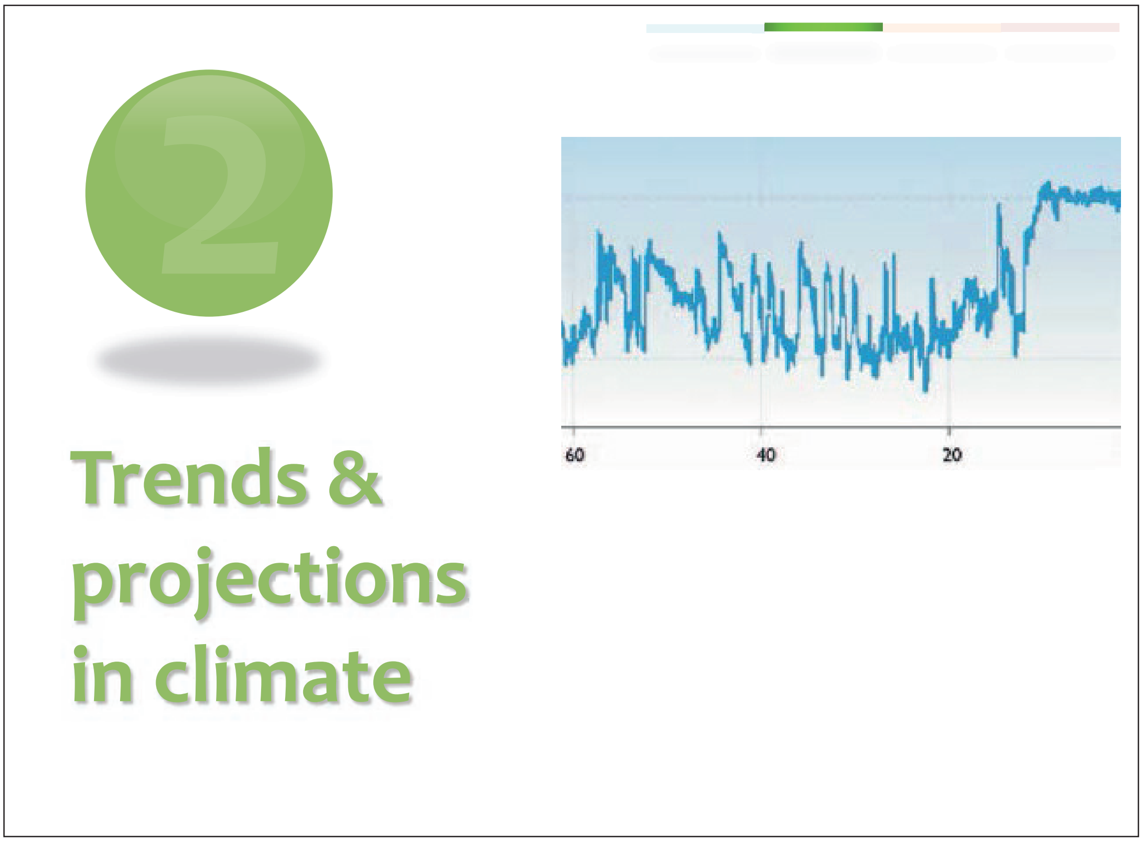
Animated short on statistics from Norwegian infotainment program Siffer. Produced by TeddyTV for NRK. Animation by Ole Christoffer Haga

At the end of the video: **Q – What do you think? Does the difference between weather and climate make more sense now?**

Gather views and responses for short discussion.

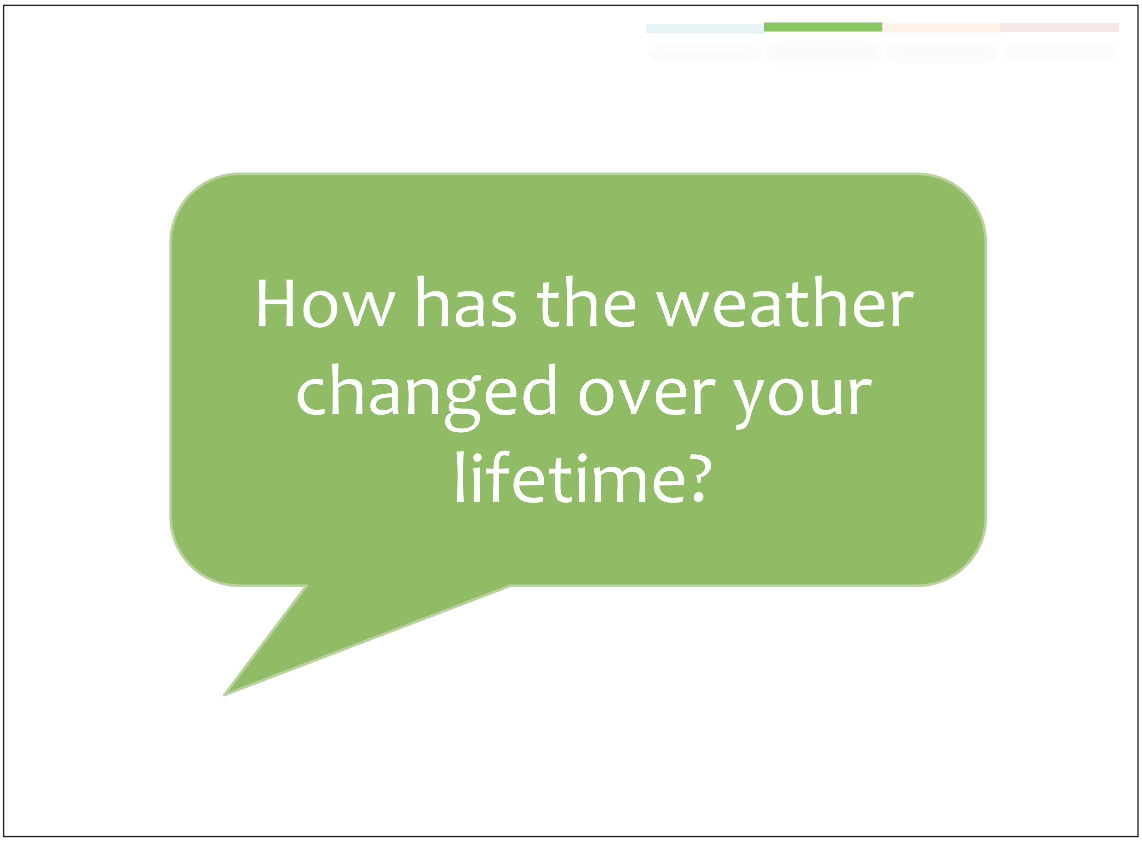
A reminder that if you need to come back to these distinctions and other related terms, you can refer back to these notes and also the glossary in your training handout folder.

8



So, now that we understand the difference between weather and climate, and the difference between climate variability and climate change, let's now look at some of the changes in climate that have occurred over human history.

9



We've talked about climate being the long-term changes in weather at a theoretical level. But I'm curious to know, how has the weather changed over the course of your lifetime? Is it different?

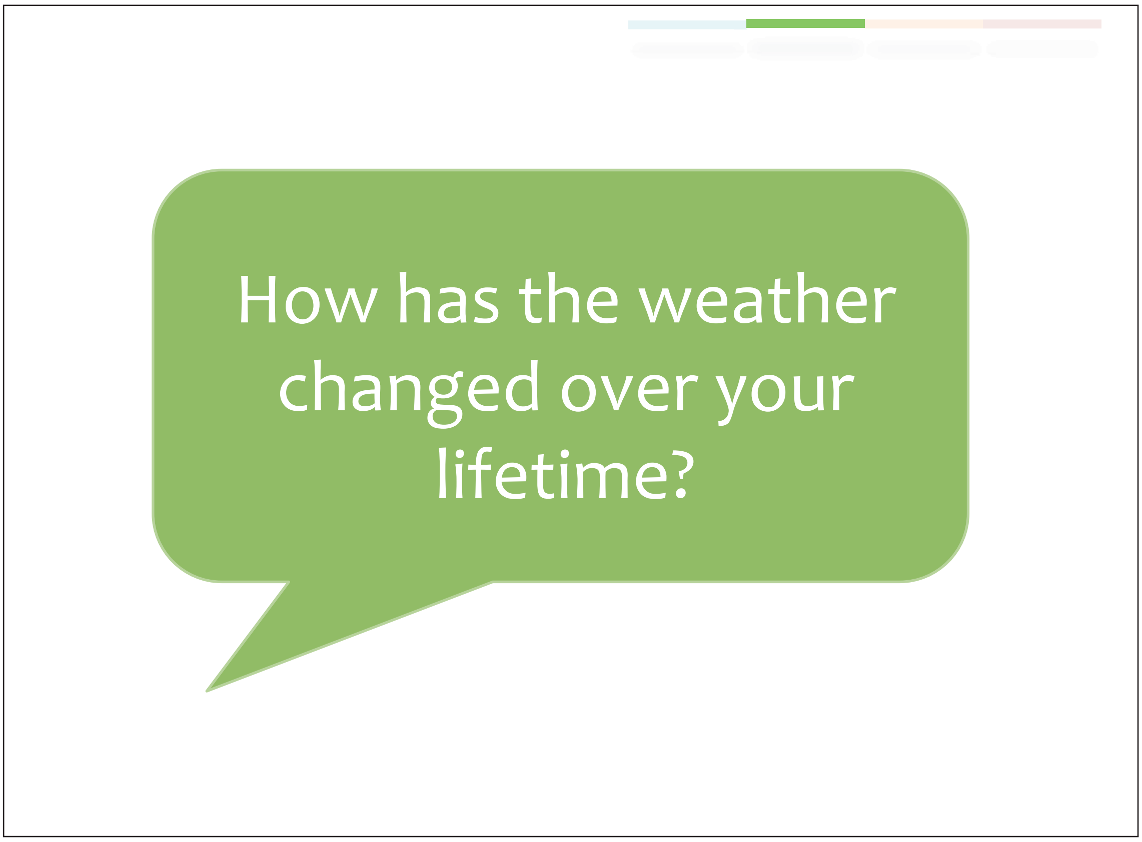
Please turn to two people near you and discuss the way the weather has changed – or not – over the course of your lifetimes, in different places you live. Is it different? In **5 minutes** I'll ask for some volunteers to report back on the outcomes of discussion in your group.

Give people a time reminder at 3 minutes – "You have another two minutes to chat about weather trends across your lifetime in your group. Make sure everyone's had a chance to share their experience in the next few minutes."

Give a wrap up instruction at 4 mins 30 seconds – "I'll get you to finish up your discussion in the next 30 seconds". **At 5 minutes -** "Thanks, it sounds like you've shared some interesting stories of change in your small groups."

Report back – "Let's hear some of the changes that were being discussed. Would a volunteer from some of your groups like to summarise the changes you've seen in 2–3 sentences?" Field 5–6 short report backs, acknowledging responses. If you'd like to, and have a whiteboard nearby, you could also write these up as they're spoken (keeping good attention on the volunteer speaker and thanking them after their 2–3 sentences so they don't continue to speak for a longer period).

9



Then verbally summarise the changes that you heard from groups. Suggest to participants that speaking to local farmers and communities in their own areas, particularly older people, can be a good way to get an idea of how residents have seen the climate change over the last few decades. Often these are the people with the best firsthand knowledge.

Note here that evidence and data of changes in climate will be shared in subsequent modules, and that it's important for professionals to learn more about what's specifically happening – and trend forecasts for further change – in their country and region.

10

VIDEO 2 - Climate 101 with Bill Nye: https://www.youtube.com/watch?v=3v-w8Cyfoq8

I'd like to show you a five-minute video now that presents the basics of climate change and shows where changes are occurring, and how these are happening.

While you're watching this video, I'd like you to consider how this is relevant for your own context. Are there any differences that you see operating in your own countries?

Double click on the black box *and the video should appear with a red start arrow.* ***Click on this arrow*** *and the video will play, as long as you are* ***connected to the Internet****. Note that this doesn't allow a full screen viewing. To view full screen, load up the downloaded version of the video in Windows Media Player before you begin, then click out of the presentation and press play on the Windows Media Player window. Make sure that you've tested sound before you begin the presentation.*

Discussion questions for after the video (for whole group):

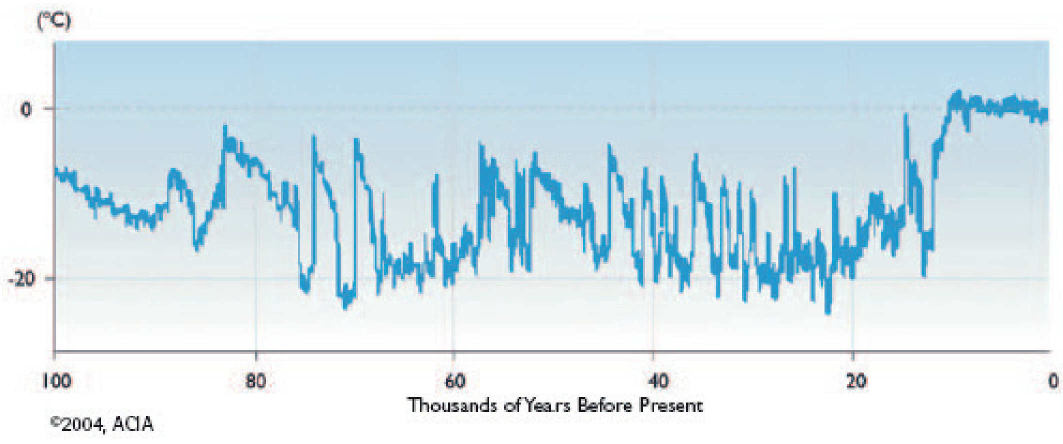
Q: What did you think of the video? (allow for 3–4 short responses)

Q: Compared to what you saw, are there any differences that you see operating in your own countries? (allow for 4–5 responses if people have things to share)

Thank people for sharing.

11

Temperature variation in Greenland over 100 000 years



Source: Arctic Climate Impact Assessment (2008)

Let's now look at some historical climate data.

The slide shows the temperature variation in Greenland over 100 000 years, determined by data from an ice core sample. First a note on how climatologists analyse historic trends. Because climate is always changing, there is no natural baseline against which to compare. Therefore, trend analyses are not appropriate for determining long-term trends. Instead, analyses start by choosing a baseline period. The baseline for many climate studies is 1961-90 (a climate normal). The weather data are normalized to that baseline and plotted to show deviations (anomalies) over time.

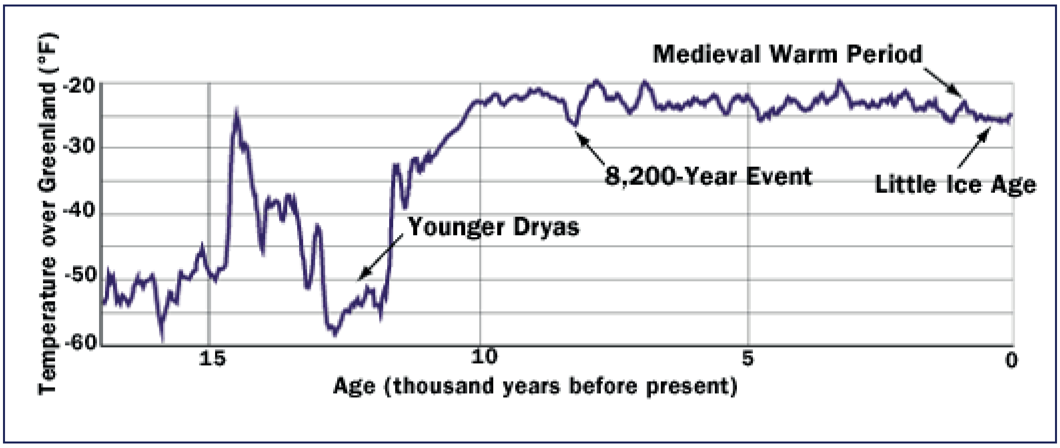
Several points should be clear from the figure. Climate is always changing, with often very large swings in temperature over relatively short time periods (on a geologic scale). One can imagine the impacts on societies if temperature patterns returned to that degree of variability.

Another point is that the last 10 000 years are unique in the climate record: they have been relatively stable. The earth is coming out of this period of stability.

Source: *Arctic Climate Impact Assessment 2008 <<http://www.acia.uaf.edu/>>*

12

Temperature in Greenland over the past 17 000 years

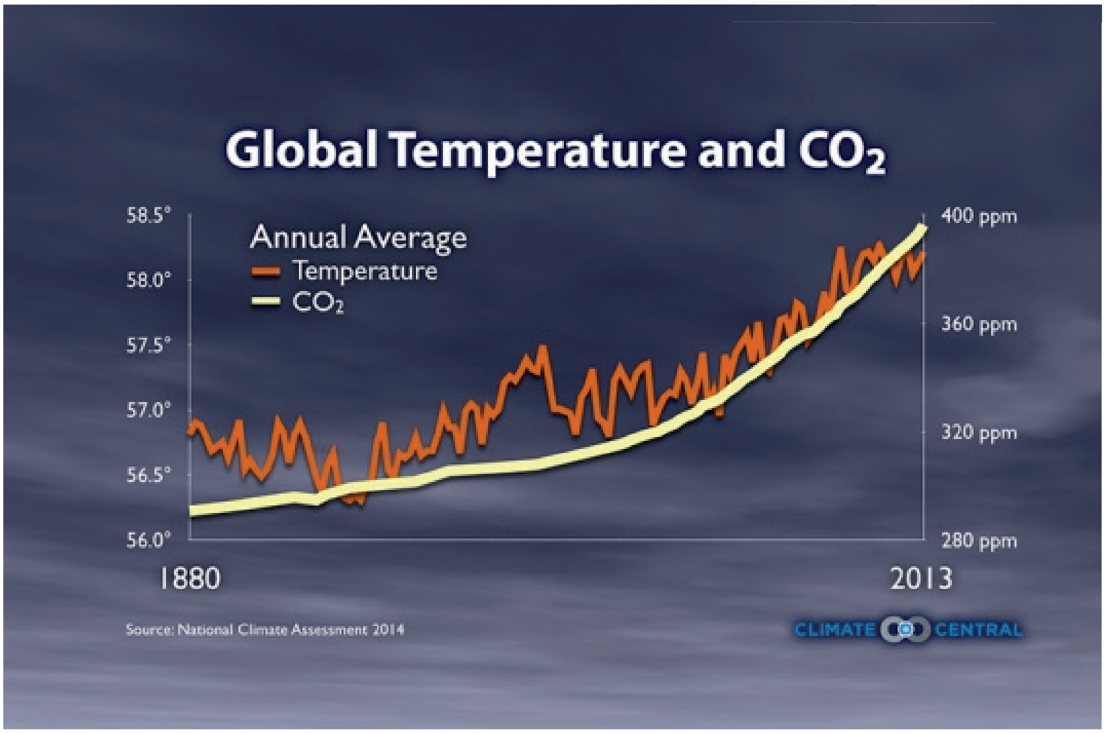


Source: Alley (2000)

This figure shows the last 17 000 years. The earth started warming out of the last ice age about 15 000 years ago. After warming considerably, temperatures fell during a period called the Younger Dryas. After several thousand years, the earth started warming again and continued to warm until about 10 000 years ago, when temperatures over Greenland (and for the rest of the world) became relatively stable. The Medieval Warm Period and Little Ice Age are marked. Although the Little Ice Age was quite small compared with the rest of the climate history, it had significant direct and indirect impacts on human health, including from reductions in crop yields leading to food insecurity.

Source: *Alley, RB. The Two Mile Time Machine 2000*

13



Source: Climate Central

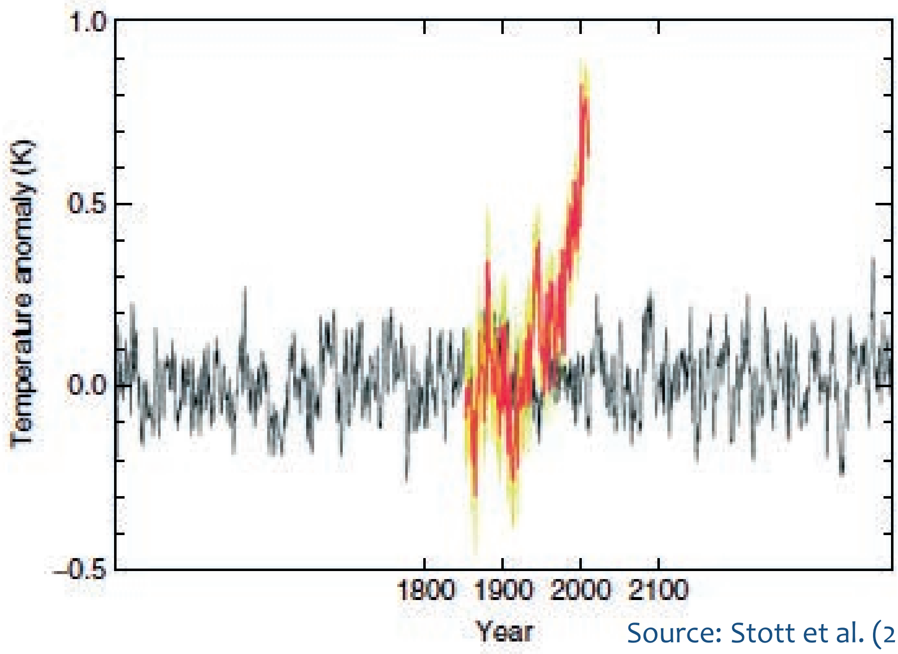
This figure shows global mean surface temperature, since shortly after measurements began in about the 1860s, and the atmospheric concentration of carbon dioxide. The considerable increase in both temperature and concentrations of carbon dioxide is obvious, as is the close correlation between these two.

Note the temperatures are in degrees Fahrenheit. In Celsius, the scale is 13.3 to 14.7.

Source: *http://www.climatecentral.org/*

14

Global mean temperature change from 1850 to 2008 relative to 1861–1899



Source: Stott et al. (2010)

The figure provides a better sense of the magnitude of the change since the start of the Industrial Revolution. The black line shows a 1000 year segment of global mean temperatures from control simulations of a coupled ocean–atmosphere climate model over many centuries, with no changes in the external drivers of climate such as increases in greenhouse gas concentrations or in solar output.

On top of this are plotted observed global mean temperature changes from 1850 to 2008 (in red) from a climate model run by the Hadley Centre in the UK. Uncertainties (yellow band) are expressed as anomalies relative to the mean temperature over the 1861–1899 period.

Source: *Stott PA et al. 2010. Detection and attribution of climate change: a regional perspective. WIREs Climate Change;1:192-211.*

15

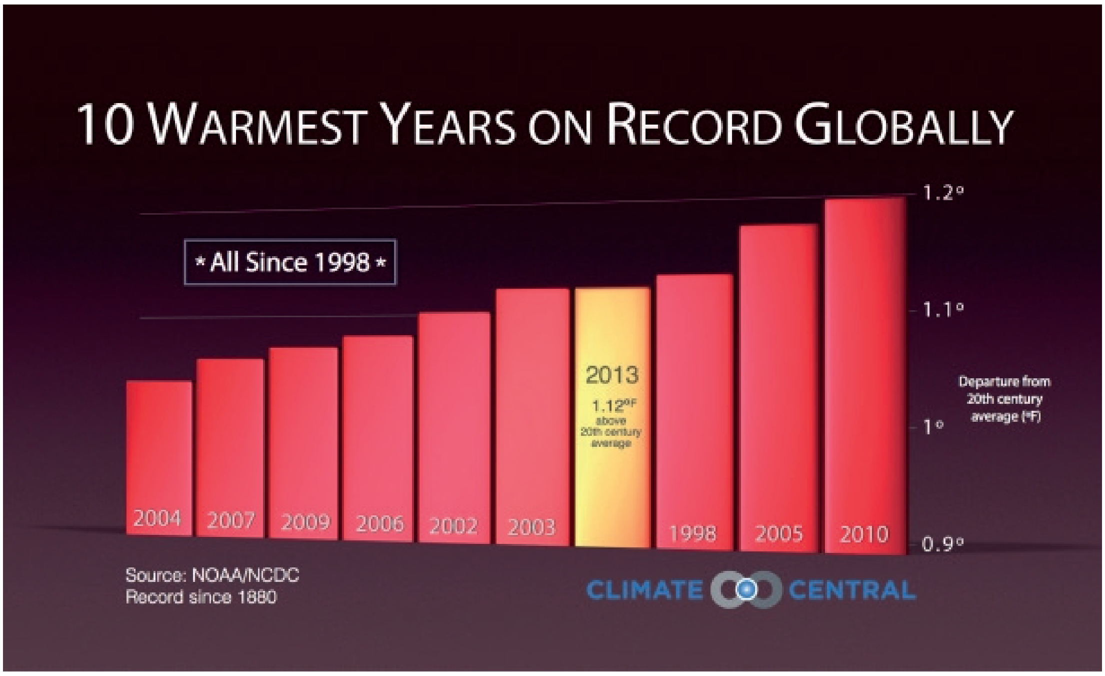
What does this mean?

- The climate is always changing
- Since the industrial revolution, atmospheric concentrations of carbon dioxide & ambient temperature have increased significantly

So what do the previous slides show, in terms of trends and predictions in climate?

In summary… (read)

16



Source: Climate Central

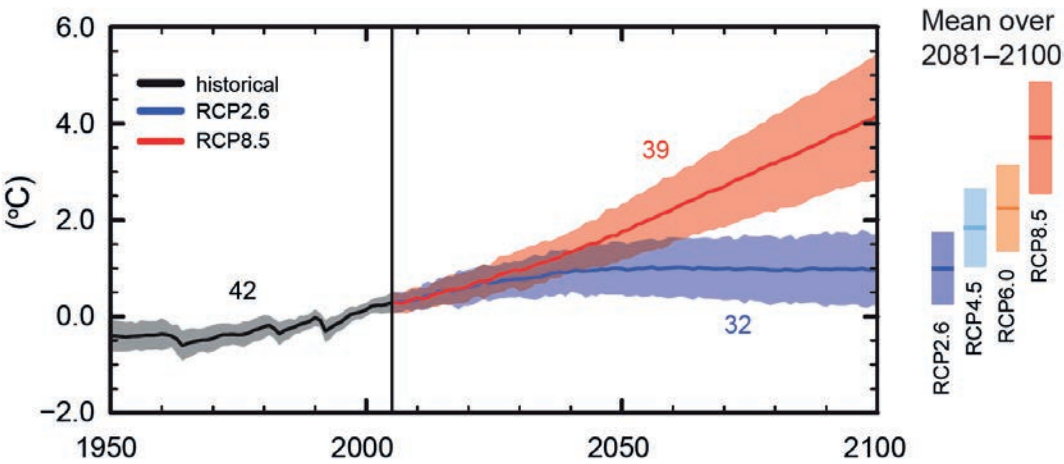
The 10 warmest years on record globally all occurred since 1998, as this figure from Climate Central shows.

Q: Do you know what the warmest year was in your own country? *Facilitate responses. Lead a short discussion of how local and international temperatures can differ.*

Source: *http://www.climatecentral.org/*

17

Global average surface temperature change – observed & projected



Source: IPCC (2013)

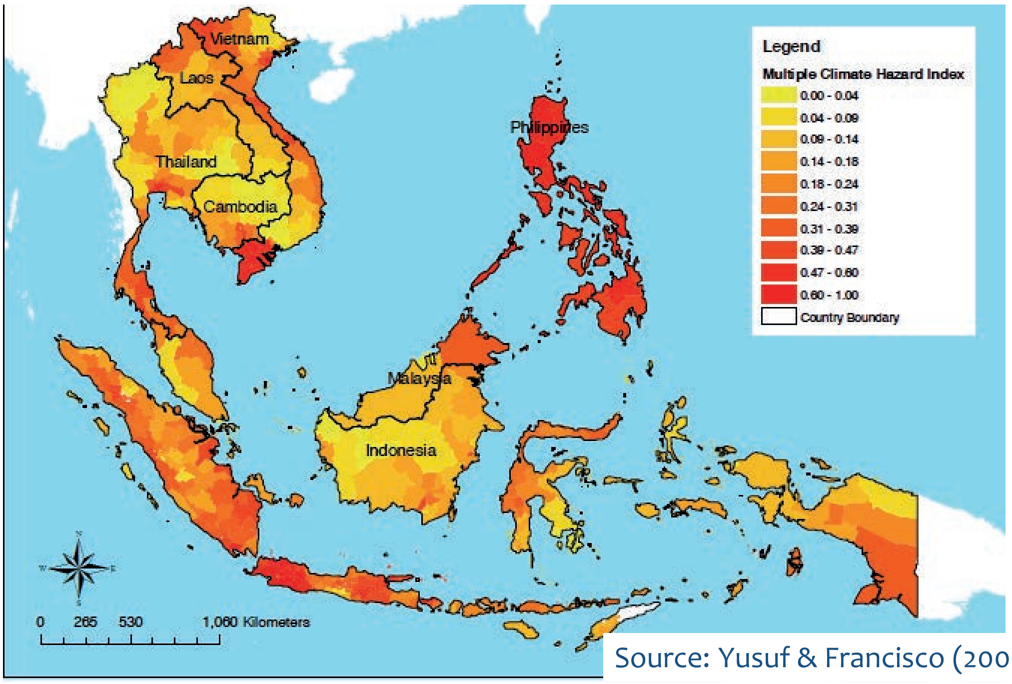
The figure from the Summary for Policy Makers for the IPCC Working Group I report shows global average surface temperature change from 1950 to the present (black line) along with projections to 2100 under different assumptions of greenhouse gas emissions. The numbers on the figure show the number of climate models. Under high emissions, the global average surface temperature could increase by as much as 6°C; this is about the same difference in global average surface temperature between now and the last ice age. The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as coloured vertical bars.

The baseline is the period 1986–2005.

Source: *http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf*

18

Multiple climate hazard map of South-East Asia



Source: Yusuf & Francisco (2009)

The trends that we've just looked at have a wide range of consequences globally. Let's finish off this section on trends and projections for climate change by focusing on climate change in South-East Asia specifically.

This map shows five hazards – cyclones, floods, droughts, landslides and sea-level rise – and plots their average risk on the South-East Asian region. This has used data from 1980–2000 to calculate the average annual frequency of cyclones, floods and droughts between 1980 and 2000, and included the degree of landslide risk and the extent of a 5-metre inundation zone due to sea-level rise.

FOR TRAINER INFO - Plotting of averages in cyclones, floods, and droughts is done in terms of average annual frequency of occurrence from 1980–2000, the degree of landslide risk, and the extent of a 5-metre inundation zone due to sea-level rise.

Data on climate hazards are taken from the PREVIEW database of UNEP, while the sea-level rise inundation zone map is produced from CReSIS.

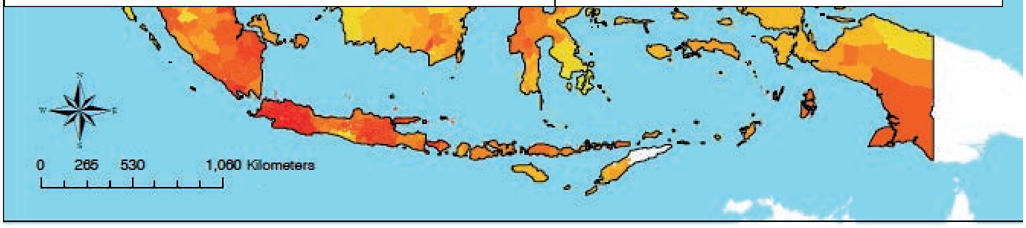
Source: *Yusfu & Francisco, 2009. Climate Change Vulnerability Mapping for Southeast Asia*

19

Multiple climate hazard map of South-East Asia

Source: Yusuf & Francisco (2009)

Climate hazard hotspots	Dominant hazards
Northwestern Vietnam	Droughts
Eastern coastal areas of Vietnam	Cyclones, droughts
Mekong region of Vietnam	Sea level rise
Bangkok and its surrounding area in Thailand	Sea level rise, floods
Southern regions of Thailand	Droughts, floods
The Philippines	Cyclones, landslides, floods, droughts
Sabah state in Malaysia	Droughts
Western and eastern area of Java Island, Indonesia	Droughts, floods, landslides, sea level rise

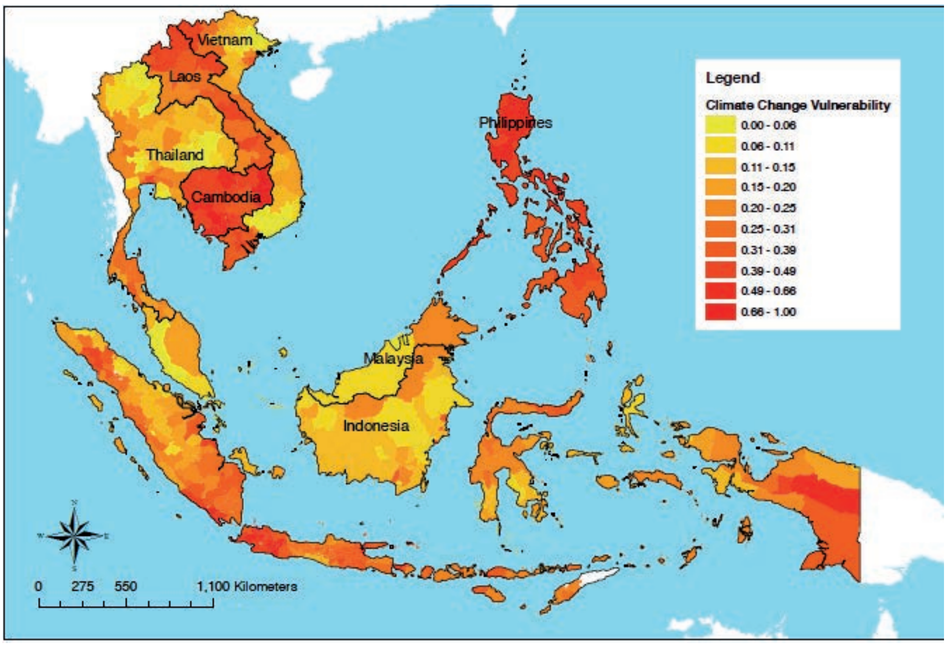


The hotspots in South-East Asia include the north-western and Mekong region of Vietnam, the coastal regions of Vietnam facing the South China Sea, Bangkok and its surrounding areas in Thailand, practically all the regions of the Philippines, and the western and eastern parts of Java Island, Indonesia.

20

Climate change vulnerability map of South-East Asia

Source: Yusuf & Francisco (2009)



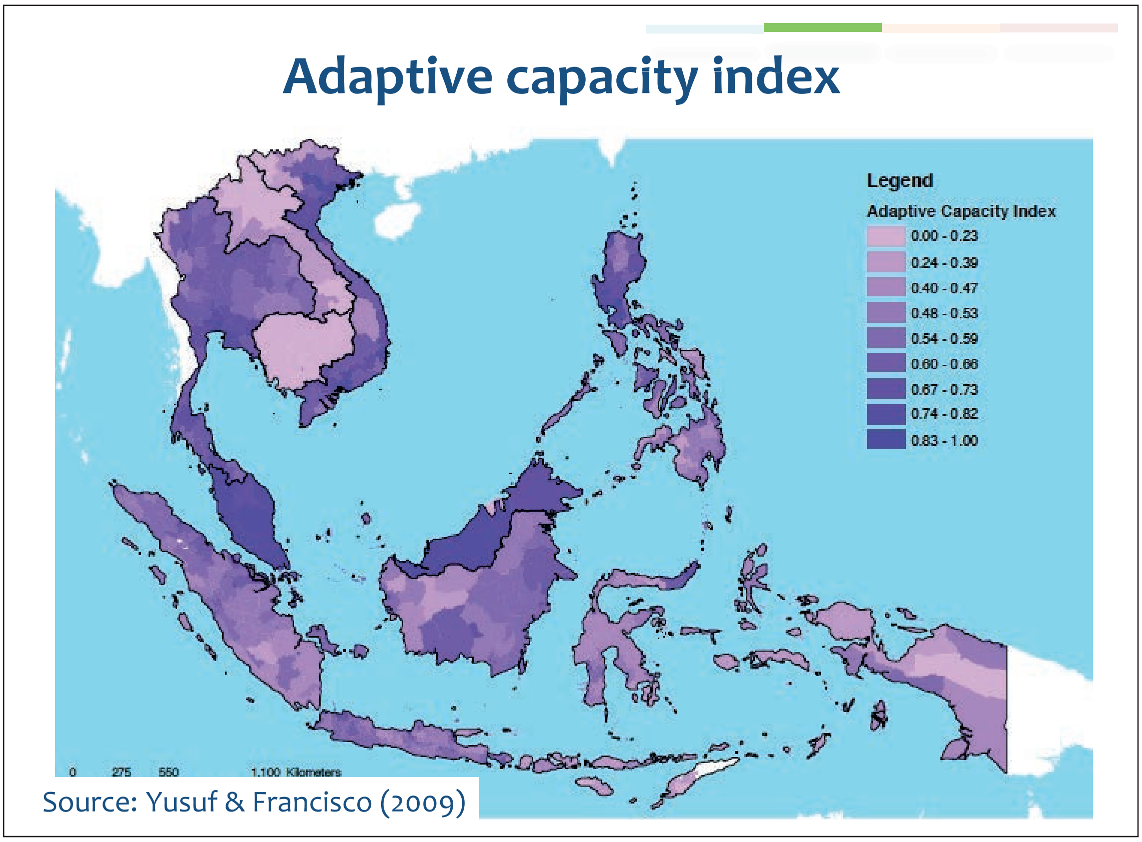
An overall understanding of vulnerability extends our knowledge from the maps you have just seen that focused on exposure. Responding to climate change is not just about knowing the exposure to hazards, but also recognising to what degree a region or country is sensitive to such exposure, and to what degree the population has the capacity to adapt.

This vulnerability map was developed by averaging the indicators of exposure (multiple hazard risk exposure), sensitivity (human and ecological) and adaptive capacity across the countries and regions in South-East Asia. The vulnerable areas were identified by ranking the regions according to the index and dividing the list into four equal parts. The geographical areas that fell into the fourth quartile were considered the vulnerable areas.

The most vulnerable areas include: all the regions of the Philippines; the Mekong River Delta in Vietnam; almost all the regions of Cambodia; North and East Lao PDR; the Bangkok region of Thailand; and West Sumatra, South Sumatra, West Java, and East Java of Indonesia. The exposure of the Philippines is more extreme compared to other South-East Asian countries in that it is not only exposed to tropical cyclones (especially in the northern and eastern parts of the country) but also to many other climate hazards particularly floods (such as in central Luzon and southern Mindanao), landslides (due to the terrain of the country) and droughts.

In general, these results confirm our general assumptions that the most vulnerable regions in South-East Asia include the Mekong River Delta in Vietnam and Bangkok due to their exposure to sea-level rise, and the northern part of the Philippines due to its exposure to tropical cyclones.

21



As discussed in the previous slide, adaptive capacity is one of the three elements that comprise vulnerability, or risk.

Adaptive capacity can be defined as: The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC 5AR).

Here is an example of adaptive capacity of the South-East Asia region.

Overall, areas with relatively high adaptive capacity are in Thailand, Malaysia and Vietnam. Areas with relatively low adaptive capacity are mostly found in Cambodia and Lao PDR.

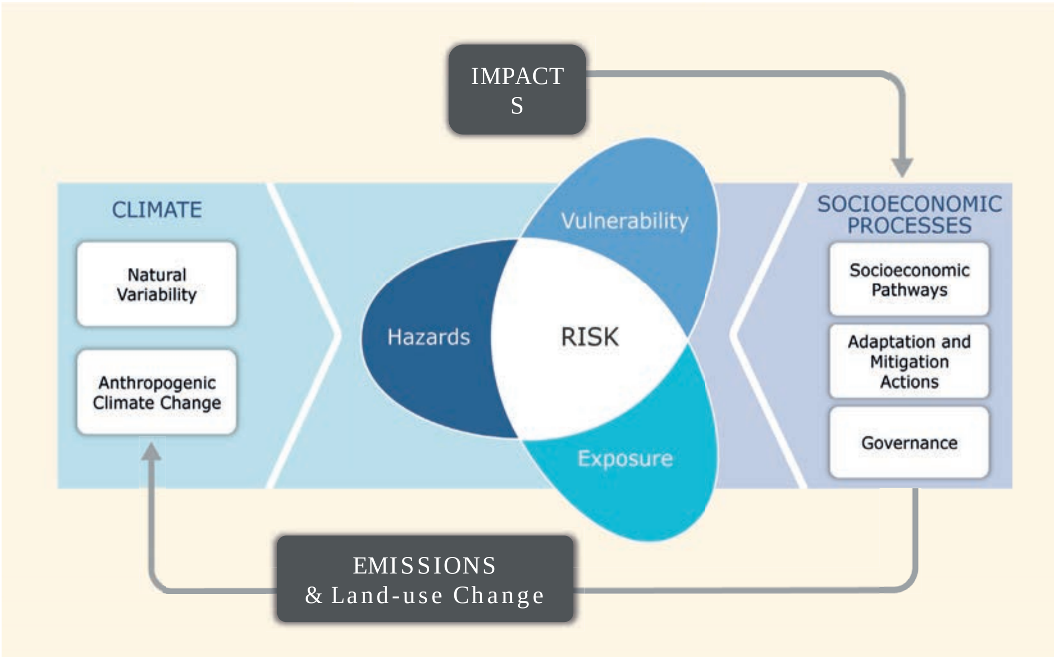
To sum up these three slides we have just seen and in order to shape policy and planning, it's important to know your own country's vulnerability or risk, which is comprised of adaptive capacity, exposure and sensitivity.

22

CHECK energy levels. Scan the room to see how engaged people are after a series of graphs. If people look like they're flagging, suggest a one or two minute stretch break – "Let's have a quick stretch break. Staying in the room, please stand up and find a way to move your legs, stretch your arms and take a few good breaths. … Thanks, I'll get you to take a seat again."

So we've covered some of the basic definitions around climate change, and how climate changed over short and longer time scales, and how climate is projected to change over this century.

Let's now look at the health risks associated with climate variability and change.



Source: IPCC (2014)

This diagram shows the risk associated with a changing climate arising from the interaction of three factors: the hazards associated with a changing climate; the human and/or natural systems exposed to those hazards; and the vulnerability of these systems. Drivers of these factors include changes in climate variability and change, and socioeconomic processes, including adaptation and mitigation.

This model comes from the IPCC Working Group II 5th assessment report.

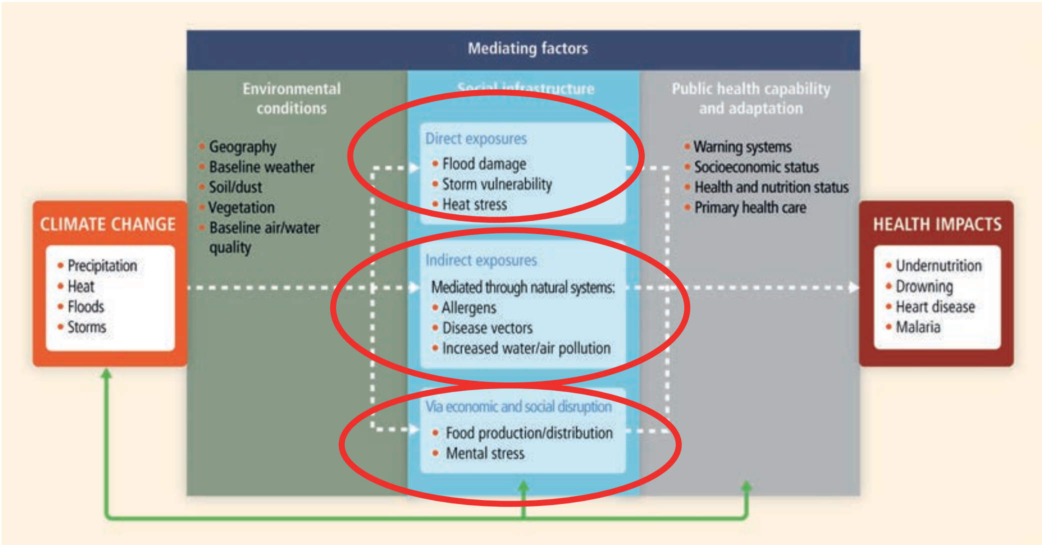
Source: *http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf*

24

Many health outcomes are seasonal…

Although more than a decade old, this slide from the Ministry of Health in Guatemala is an example of the seasonality of many health outcomes. One doesn't need to understand Spanish to see that infectious diseases typically occur only during certain months of the year. Any health outcome that is seasonal may be affected by climate change. The extent to which the incidence or geographic range of a seasonal disease could be affected by climate change will be determined by how sensitive it is to weather variables. Although not all diseases are seasonal because of temperature and precipitation patterns, most infectious diseases are.

Ways in which climate change may affect human health:

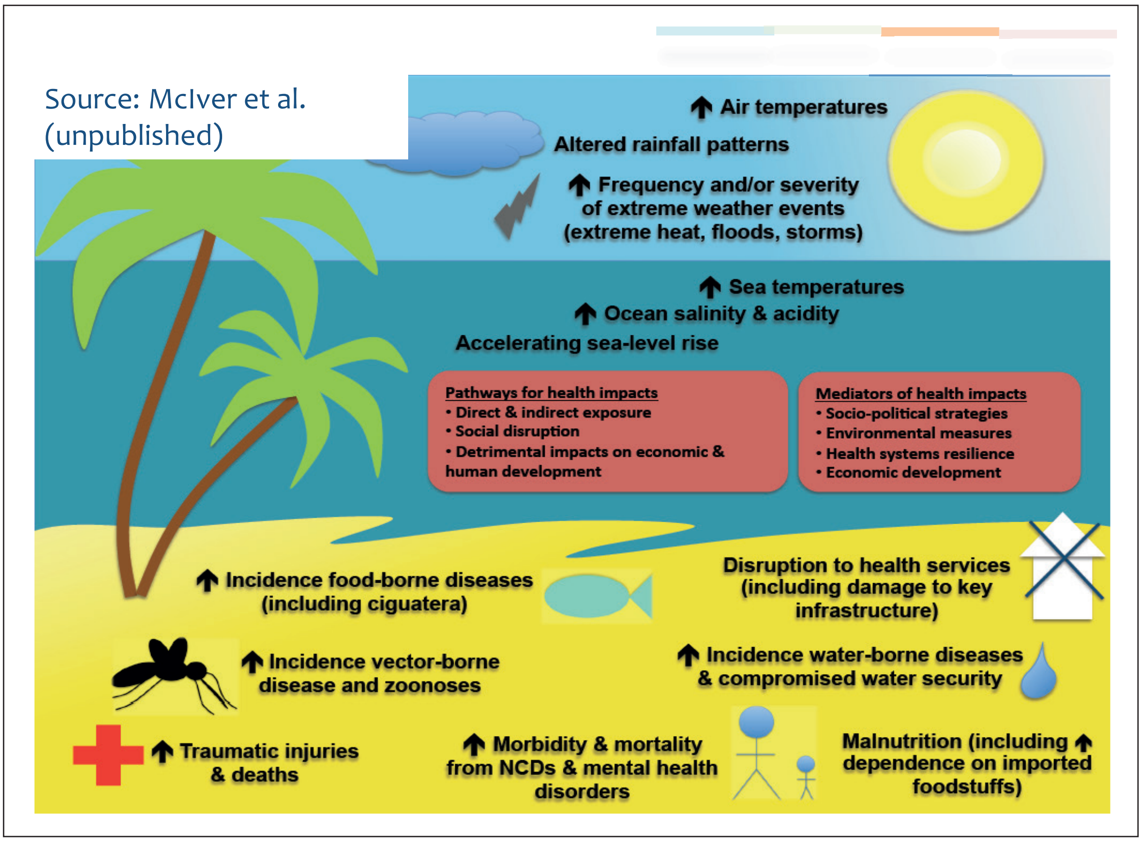


The figure illustrates the various exposure pathways by which climate change affects health. Climate change can affect human health:

- CLICK - Directly through weather variables such as heat and storms, or from changes in ocean acidification;
- CLICK - Indirectly through changes in natural systems that affect disease vectors; and
- CLICK - Through pathways heavily mediated through human systems, such as undernutrition.

Source: *IPCC Working Group II AR5 (2014)*

26



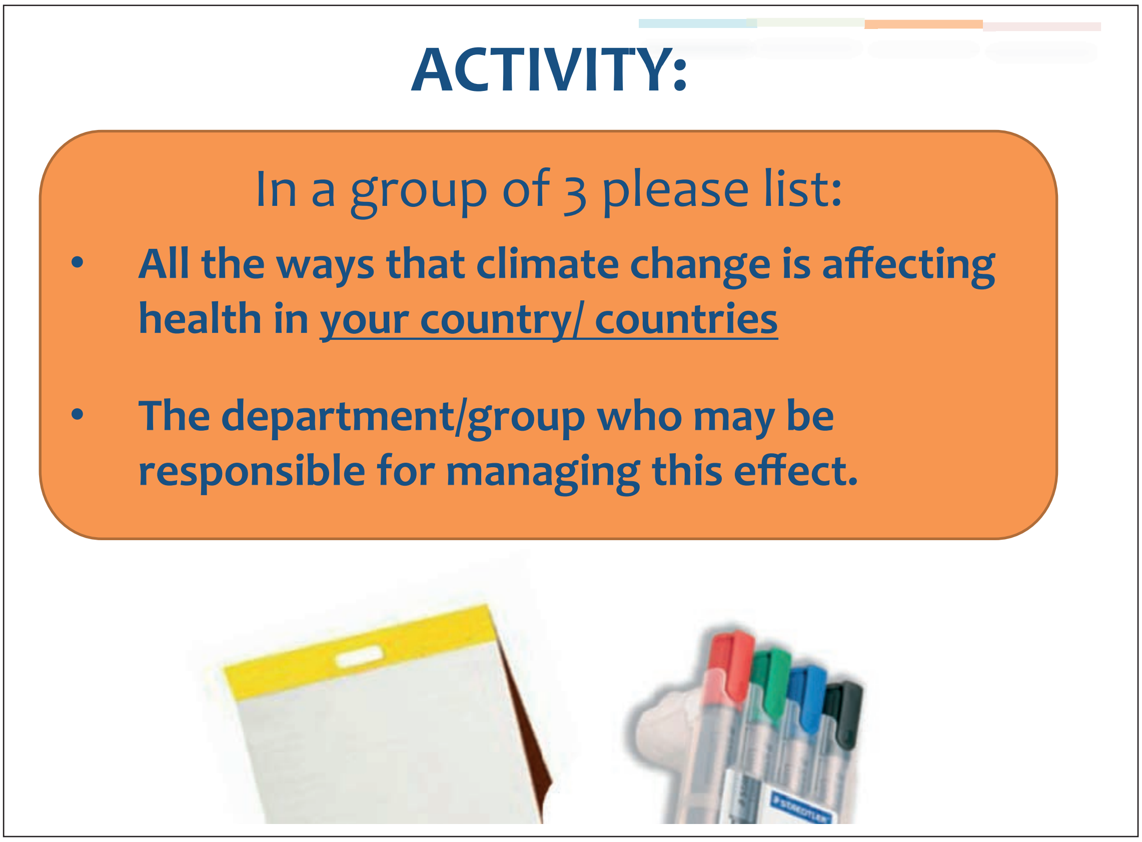
More specifically, climate change can lead to:

- Disruption to health services, including damage to key infrastructure
- Increased incidence of food-borne diseases
- Increased incidence of vector-borne diseases and zoonoses
- Increased incidence of water-borne diseases & compromised water security
- Increased traumatic injuries & deaths
- Heat stress
- Increased morbidity & mortality from noncommunicable diseases and mental health disorders
- Malnutrition, including increased dependence on imported foodstuffs
- Mental stress.

In a minute I'm going to ask you to consider which of the health outcomes listed on the slide are particular problems in your country.

Q: Any questions on this slide?

27



"In a minute I'd like you to get into groups of 3 – ideally with someone from your country or region, if possible. If there aren't two others from your country, see if you can team up with someone from a nearby country.

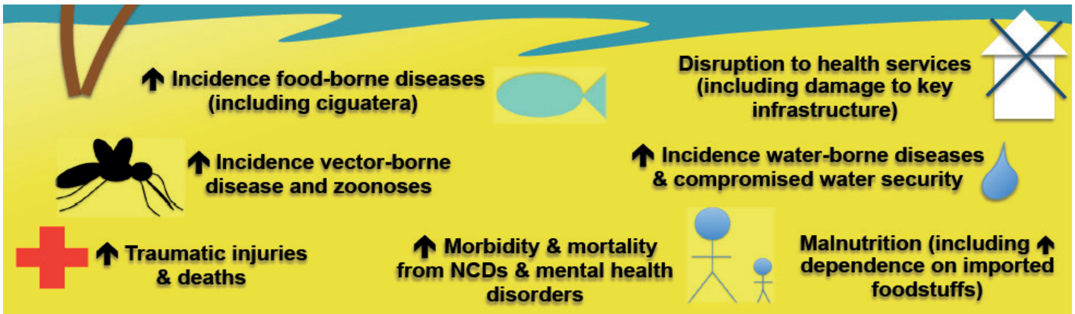
Find yourselves a table to work at and a piece of flipchart paper and markers, and hand a marker around to each person. Introduce yourselves and then please brainstorm all the ways that climate change can affect health. These affects were listed on the previous slide, which I'll put up again in a minute. If you know the department or group that is likely to be responsible for managing this effect, please list it, using two colours if you are from different countries.

You'll have 8 minutes for this activity."

Go to next slide for full-screen image of possible health effects of climate change

28

Ways in which climate change may affect human health:



Source: McIver et al. (2014)

So here again are some of the possible health effects of climate change.

Give time warnings: **4 mins** – "Ok you are half way, so you have another four minutes to work on your brainstorm. If you haven't done so, have a look at the slide and make sure you've covered the range of affects that could be possible in your countries."

7 mins: "Please finish your notes over the next minute. Please make sure that your country or countries are written on your page".

8 mins: "Ok, wrap up now, thanks."

"Can I ask one volunteer from each group to take your page to the back/side wall and stick it up. Then at the end of this module we can have a look at how health in other countries is already being affected by climate change, and who is likely to be responsible or involved in managing these impacts."

The rest of you can return to where you're sitting." Wait for volunteers to return to their seats and get people's attention back by going to the next slide.

Source: *IPCC Working Group II AR5 (2014)*

29

Policy responses to manage the risks of climate change

1. Mitigation

- A human intervention to **reduce** the sources or enhance the sinks of greenhouse gases.

2. Adaptation

- Term used by the climate change community to describe the **process of adjustment to actual or expected climate & its effects**.
- Seeks to moderate harm or exploit beneficial opportunities
- Basically, means **prevention** from the perspective of public health.

In terms of managing these impacts, there are two main policy responses to managing the risks of climate change: adaptation and mitigation.

Mitigation actions reduce greenhouse gas emissions or enhance the sinks (e.g. sources that take up carbon dioxide, such as soil and rocks).

***CLICK** to animate.* **Adaptation** is a term used in the climate change community to describe the process of adjustment of human and natural systems to actual or expected climate change. This is similar to the idea of prevention in public health.

30

Health systems have been managing, with various degrees of success, the health risks associated with temperature and precipitation patterns for more than 150 years. For nearly all health outcomes of concern, policies and programmes are in place to prevent and reduce health burdens. This means that health systems are well placed to incorporate concerns about climate change into existing programmes. This slide illustrates some of the opportunities.

Health system policies and programmes are traditionally grouped into primary, secondary, and tertiary prevention. The goal of primary prevention is to reduce exposures. This slide illustrates a few of the many opportunities to reduce exposure to higher ambient temperature, changing precipitation patterns, and sea-level rise. The goal of secondary prevention is to prevent the onset of adverse health outcomes once exposure has occurred. The examples listed are core programs in many ministries of health. The goal of tertiary prevention is response and/or treatment once an adverse health outcome is manifest. Most of the activities in this area fall within health care services and emergency response.

Source: *Ebi KL. Public health responses to the risks of climate variability and change in the United States. Journal of Occupational and Environmental Medicine 2009;51:4-12*

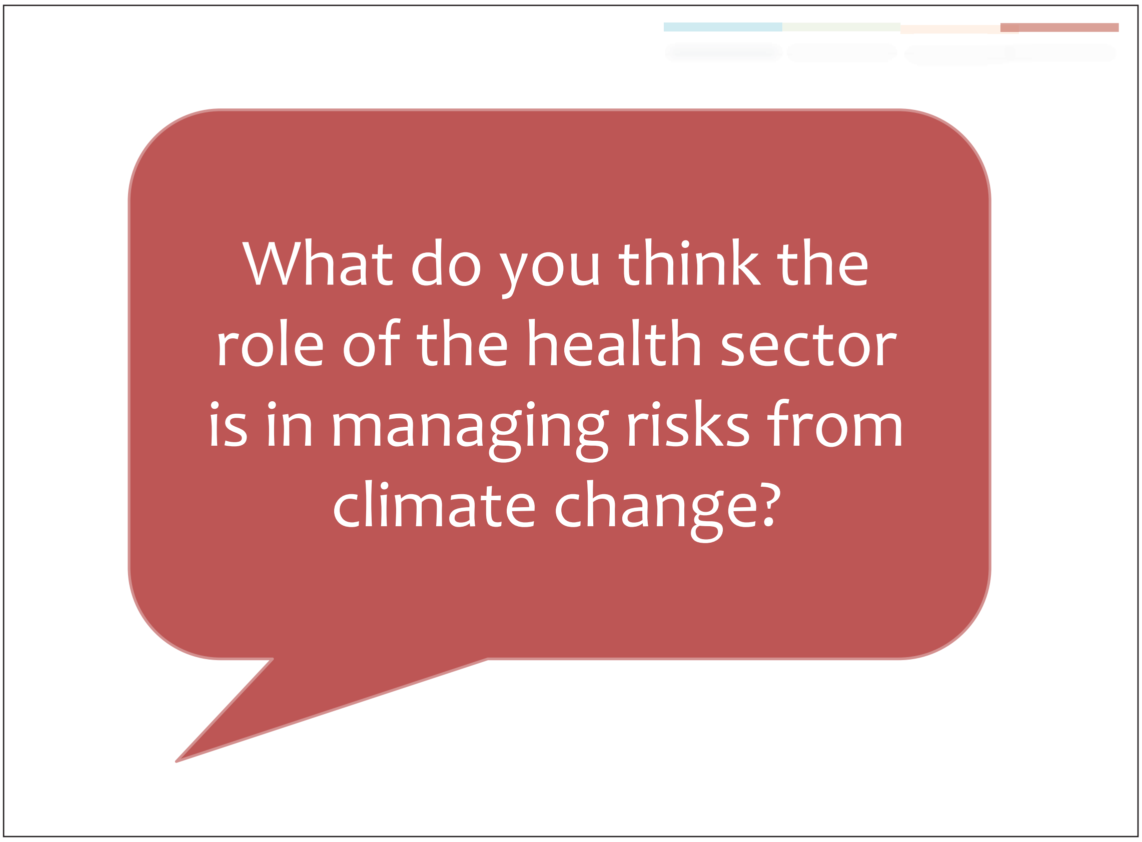
31

4

The role of the health sector

Finally, let's look at the role of the health sector – you and your colleagues globally – in managing the health risks of climate change. (KT)

32

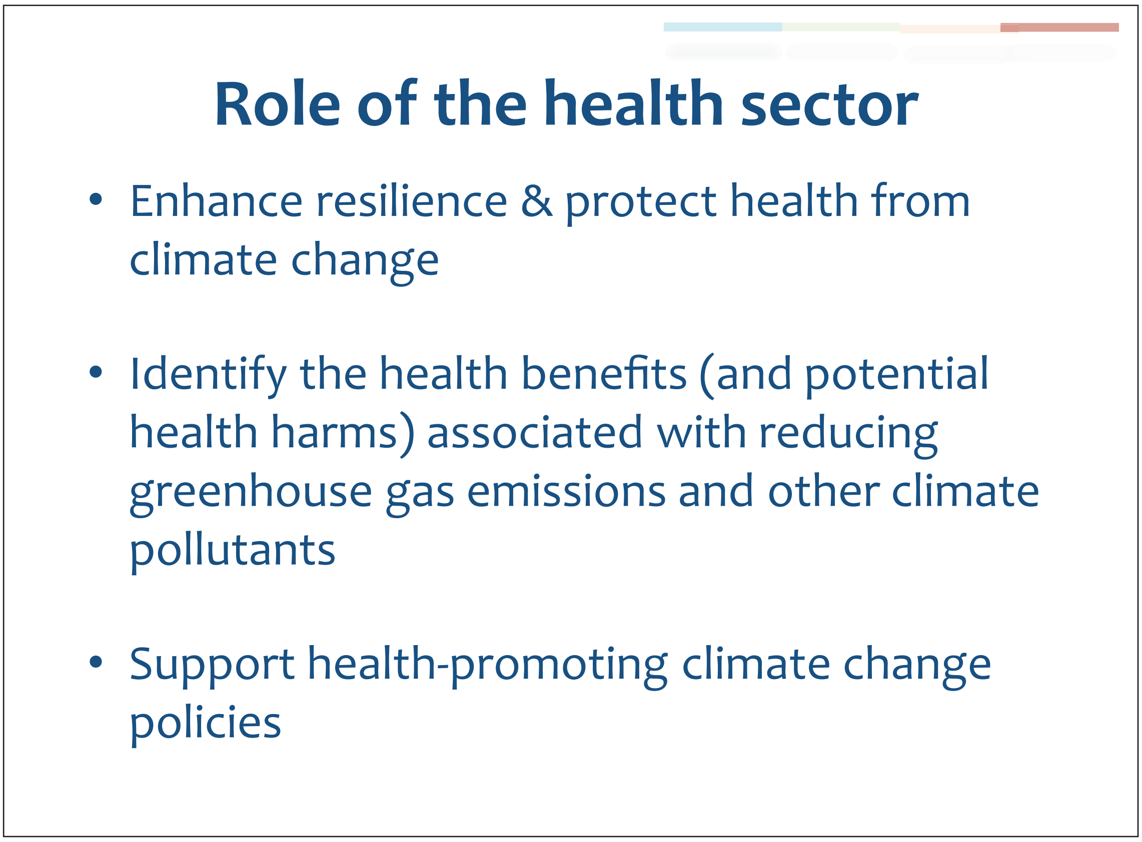


"I'd like to ask you to turn to two others you're sitting near. Over the next **4 minutes** please discuss between the three of you what you think the role of the health sector is in managing the risks from climate change. This includes your own role, the role of your colleagues and your organization, as well as your country's health sector as a whole. Take some notes as you talk in the notes next to this slide.

Give one minute warning – "You have another minute to finish up your discussion" – and then a wrap-up call "Ok thank you, I'll ask you to finish the last point you're discussing and turn your attention back this way."

It sounded like you came up with lots of good ideas in your discussions on the role the health sector can play in managing the risks of climate variability and climate change. It's great to see this enthusiasm and range of ideas, as the health sector does indeed have a really significant role to play. That's why we're here! ☺

33



Here is a short overview of some of the many roles we believe the health sector can play nationally and internationally around climate change.

CLICK to animate three summary points, reading each one.

Overall, health systems need to be strengthened to ensure that communities and regions are resilient to the risks of climate variability and change, with strategies, polices and measures explicitly incorporating climate change and with close cooperation across sectors. The health sector also needs to assess the health benefits and potential harms of policies, measures and technologies to reduce greenhouse gas emissions and other climate pollutants. Finally, the health sector needs to support national and international negotiations to ensure that agreements promote health.

34

"We stand to lose the most of any country in the world due to climate change & rising sea levels... we will be among the first to go under water."

Ulu of Tokelau, Mr Foua Kerisiano Toloa

For some countries, the risks of climate change are extensive.

This quote is part of a powerful message from a representative of the government of Tokelau. Tokelau is a territory of New Zealand in the South Pacific Ocean that consists of three tropical coral atolls with a combined land area of 10 km^2 and a population of around 1400. Under projected climate change scenarios, Tokelau is expected to be significantly impacted by sea-level rise, cyclones, storm surges, drought and longer spells of hot weather, affecting coastal land, housing and infrastructure, water supply, coral health, and the quantity and quality of fish supply.

Source: *http://tokelau.org.nz/Tokelau+Government/Government+Departments/Department+of+Economic+Development+Natural+Resources++Environment.html*

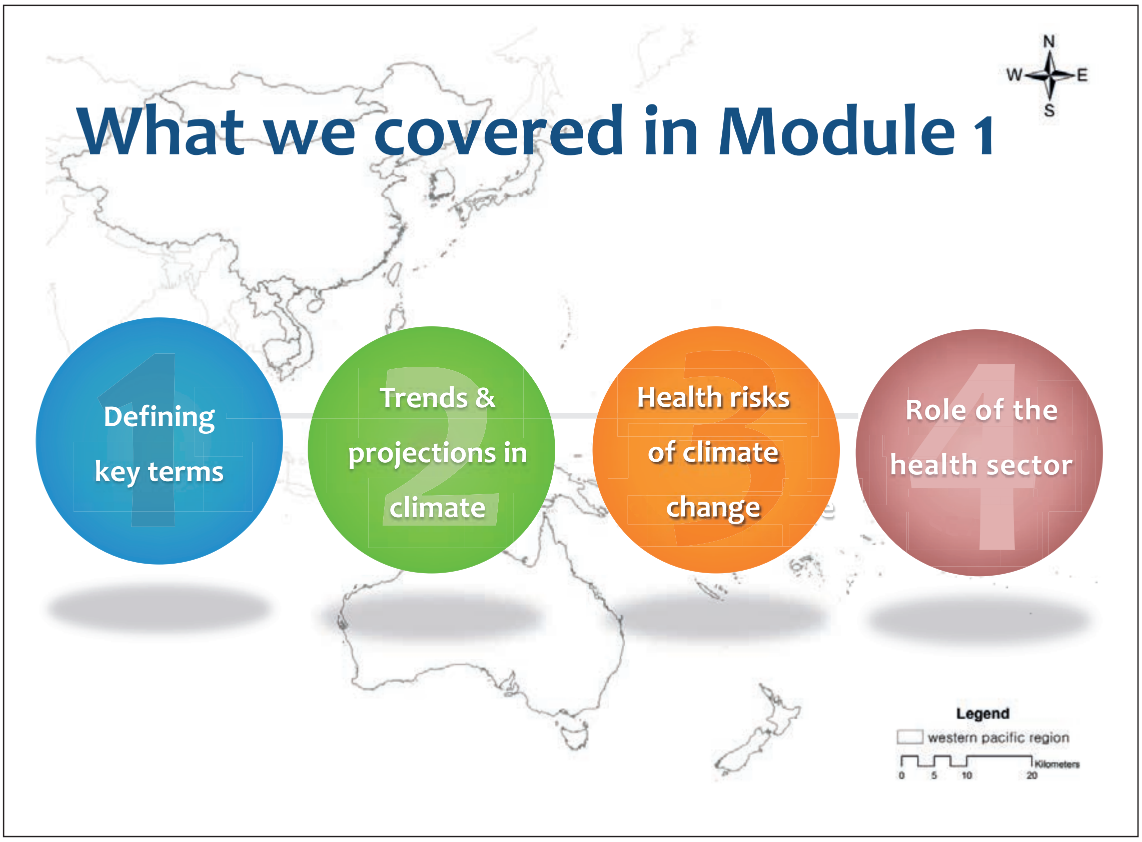
WHO Conference on Health & Climate, August 2014

The health sector is already starting to play an important leadership role. In August 2014, WHO held its first international conference on health and climate; the photo is of some of the delegates. It was attended by 360 participants, including health and environment ministers of WHO Member States, senior civil servants, technical experts, UN agencies, NGOs, chief executives from health authorities and relevant private sector entities.

The meeting discussed: the state of climate science, particularly as it relates to health; the public health response to climate change; health resilience; health benefits and health promotion while mitigating climate change; and the economics of health and climate change. Throughout the conference, participants discussed linking climate, sustainable development and health policy.

The meeting produced a draft summary that recognizes the need to strengthen health resilience to climate change and the opportunity to make gains in public health through well-planned mitigation measures. The document also recognizes policy gaps and next steps. A final version was presented at the 2014 Climate Summit in New York in September. The conclusions are also intended to serve as input to the 21st session of the Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC COP 21), the post-2015 development agenda discussions, and the 2nd Hyogo Framework for Action on Disaster Risk Reduction in 2015.

We look forward to more of you being involved in understanding and managing the health risks of climate change.



In Module 1 we introduced many of the topics that will be covered in more detail in subsequent modules. We introduced and defined the terms ‘weather, climate, climate variability and change’. Figures showed how the climate is changing. We then examined the range of health risks posed by climate change. And we finished off by looking at the roles of the health sector in international and national efforts to manage climate change.

37

Learning from Module 1

- It is important to know that there is a difference between weather, climate, climate variability & climate change
- Climate change is occurring & has a strong anthropogenic (human) influence
- The resulting changing weather patterns can affect human health trends & projections in climate

A reminder on the key takeaways from Module 1:

1. CLICK - It's important to know that there is a difference between what we mean by weather, climate, climate variability and climate change. I will be providing you with some useful ways of remembering the difference between these concepts soon.
2. CLICK - Climate change is occurring, and humans are influencing the rate of change that we are witnessing.

38

Learning from Module 1

- Current & future consequences include sea-level rise, extreme weather events, droughts, etc.
- The health sector has a role nationally & internationally in preparing for, preventing & coping with the health risks of climate change

The last two key concepts in this module were:

1. CLICK - There are many current and future consequences of climate change, including sea-level rise, extreme weather events such as floods and cyclones, and droughts. We will see some examples of these and also provide some time where you can discuss what you have seen in your own countries and regions.
2. CLICK - The health sector has a role nationally & internationally in preparing for, preventing & coping with the health risks of climate change

Module 2

Population health and climate change

Key learning messages in Module 2

- Health impacts of climate change will be felt globally
- Climate change will exacerbate current and underlying burden of disease
- Populations will be exposed differently depending on regions
- The SEA and WP regions have large populations that are currently vulnerable to a number of climate sensitive health stressors
- Current impacts in the Asia Pacific region are substantial and varied. These include:
  - Sea-level rise, more frequent and intense extreme weather events, more hot days
  - Without adaptation and mitigation climate change could result in a dramatically increased health burden in the regions.

Estimated length: 60 minutes

Structure of Module 2

Section	Slides	Activity (if any)
Key learning messages	2–3	
Module outline	4	
1. South East Asia and the Western Pacific are disaster prone regions	5–9	
2. Overview of the main findings most relevant to health from the latest IPCC report, called the AR5	10–35	EXERCISE on slide 23: How has urbanisation affected your community or region? How can you imagine urbanisation changing with further climate change? Groups of 4, 5 minutes
3. Action the health sector can take to reduce the health impacts of climate change in SE Asia and the Western Pacific	36–38	
Module outline	39	
Learning from Module 2	40–41	
Learning reflection, action generation	42	

Required resources

- Data projector and slide changer
- Module 2 slides
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 2

Section 2 (slides 10 – 35) is quite a long section, full of detailed information of the health impacts of climate change. Break the material into clear sections with 'signposting' so that participants are clear on where you are, such as "Hunger is a second important health impact of climate change, closely tied to drought."

Key terms introduced in Module 2

- Climate vulnerability
- Drought
- Hunger
- Vector borne disease
- Heat-related mortality
- Flooding
- Water-borne disease
- Water scarcity
- Flooding: Glacial Lake Outburst Flood
- Sea level rise
- Climate change and human migration
- Solastalgia.

References (in order of presentation)

- IPCC. 2007. *Assessment Report 4*.
- IPCC. 2013. *Assessment Report 5. Chapter 11 - Human Health*.
- WMO/WHO. 2012. *Atlas of Health and Climate*.
- IPCC. 2013. *Assessment Report 5, Asia Report*.
- Bhattacharya et al. 2006.Climate change and malaria in India
- Hales et al. 2002. *Potential effect of population and climate changes on global distribution of dengue fever: an empirical model*
- World Health Organization. 2008. *Public Health Information and Geographical Information Systems*.
- McMichael et al. 2012. *An Ill Wind? Climate Change, Migration, and Health*
- McMichael et al. 2003. *Climate change and human health: Risks and responses*.
- *BMJ 2008;336:191, McMichael, Global environmental change and health: impacts, inequalities, and the health sector*
- G. Albrecht. 2005. *Solastalgia, a new concept in human health and identity*, Philosophy Activism Nature 3:41-44.

Module 2: Population health & climate change

Global & regional perspectives: SE Asia & Western Pacific

In Module 2 we'll be looking at population health and climate change, and particularly at the relationship this has in SE Asia and the Western Pacific.

2

Key messages in Module 2

- Health impacts of climate change will be felt globally
- Climate change will exacerbate current & underlying burden of disease
- Populations will be exposed differently depending on regions
- The SEA & WP regions have large populations that are currently vulnerable to a number of climate sensitive health stressors

The key messages from this module, which we'll cover, are:

1. The health impacts of climate change will be felt by everyone, everywhere. Climate change does not respect borders.
2. Climate change will exacerbate current and underlying burden of disease. It won't bring anything remarkably new or different, rather it will worsen our current health issues, such as undernutrition, diarrhoeal disease, and infectious diseases.
3. People will feel the effects of climate change differently, depending on where they live. Some places will experience changes such as increasing intensity of cyclones, while others may experience longer-term changes, such as drought and drying.

3

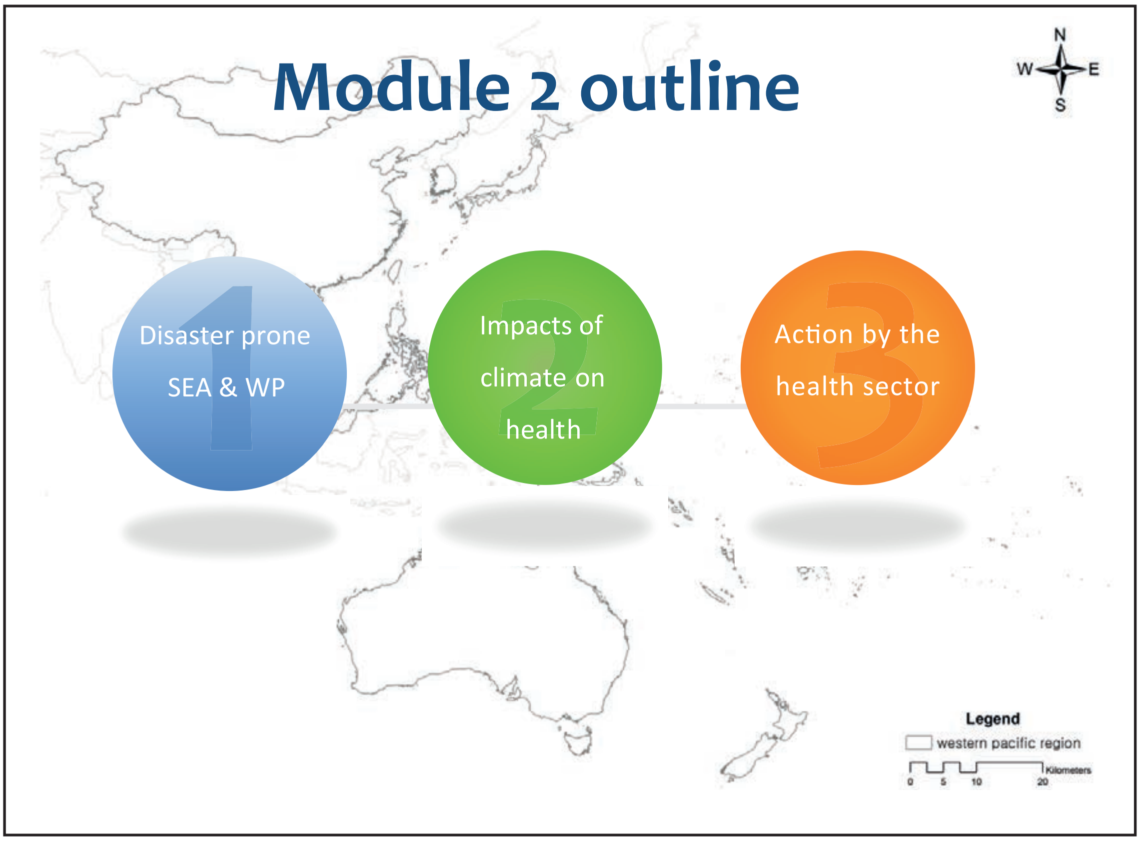
Key messages in Module 2

- Current impacts in the Asia Pacific region are substantial & varied. These include:
  - sea-level rise, more frequent & intense extreme weather events, more hot days
  - Without adaptation & mitigation, climate change could result in a dramatically increased health burden in the regions

4. Climate change will impact on health in the Asia Pacific region in a variety of ways, including more frequent and intense extreme weather events – such as storms/cyclones/floods, an increase in the number of hotter days, and sea-level rise.

5. Without adaptation & mitigation, climate change could result in a dramatically increased health burden in the regions.

4



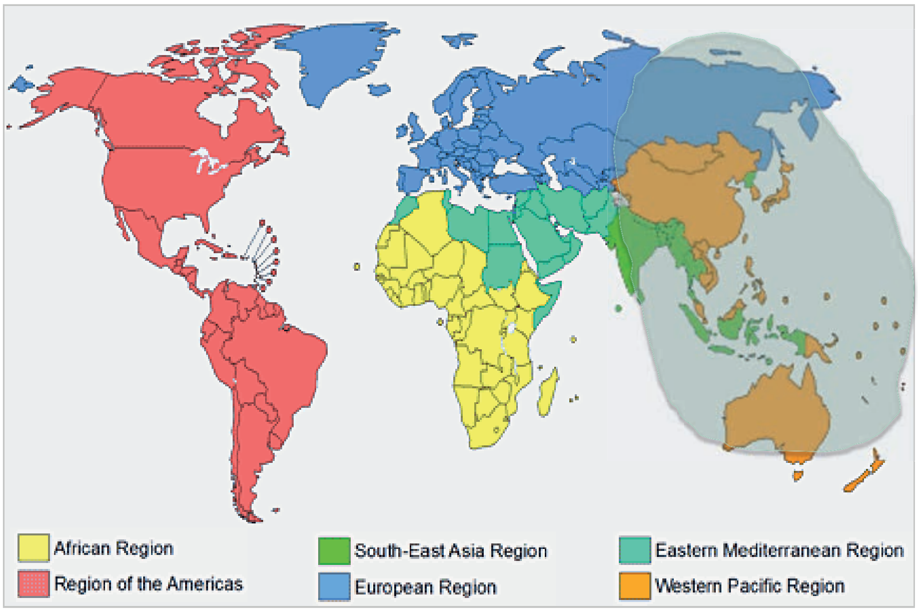
We'll divide Module 2 into these three sections:

1. South-East Asia and the Western Pacific are disaster prone regions
2. Overview of the main findings most relevant to health from the latest IPCC report, called the AR5
3. Action the health sector can take to reduce the health impacts of climate change in SE Asia and the Western Pacific.

5

6

WHO Regions:
SEA & WP Regions



This map is to remind us of how large our regions are, and that climate change will effect the regions differently, depending on exposure, sensitivity and adaptive capacity (we will revisit these terms in the next slide).

The South-East Asia (SEA) Region consists of eleven countries: Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, and Timor-Leste.

The Western Pacific Region stretches over a vast area, from China in the north and west, to New Zealand in the south, and French Polynesia in the east. One of the most diverse of the WHO regions, the Western Pacific, constitutes some of the world's least-developed countries as well as the most rapidly emerging economies. It includes highly developed countries such as Australia, Japan, New Zealand, the Republic of Korea and Singapore; and fast growing economies such as China and Viet Nam.

There are 37 countries and areas in the Western Pacific Region.

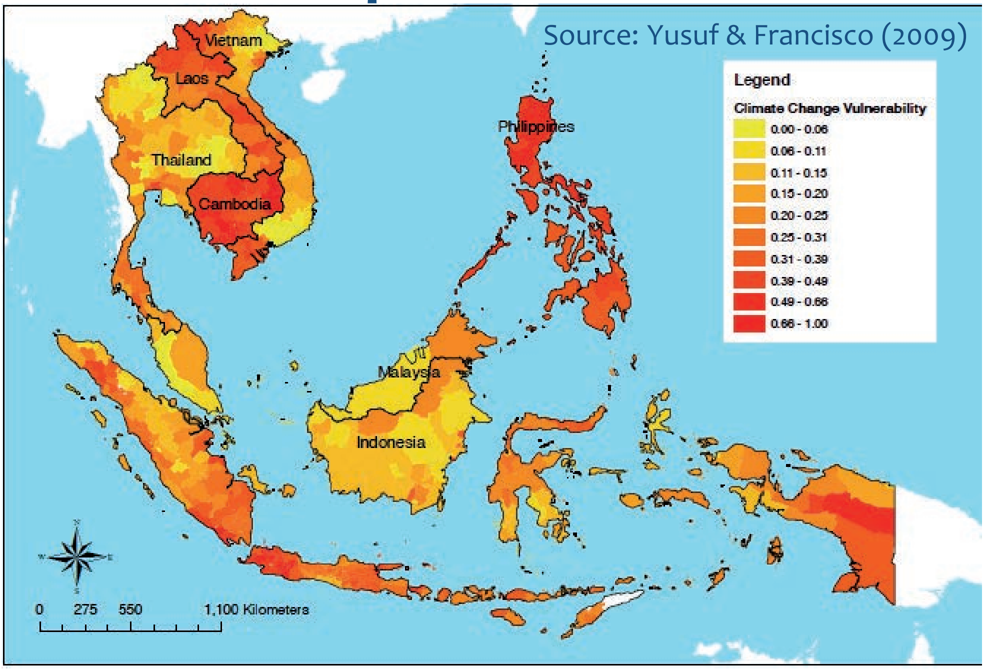
The burden of communicable diseases is still high. Dengue continues to pose a major and increasing public health problem. Chikungunya fever is re-emerging and outbreaks of Nipah virus infections are being reported. Drug-resistant malaria has spread.

Countries have made significant progress toward increasing water supply coverage, but sanitation coverage remains low. As a consequence, diarrhoeal cause substantial mortality. Public awareness of food hygiene related to food standards is limited, as is the food safety surveillance system. More than 70% of workers are not covered by occupational health provisions.

Source: *http://www.who.int/about/regions/en/*

7

Climate change vulnerability map of SE Asia



This climate change vulnerability map is a useful reminder of how vulnerable our region is – unfortunately only part of the Western Pacific and part of South-East Asia is included in this map.

You'll recall that responding to climate change is not just about knowing the exposure to hazards, but also recognising to what degree a region or country is sensitive to such exposure, and to what degree the population has the capacity to adapt. This is known as 'vulnerability'.

[This vulnerability map was developed by averaging the indicators of exposure (multiple hazard risk exposure), sensitivity (human and ecological) and adaptive capacity across the countries and regions in SE Asia. The vulnerable areas were identified by ranking the regions according to the index and dividing the list into four equal parts. The geographical areas that fell into the fourth quartile were considered the vulnerable areas].

So, again, the most vulnerable areas include: all the regions of the Philippines; the Mekong River Delta in Vietnam; almost all the regions of Cambodia; North and East Lao PDR; the Bangkok region of Thailand; and West Sumatra, South Sumatra, West Java, and East Java of Indonesia. The exposure of the Philippines is more extreme compared to other Southeast Asian countries in that it is not only exposed to tropical cyclones (especially in the northern and eastern parts of the country) but also to many other climate hazards particularly floods (such as in central Luzon and southern Mindanao), landslides (due to the terrain of the country), and droughts.

In general, these results confirm our general assumptions that the most vulnerable regions in Southeast Asia include the Mekong River Delta in Vietnam and Bangkok due to their exposure to sea-level rise, and the northern part of the Philippines due to its exposure to tropical cyclones.

8

"Adverse health impacts will be greatest in low-income countries. Those at greater risk include, in all countries, the urban poor, the elderly & children, traditional societies, subsistence farmers, & coastal populations (*high confidence*)."

IPCC AR4 (2007) & IPCC AR5 (2013)

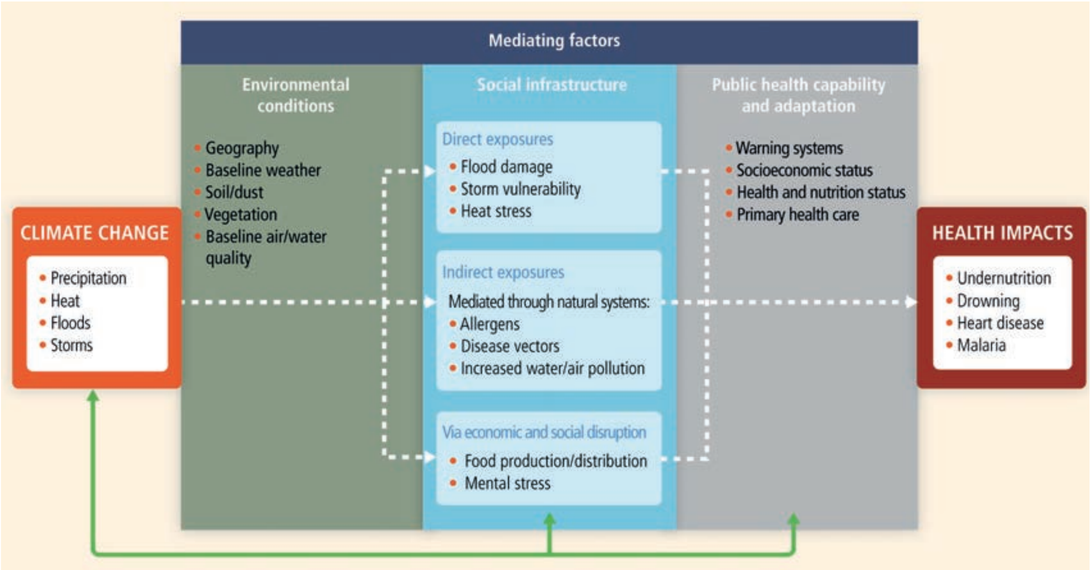
So to put a face to the map of SEA and the WP we just saw - the most vulnerable are those who have less capacity to cope: the poor, children, women, the elderly, disabled and sick people, slum dwellers, the landless and marginalized, informal open air workers, but also the displaced communities and individuals.

Low-income countries and areas where malnutrition is widespread, the level of education is poor and with weak infrastructures will have the most difficulty adapting to climate change and related health hazards. The populations considered to be at greatest risk are those living in small islands, low-lying and coastal areas, mountainous regions, water-stressed areas, in mega-cities – particularly the large urban and peri-urban agglomerations in delta regions in the SEA Region.

The most vulnerable of populations in the Region will be the poor because they have fewer resources to adapt to the rapid changes of the natural environment whose livelihood is dependent upon. In rural areas, women are increasingly becoming household heads and have the double burden of social reproduction and agricultural work as their husbands leave the rural areas in search of work in urban centres.

Mountain people, communities living in remote areas, slums dwellers in and around mega cities, islanders, and fisher folk will be deeply affected. But it is women, elderly groups, poor communities, children, the disabled, and ethnic minorities who have the least coping and recovering capacity and who, therefore, will be the most physically, socially, and psychologically vulnerable.

How climate change affects health & increases vulnerability



Source: IPCC AR5 (2013)

In terms of understanding how exactly climate change affects health, and increases vulnerability, it is helpful to look at this diagram. **(CLICK to show the diagram).**

This diagram from the IPCC AR5 report shows three primary exposure pathways by which climate change affects health:

1. Directly through weather variables such as heat and storms;
2. Indirectly through natural systems such as disease vectors; and
3. Pathways heavily mediated through human systems such as undernutrition.

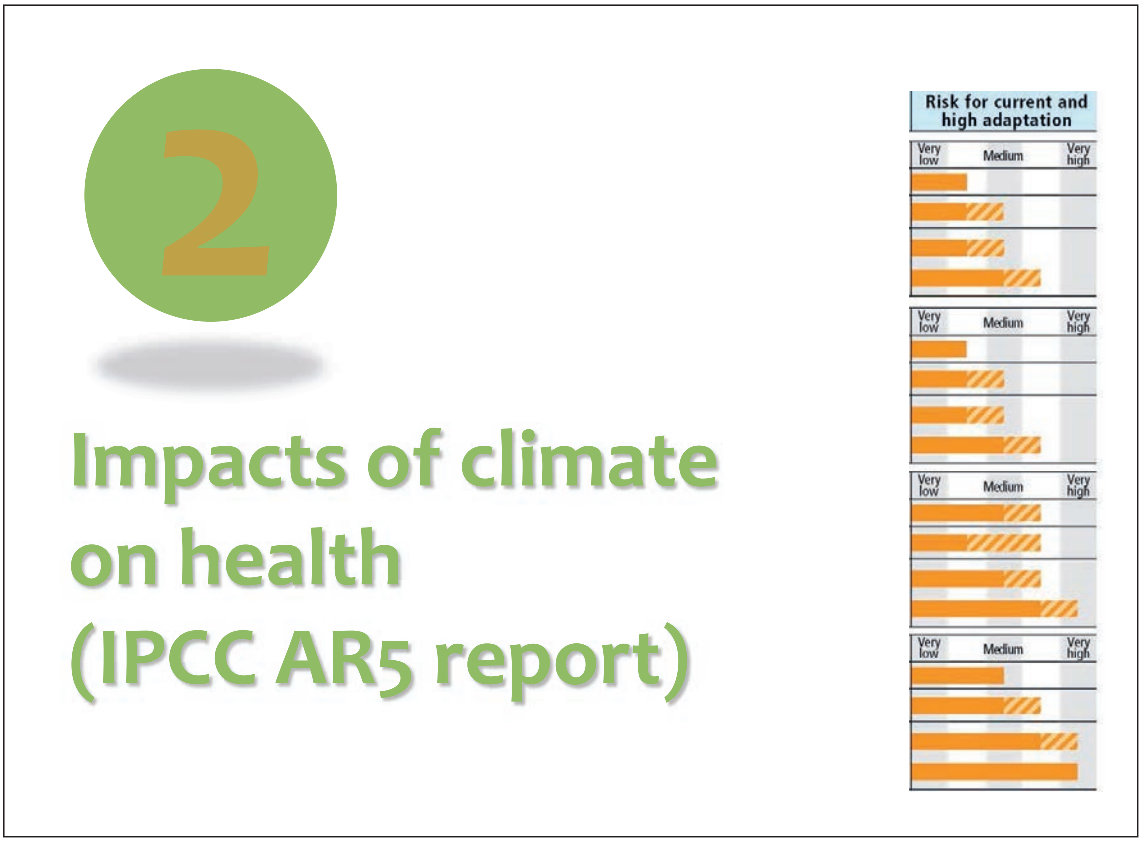
The yellow box indicates the moderating influences of local environmental conditions on how climate change exposure pathways occur in a particular population.

The orange box indicates that the extent to which the three categories of exposure translate to actual health burden is moderated by such factors as background public health and socioeconomic conditions, and adaptation measures.

The green arrows at the bottom indicate that there may be feedback mechanisms, positive or negative, between societal infrastructure, public health, and adaptation measures and climate change itself.

Source: *IPCC AR5 Chapter 11 (2013)*

10



So we've looked at the SE Asia and Western Pacific regions, and how generally climate change affects human health and vulnerability.

Now let's look in more detail at some of the specific impacts of climate change on human health.

11

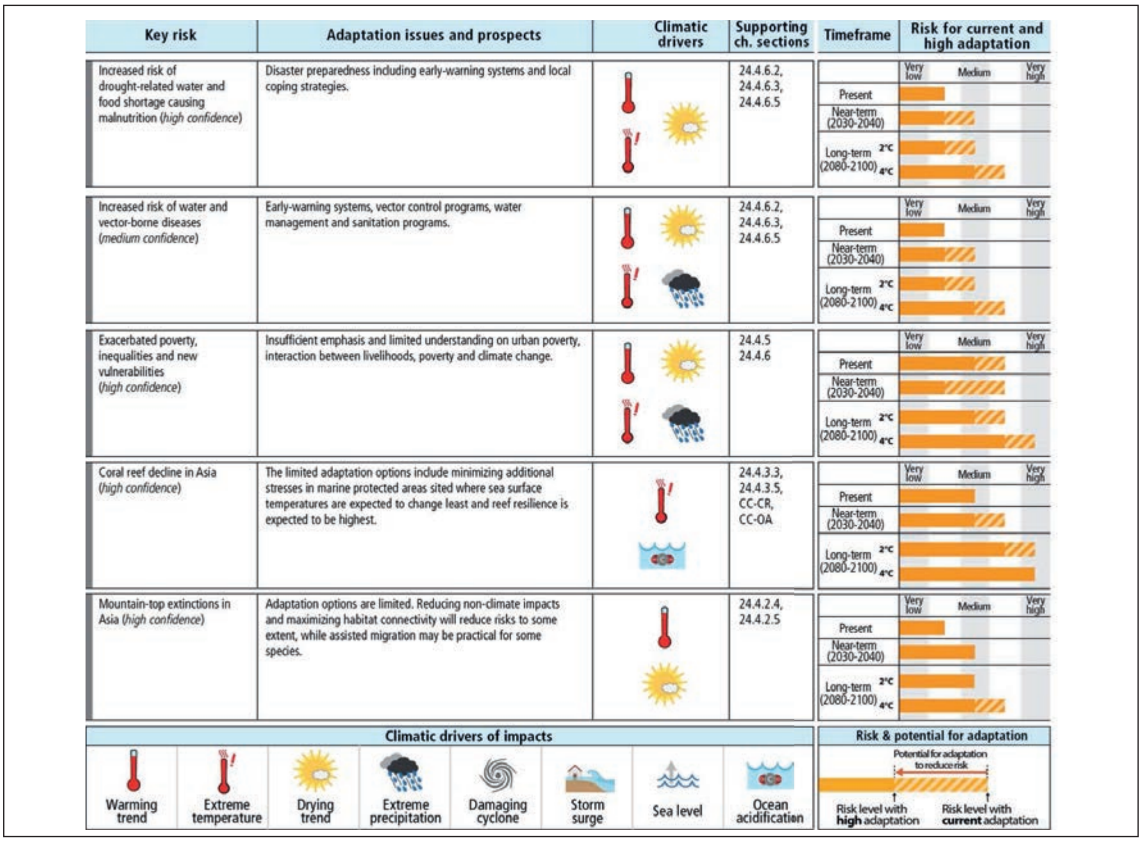
Impacts of climate change on health

- Drought
- Hunger
- Vector-borne disease
- Heat-related mortality
- Flooding
- Water-borne disease
- Water scarcity
- Flooding: Glacial Lake Outburst Flood
- Sea-level rise

Some of the impacts of climate change on health include… (read)

We'll look at each of these in turn in the following slides.

12



Key risk	Adaptation issues and prospects	Climatic drivers	Supporting ch. sections	Timeframe	Risk for current and high adaptation
Increased risk of drought-related water and food shortage causing malnutrition (*high confidence*)	Disaster preparedness including early-warning systems and local coping strategies.		24.4.6.2, 24.4.6.3, 24.4.6.5	Present; Near-term (2030-2040); Long-term (2080-2100) 2°C, 4°C	Very low – Medium – Very high
Increased risk of water and vector-borne diseases (*medium confidence*)	Early-warning systems, vector control programs, water management and sanitation programs.		24.4.6.2, 24.4.6.3, 24.4.6.5	Present; Near-term (2030-2040); Long-term (2080-2100) 2°C, 4°C	Very low – Medium – Very high
Exacerbated poverty, inequalities and new vulnerabilities (*high confidence*)	Insufficient emphasis and limited understanding on urban poverty, interaction between livelihoods, poverty and climate change.		24.4.5 24.4.6	Present; Near-term (2030-2040); Long-term (2080-2100) 2°C, 4°C	Very low – Medium – Very high
Coral reef decline in Asia (*high confidence*)	The limited adaptation options include minimizing additional stresses in marine protected areas sited where sea surface temperatures are expected to change least and reef resilience is expected to be highest.		24.4.3.3, 24.4.3.5, CC-CR, CC-OA	Present; Near-term (2030-2040); Long-term (2080-2100) 2°C, 4°C	Very low – Medium – Very high
Mountain-top extinctions in Asia (*high confidence*)	Adaptation options are limited. Reducing non-climate impacts and maximizing habitat connectivity will reduce risks to some extent, while assisted migration may be practical for some species.		24.4.2.4, 24.4.2.5	Present; Near-term (2030-2040); Long-term (2080-2100) 2°C, 4°C	Very low – Medium – Very high

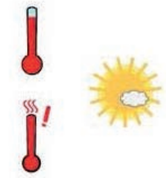
This is an example of the tables featured in the latest IPCC AR5 report from the chapter on the Asia Pacific region that set out specific impacts of climate change on health.

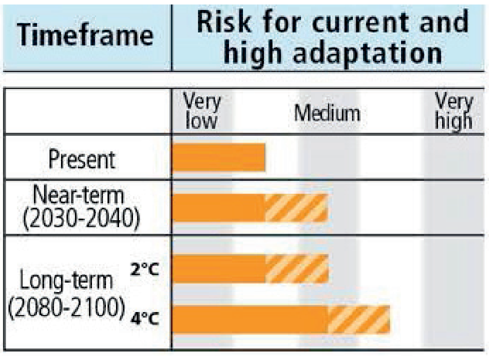
The figure outlines the key risks and the climatic drivers for these, indicates the adaptation issues and prospects, and suggests a timeframe for risks for current and high adaptation. We can see that in each example, the lowest risks are faced when adaptation occurs in the present – i.e. now. We face higher risks for adaptation when we delay our responses.

We'll now look at these impacts one by one.

13

Drought

Key risk	Adaptation issues and prospects	Climatic drivers
Increased risk of drought-related water and food shortage causing malnutrition (*high confidence*)	Disaster preparedness including early-warning systems and local coping strategies.	



Let's take drought as our first example. Drought is listed here as a key risk – particularly the increase risk of drought-related water and food shortage causing malnutrition. This climate change risk is indicated with 'high confidence', meaning that there is a good degree of certainty that this will in fact occur.

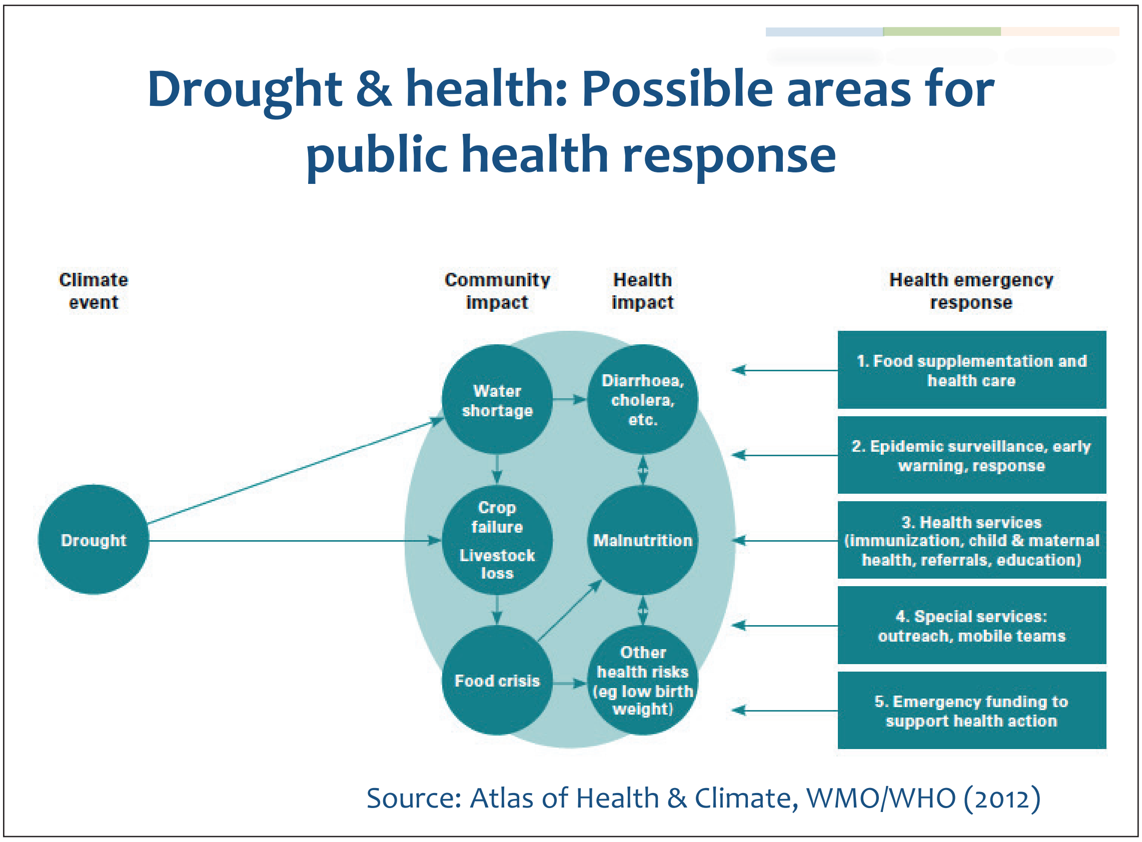
Adaptation issues to respond to drought and corresponding effects include disaster preparedness, such as early-warning systems, and local coping strategies.

Source: *IPCC AR5 Asia Report*

[SUPPORTING BACKGROUND INFO

Key risks are identified based on assessment of the literature and expert judgments, with supporting evaluation of evidence and agreement in the referenced chapter sections. Each key risk is characterized as very low, low, medium, high, or very high. Risk levels are presented for the near-term era of committed climate change (here, for 2030-2040), in which projected levels of global mean temperature increase do not diverge substantially across emissions scenarios. Risk levels are also presented for the longer-term era of climate options (here, for 2080-2100), for global mean temperature increase of 2°C and 4°C above preindustrial levels. For each timeframe, risk levels are estimated for the current state of adaptation and for a hypothetical highly adapted state. As the assessment considers potential impacts on different physical, biological, and human systems, risk levels should not necessarily be used to evaluate relative risk across key risks. Relevant climate variables are indicated by symbols.]

14



This image shows the impacts of drought through two lenses – community and health. Drought can be seen here as a risk factor for complex public health impacts – ranging from infectious diseases and malnutrition to other health risks such as low birth weight.

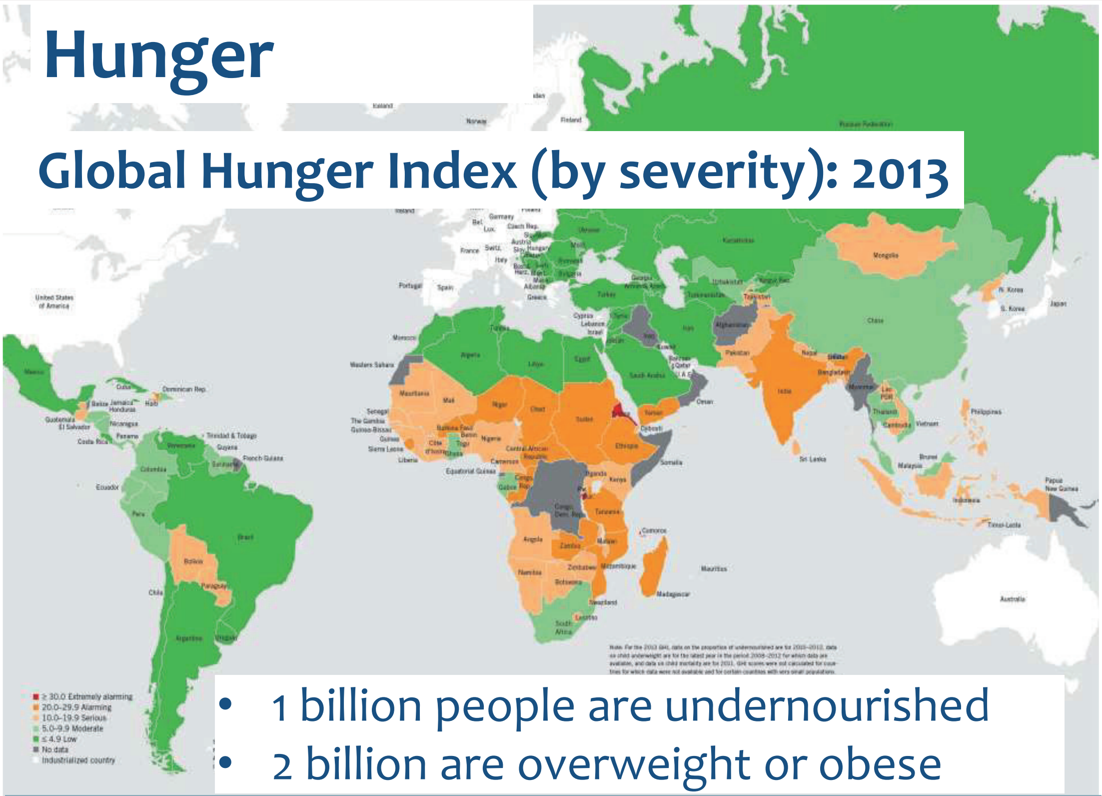
If we take one example, we can see that drought has a community-level impact on water shortage, which in turn effects infectious diseases such as diarrhoea and cholera. Health emergency responses to this are suggested as (for example) food supplementation and health care, as well as epidemic surveillance and early warning systems.

There are many areas for public health responses to drought – 5 are listed here - these can be seen as broadly strengthening the health system, and will be relevant regardless of the extent of climate change that we observe. These are win-win approaches and will strengthen our health system to respond to climate change as well as many other threats – Ebola is a good example of other nonclimate-related threats that will also benefit from stronger health systems.

15

Hunger

Global Hunger Index (by severity): 2013



- 1 billion people are undernourished
- 2 billion are overweight or obese

Hunger is a second important health impact of climate change, closely tied to drought.

This map is the Global Hunger Index by severity.

The red, orange and apricot colours depict where hunger is the greatest. We can see here that the regions with the highest problems relating to hunger are in Africa, India and parts of north Asia and the Western Pacific.

We face a growing problem in the world – more people are facing food insecurity and hence undernutrition, while more and more are becoming obese or overweight.

Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions, increasing risks of malnutrition (Parry et al., 2004).

According to IPCC, crop yields could decrease up to 30% in Central and South Asia by the mid-21st century. The rapid population growth and urbanization in the region will magnify the number of malnourished and the risk of hunger for most SEAR countries.

In Bangladesh, production of rice and wheat might drop by 8% and 32%, respectively, by the year 2050 (Faisal and Parveen, 2004).

Recent studies suggest a 2 to 5% decrease in yield potential of wheat and maize for a temperature rise of 0.5 to 1.5°C in India (Aggarwal, 2003).

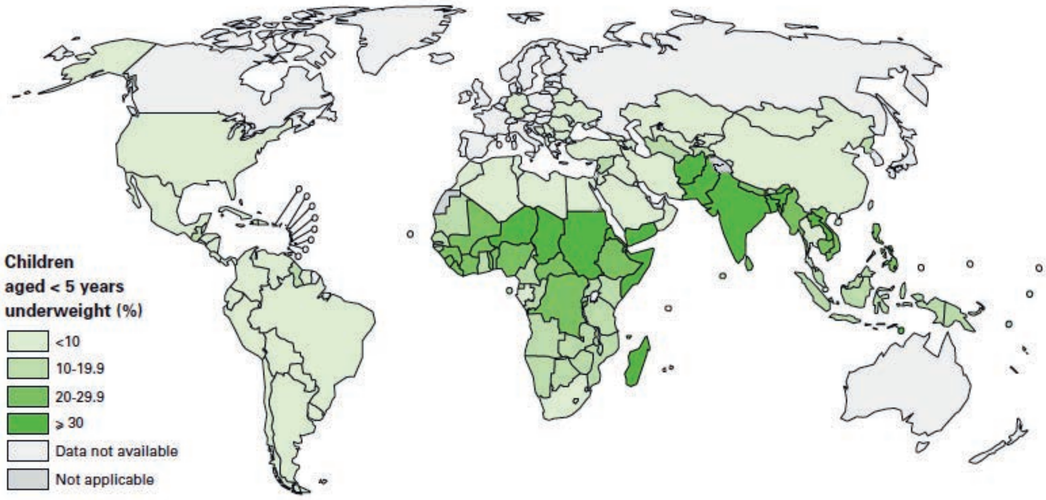
The net cereal production in South Asian countries is projected to decline at least between 4 to 10% by the end of this century under the most conservative climate change scenario.

Some studies agree that higher temperatures and longer growing seasons could result in increased pest populations in temperate regions of Asia (Roy, 2006).

Given that 60% of the cropped area is still dependent on rainfall (MoEF, 2002), Indian agriculture continues to be fundamentally dependent on rainfall.

16

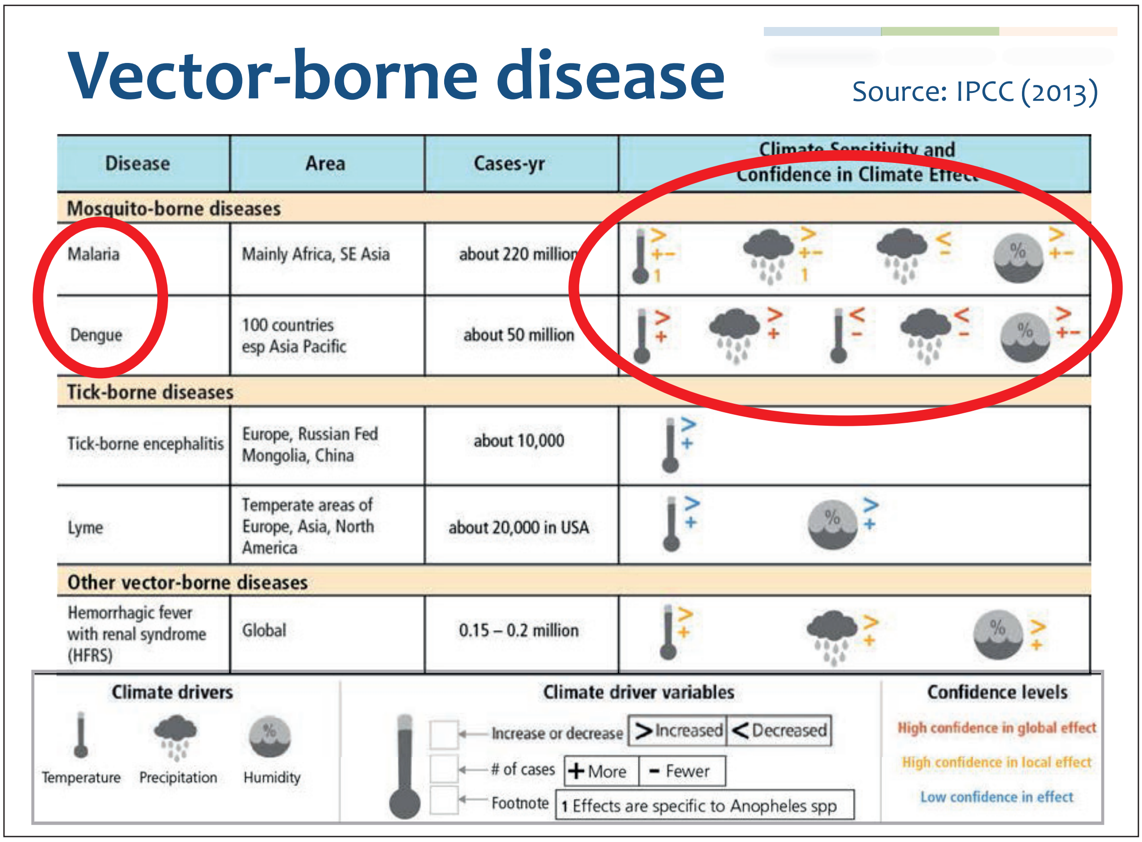
Percentage of underweight children under 5 yrs of age



Source: Atlas of Health & Climate, WMO/WHO (2012)

Again – another figure depicting the enormous inequity in relation to underweight children (under 5). We can see here that the SE Asia and WP regions are both burdened heavily by this.

17



Now, moving to our third example of health impacts – vector-borne diseases. Again, this is taken from the Human Health Chapter (11) of the latest IPCC assessment report (AR5). We can see here **(CLICK)** that malaria and dengue present the greatest burden of disease globally, with 220 millions cases/year for malaria, and 50 million cases/year for dengue. It is also shown here **(CLICK)** that both diseases are sensitive to changes in the climate which has been observed over the period 2008-2012.

Here's **(CLICK)** a reminder of what these symbols and confidence levels mean.

In terms of burden of disease, and priority setting, malaria and dengue are the current focus for many countries.

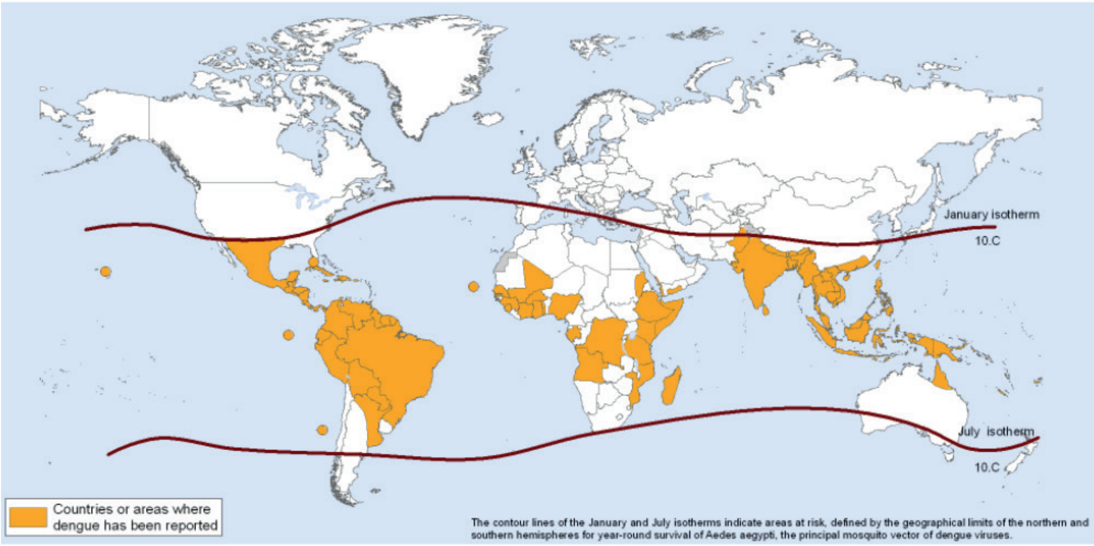
Changes in climate are likely to lengthen the transmission season of important vector-borne diseases like dengue and malaria and to alter their geographic range, potentially reaching regions that lack either population immunity and/or a strong public health infrastructure (Bhattacharya et al., 2006, Climate change and malaria in India; Hales et al., 2002, Potential effect of population and climate changes on global distribution of dengue fever: an empirical model).

Warmer temperatures and disturbed rain patterns could alter the distribution of important disease vectors. Combined with altered rainfall patterns, hotter conditions may increase the spread of disease, such as malaria, dengue, and chikungunya, to new areas.

Next we will look at the example of dengue in more detail.

18

Dengue: distribution



Source: WHO (2008)

This image shows countries or areas at risk of dengue, 2011. What this shows is that much of the SE Asia and Western Pacific regions have reported dengue, so are already vulnerable to the disease, which is expected to worsen under climate change.

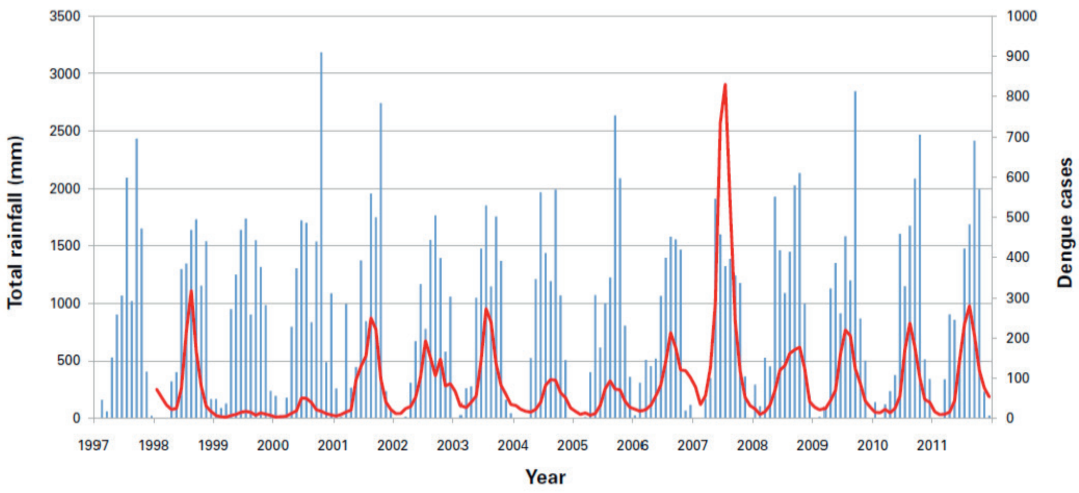
Japan should also be added to this image, given the recent outbreak there in 2014.

The red contour lines of the January and July isotherms indicate areas at risk, defined by the geographical limits of the northern and southern hemispheres for year-round survival of Aedes aegypti, the principal mosquito vector of dengue.

Source: *WHO Map Production: Public Health Information and Geographical Information Systems, Public Health Information and Geographic Information System World Health Organization, 2008*
[from WPRO report]

19

Dengue & rainfall: Cambodia



Source: WHO & WMO (2012)

This graph shows the relationship between monthly dengue reports (red line) and monthly rainfall (blue bars) in Siem Reap and Phnom Penh, Cambodia.

What we can see here is that an increase in dengue cases seems closely correlated to an increase in rainfall.

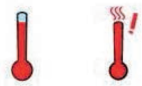
Data supplied by Ministry of Health and Ministry of Water Resources and Meteorology, Kingdom of Cambodia.

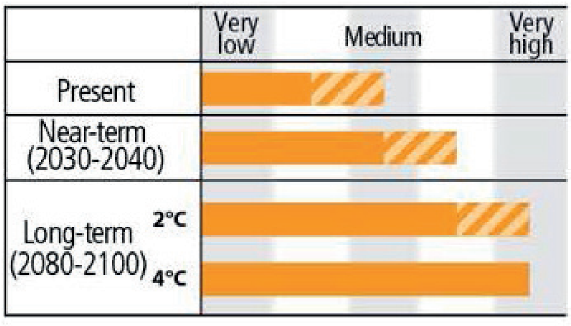
Source: *WHO and WMO, 2012*

[from WPRO report]

20

Heat-related mortality

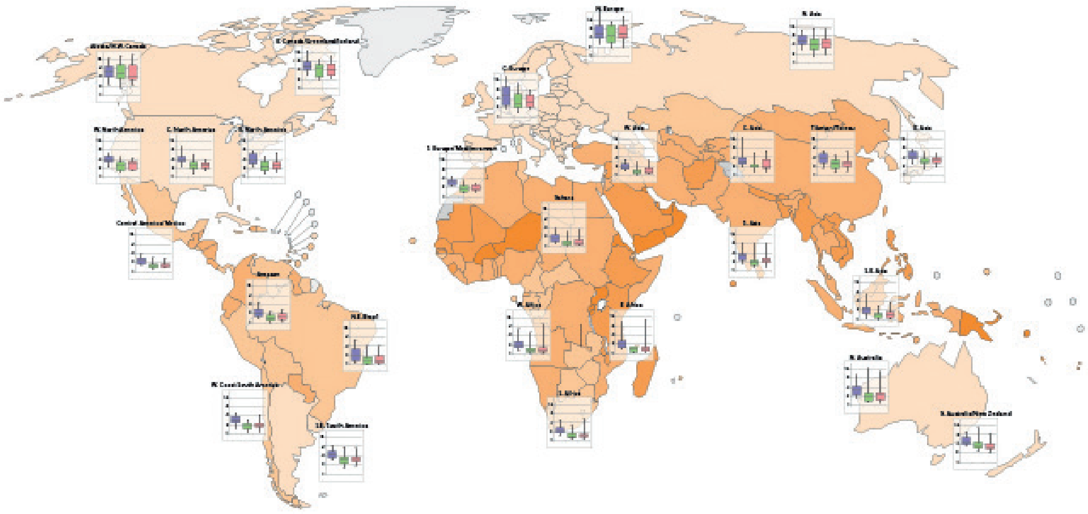
Increased risk of heat-related mortality (*high confidence*)	Heat health-warning systems, urban planning to reduce heat islands and improvement of built environment.	



Now we move on to looking at another health impact of climate change – heat-related mortality. The IPCC has indicated here (in the Asia chapter of the AR5) that there is a high confidence of an increase in heat-related mortality. Adaptation issues and prospects to respond to this include heat health-warning systems, urban planning to reduce heat islands, and the improvement of the built environment.

21

Heat extremes & urbanization



Source: WHO/WMO (2012)

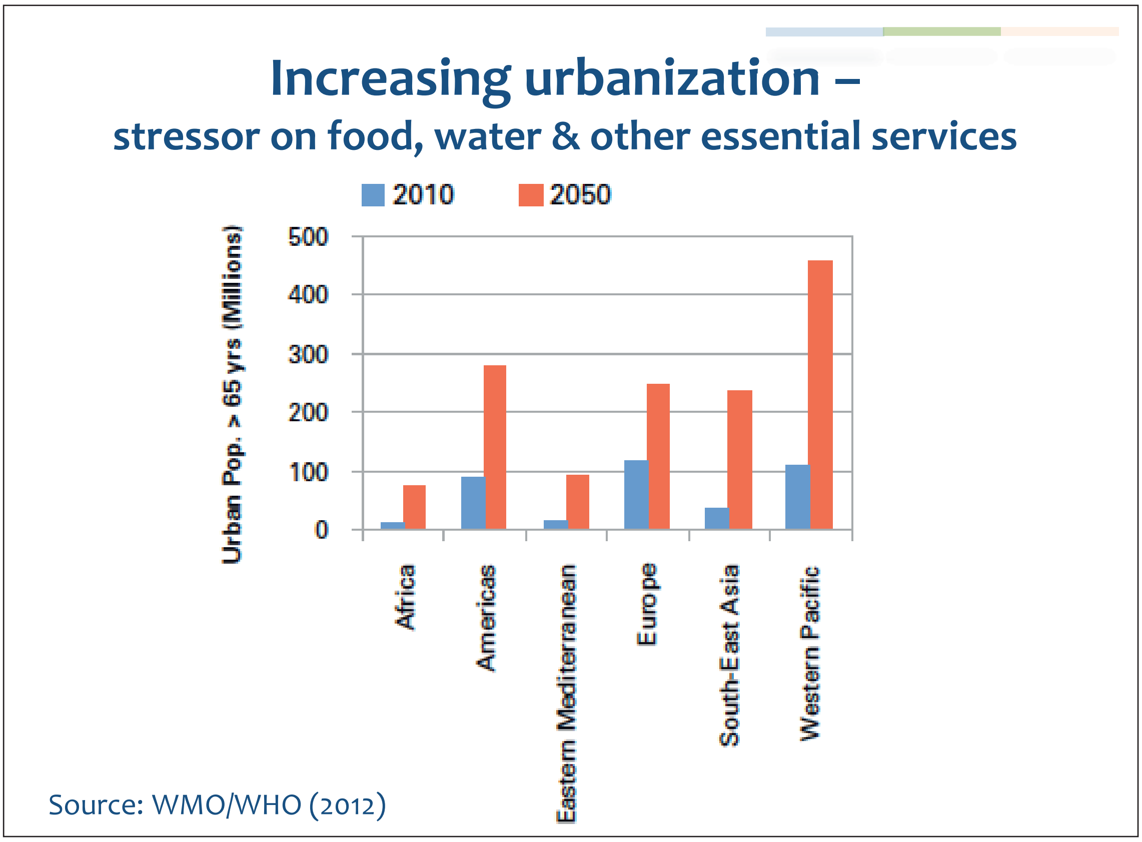
This figure shows increasingly frequent heat extremes will combine with rapidly growing numbers of older people living in cities – who are particularly vulnerable to extreme heat.

Countries are shaded here according to the expected proportional increase in urban populations aged over 65 by the year 2050. Bar graphs show how frequently the maximum daily temperature that would have occurred only once in 20 years in the late 20th century is expected to occur in the mid-21st century, with lower numbers indicating more frequent events. Results are shown for 3 different

"SRES" scenarios (Blue = B1; Green = A1B, Red = A2), as described in the IPCC Special Report on Emissions Scenarios.

Population growth is linked to climate change vulnerability. If nothing else changes, increasing numbers of people in locations that are already resource-poor and are affected by climate risks will magnify harmful impacts. Virtually all the projected growth in populations will occur in urban agglomerations, mostly in large, low latitude hot countries in which a high proportion of the workforce is deployed outdoors with little protection from heat. About 150 million people currently live in cities affected by chronic water shortages and by 2050, unless there are rapid improvements in urban environments, the number will rise to almost a billion (McDonald *et al*., 2011). Under a "business as usual" scenario with mid-range population growth, the OECD projects that about 1.4 billion people will be without access to basic sanitation in 2050 (OECD, 2012). The age structure of the population also has implications for vulnerability (see Figure 11-2). The proportion aged over 60, world-wide, is projected to increase from about 10% presently to about 32% by the end of the century (Lutz *et al*., 2008). The prevalence of overweight and obesity, which is associated with relatively poor heat tolerance, has increased almost everywhere in the last 20 years, and in many countries the trend continues upwards (Finucane et al., 2011). It has been pointed out that the Sahel region of Africa may be particularly vulnerable to climate change because it already suffers so much stress from population pressure, chronic drought, and governmental instability (Diffenbaugh and Giorgi, 2012; Potts and Henderson, 2012).

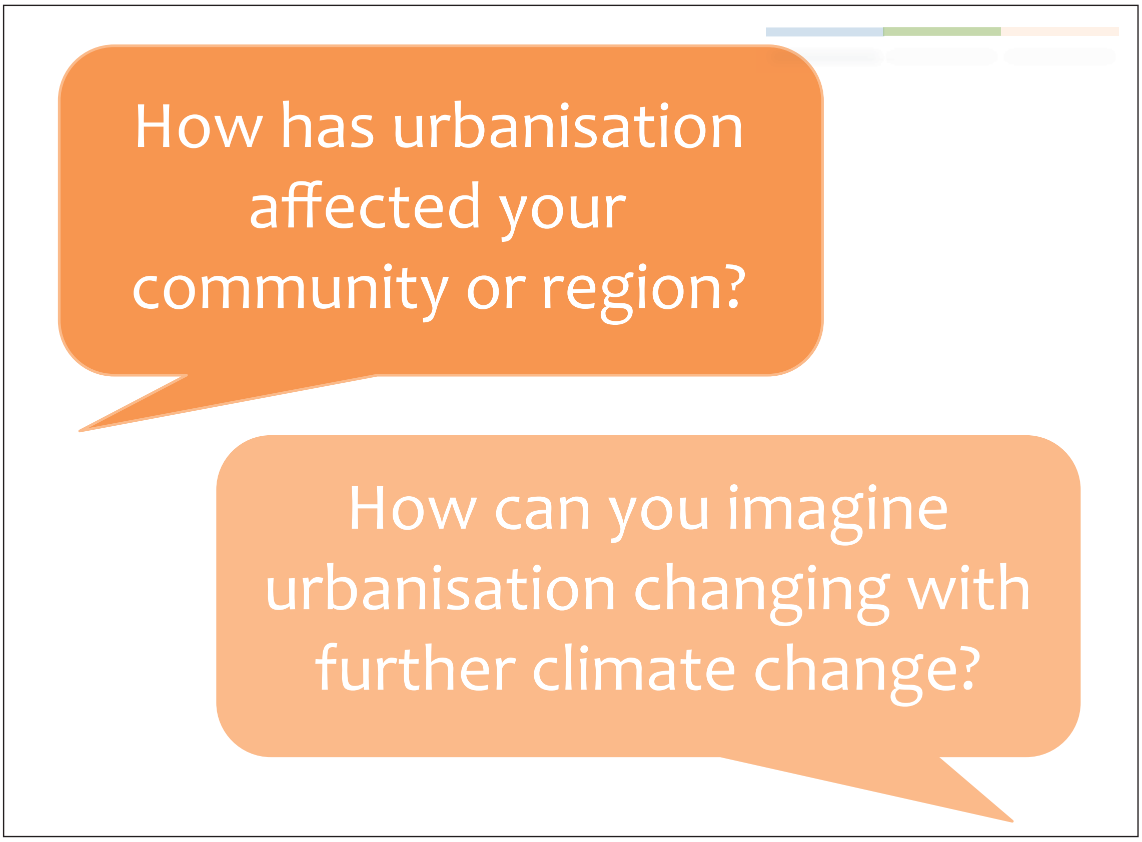
Source: *World Health Organization and World Meteorological Organization, 2012.*
[from AR5 Ch11)



This is another figure that shows our increasing rate of urbanisation. This is predicted to continue, and will bring further stress to food, water and other essential services.

Source: *WMO/WHO atlas (2012)*

23



5 minute small group discussion

"Ok, I'd like you to get into groups of 4. In your 4, please chat with each other about how your community has felt the impacts of urbanization, either with people leaving it (if rural) or entering it (if urban)?

Once you've discussed that, please focus on the second question: How can you imagine this urbanisation (either to or from where you live) changing with climate change?

You'll have 5 minutes to cover both questions."

Give time count down reminders – 3 minutes: "Ok, you have two minutes left. Make sure you're now discussing the second question if you're not already." **4 mins 30 secs:** "Please finish off your discussion in the next 30 seconds."

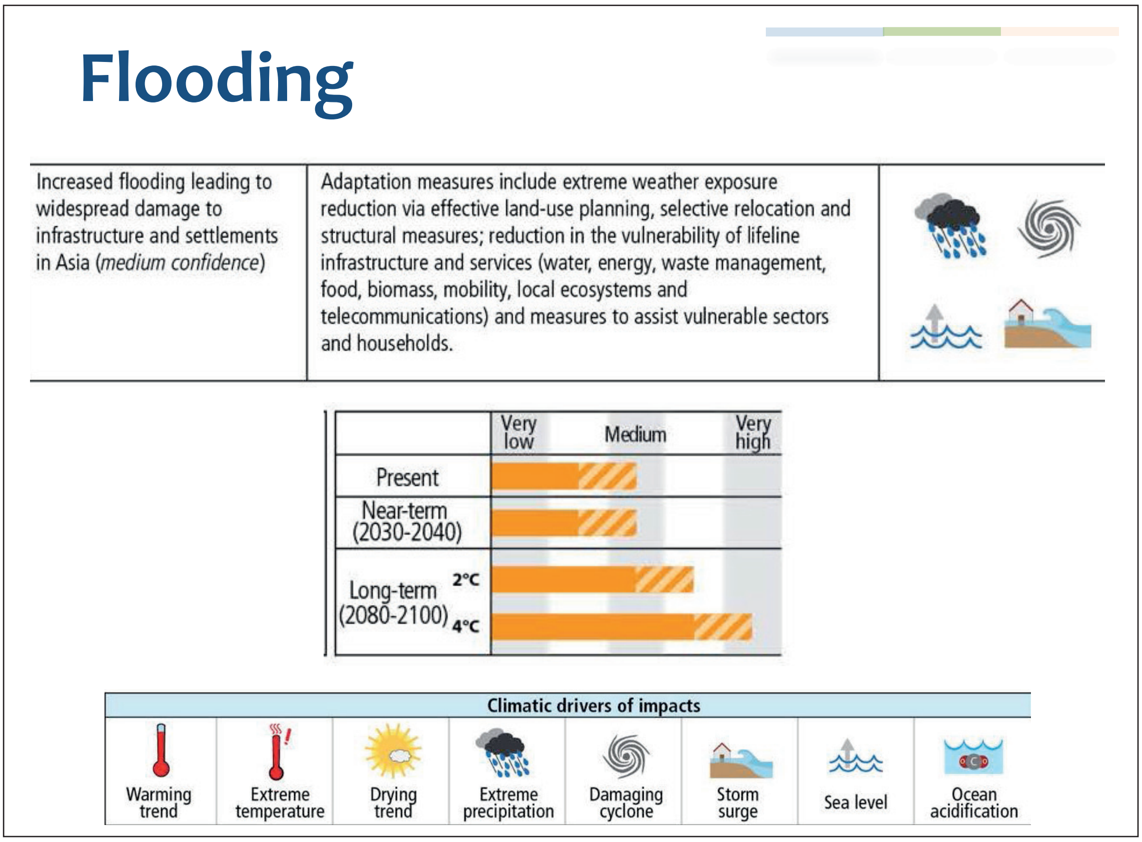
"Ok, if I can have your attention back please."

Report back - "I'm curious about some of the affects of urbanisation that were discussed in your group. Would any groups like to report back?" Look for raised hands. "Ok, thanks. Can you let us know a few of the affects of urbanisation on the communities represented in your group? (gather 2 – 5 quick affects from one representative of the group). And how did you think in your group that climate change would influence those effects?"

Is there a second group who'd like to also report back? Repeat.

Thank. Summarise some of the affects contributed, and wrap up by reiterating how urbanisation is likely to be an important trend in influencing health impacts under climate change.

24



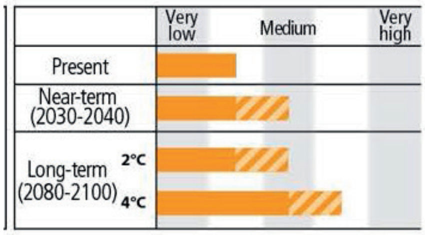
Let's now look at another example of how climate change affects health – flooding. Again, the IPCC (in the Asia chapter) notes a key climate change risk as increased flooding leading to widespread damage to infrastructure and settlements in Asia.

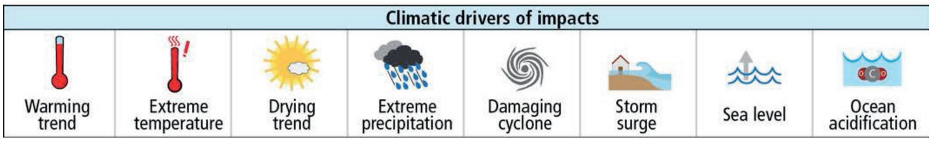
Adaptation measures suggested to respond to flood include extreme weather exposure reduction via better land-use planning, selective relocation of communities, reducing the vulnerability of essential services such as water, energy, waste management, food, telecommunications, and measures to assist vulnerable sectors and households.

Source: *IPCC AR5 Asia Report*

Flooding

Increased risk of flood-related deaths, injuries, infectious diseases and mental disorders (*medium confidence*)	Disaster preparedness including early-warning systems and local coping strategies.	

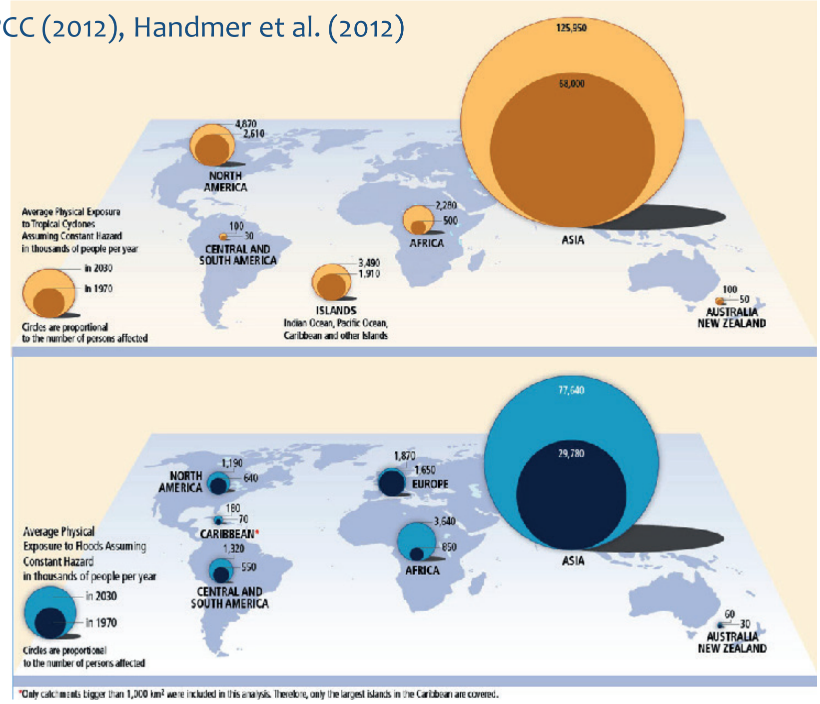




Flooding is also linked to flood-related deaths, injuries, infectious diseases & mental disorders, with medium confidence.

Cyclones & floods

Source: IPCC (2012), Handmer et al. (2012)



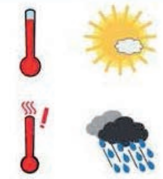
This image shows average physical exposure to: a) tropical cyclones (top half); and b) floods in different global regions (bottom half). The darker circles indicate thousands of people affected in 1970, while the lighter circles indicate thousands of people predicted to be affected in 2030.

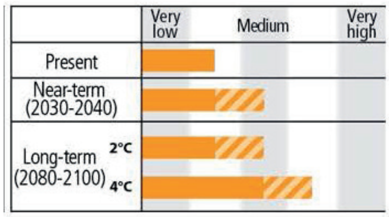
We can see here that the Asia region is indicated in both examples as bearing the most burden of both cyclones and floods.

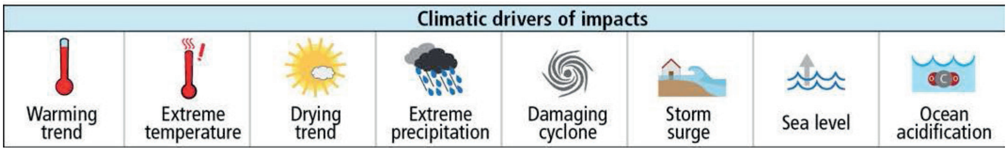
Source: *IPCC 2012, Handmer et al., 2012 [from WPRO regional Climate change and health report)*

27

Water-borne disease

Increased risk of water and vector-borne diseases *(medium confidence)*	Early-warning systems, vector control programs, water management and sanitation programs.	





The next key risk from the IPCC's AR5 that we take a quick look at is the increased risk of water-borne disease. Early warning systems, water management and sanitation programmes are suggested as useful adaptation responses.

Source: *IPCC AR5 Asia Report*

28

More water-borne diseases

In 2005, diarrhoeal diseases accounted for 20.1% of deaths in children less than five years.

Photo: Shehzad Noorani, Still Pictures

More variable precipitation patterns, together with warmer temperatures, are likely to compromise the supply of freshwater, increasing the risks of water-borne diseases like cholera and outbreaks of diarrhoeal diseases (Rodó et al., 2002).

Floods cause sewage and drinking water systems to mix. The lack of proper sanitation would make the problem worse.

In 2012, the sanitation coverage in the South-East Asia Region was only of 45%, posing this as a major threat to water sources in terms of pollution with human faeces.

Photo credit: *© Shehzad Noorani/Still Pictures*

Source: *WHO/UNICEF, 2014, Progress on drinking water and Sanitation Joint Monitoring Programme update 2014.*

29

Water scarcity

Rapid glacier melting = Less freshwater

From water-borne disease, let's move to water supply. One critical influence of water supply in Asia is glaciers. The Himalayas have the largest concentration of glaciers outside the polar region.

These glaciers are a freshwater reserve; they provide the headwaters for nine major river systems in Asia – a lifeline for almost one-third of humanity.

There is clear evidence that Himalayan glaciers have been melting at an unprecedented rate in recent decades; this trend causes major changes in freshwater flow regimes and is likely to have a dramatic impact on drinking water supplies, biodiversity, hydropower, industry, agriculture, and others, with far-reaching implications for the people of the Region and the earth's environment.

Rapid glacier melting would result in a drastic reduction in the contribution to the river flow. Current permanent rivers would become seasonal.

Melting glaciers together with disturbed rainfall patterns will increase the amount of water-induced hazards such as floods, flash floods, landslides, debris flows, and droughts. Rainfalls will increase in high latitudes and decrease in most subtropical land regions, many of which are already affected by drought.

Population growth and increasing demand for water due not only to higher temperatures – demand for irrigation water will increase by 10% for an increase in temperature of 1°C – but also to higher standards of living, could adversely affect more than a billion people by the 2050s. Increasing withdrawal rates of groundwater and decreasing recharge time of the aquifers will accelerate the water crisis, notably in drier areas (Gosain et al., 2006).

Photo credit: *http://msnbcmedia3.msn.com*

30

Flooding: Glacial Lake Outburst Flood

- Excess melt water leads to Glacial Lake Outburst Flood (GLOF) or 'mountain tsunami'
- In 2007, two hundred glacial lakes in the Himalayas were at risk of bursting

Photo: Nare glacier GLOF hits Pangboche village Nepal, 1977

Flooding is another impact of climate change that has impacts on human health.

Twenty-one GLOF events have adversely affected Nepalese territory in the recent past.

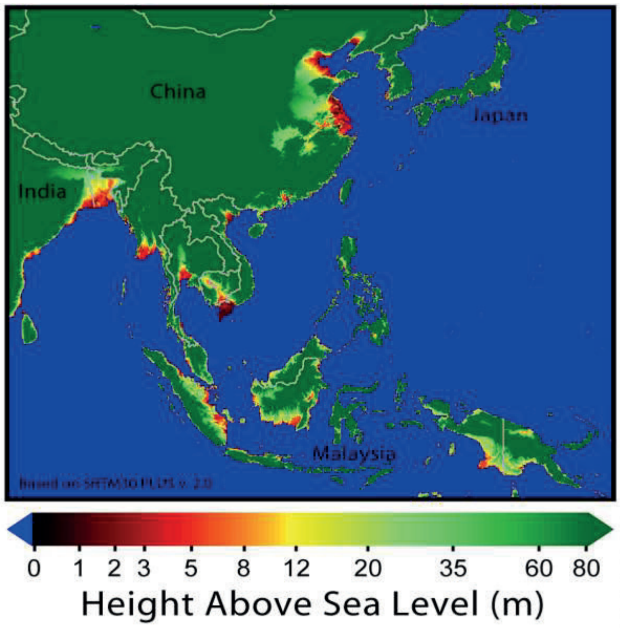
The International Centre for Integrated Mountain Development (ICIMOD), in partnership with UNEP and the Asia Pacific Network and in close collaboration with national partner organizations, documented baseline information on the Himalayan glaciers, glacial lakes, and GLOFs in a study that identified some 200 potentially dangerous glacial lakes in the Himalayas.

Photo credit: *Foto M. J. Hambrey, 2004, www.swisseduc.ch/glaciers/glossary/glof-2-de.html*

31

Sea-level rise

Risks in South-East Asia



Source: Global Warming Art

Lastly related to water, let's look briefly at sea-level rise.

The warming of sea water leads to sea-level rise. Sea levels have risen faster in the last decade than in the previous 30 years. The total rise in sea level during the twentieth century is estimated to be 0.17 m. But a recent research report indicates that the rate of ocean warming from 1961 to 2003 is about 50% larger than previously reported (CSIRO, 2008). Global mean sea level is projected by IPCC to rise by between 18 and 59 cm by the year 2100, but much larger increases cannot be ruled out.

India has one of the most populated coastal communities in the world with approximately 500 people per mile of coastline, compared to the U.S., which has approximately 30 people per mile. India, for instance, has a 7500-km long densely populated and low-lying coastline inhabited by more than 10 million people (Shukla et al., 2003).

UNEP identifies India among the 27 countries that are most vulnerable to sea level rise. Most of the coastal regions are agriculturally fertile, with paddy fields that are highly vulnerable to inundation and salinization. Coastal infrastructure, tourist activities, and onshore oil exploration are also at risk. The impacts of any increase in the frequency and intensity of extreme events, such as storm surges, could be disproportionately large, not just in heavily developed coastal areas, but also in terms of the paralyzing devastation in low-income rural areas. The 1999 tropical cyclone that hit Orissa resulted in a death toll of about 10 000, and demonstrates the extreme significance of impacts related to climate variability.

A district level ranking of vulnerability to one-metre sea level rise by constructing a weighted index. The study also assesses the economic implications of such a rise on the most and least vulnerable districts in order to provide the range of projected economic impacts on the Indian coast. In present value terms, the results range from 4.5 billion USD in the case of Mumbai, to 72 million USD in the case of Balasore.

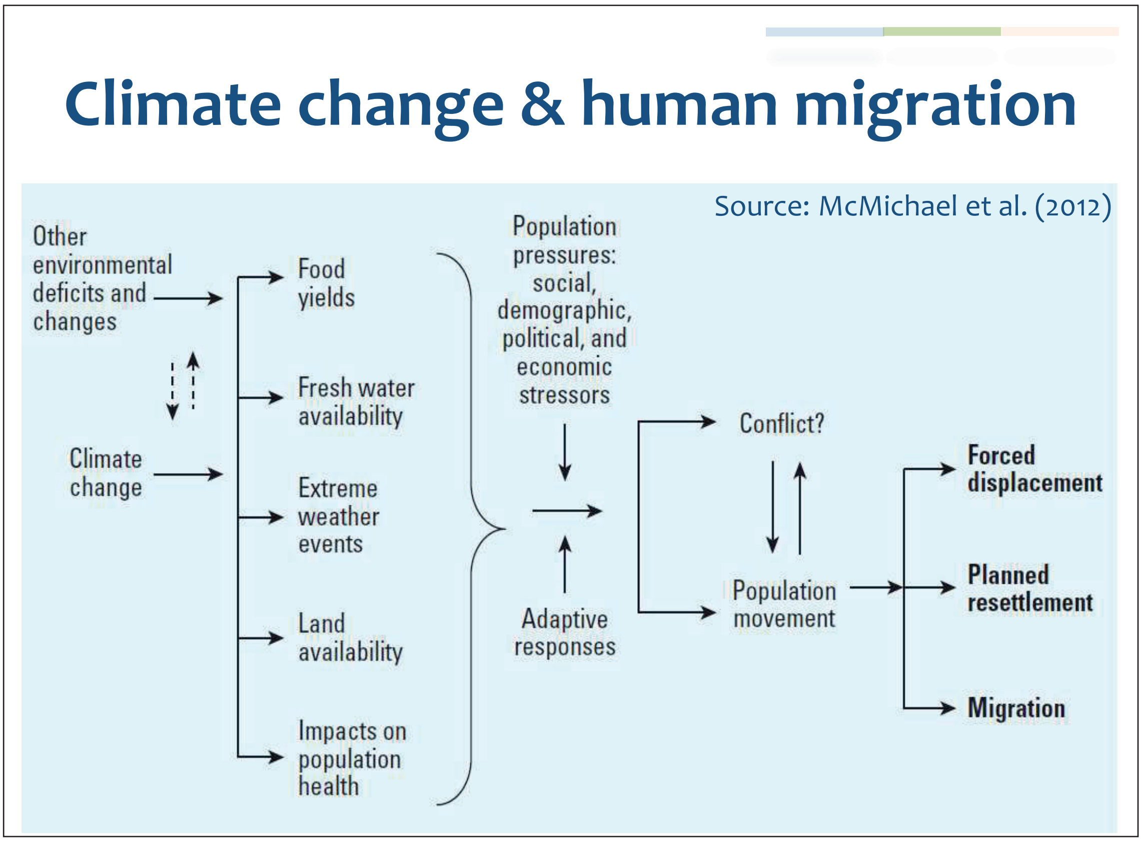
Image created by Robert A. Rohde / Global Warming Art, http://www.globalwarmingart.com/wiki/Image:SE_Asia_Sea_Level_Risks_png

32

Other human affects of climate change:

- Migration
- Psychosocial stress

In these last few slides I will briefly touch on some emerging themes that are starting to be understood a little better: migration and psychosocial stress.



The first is migration, and the potential for climate change to create 'climate refugees', due to a range of factors arising from climate change and its myriad flow on effects. We can see here that 5 direct impacts of climate change are listed – changes in food yields and fresh water availability, extreme weather events, changes to land availabiilty and general impacts on population health. These might then result in population pressures and social, demographic, political and economic stressors (which are mediated by adaptive responses), which can give rise to population movement and/or conflict. Finally, three types of population movement are indicated – forced displacement, planned resettlement or migration.

Source: *McMichael et al. 2012. An Ill Wind? Climate Change, Migration, and Health*

34

Psychosocial stress will affect the health of communities & individuals

Photo: Gil Moti / Still Pictures

Coastal flooding, malnutrition, illnesses, migration, displaced people, and social conflicts are amongst the most significant effects from climate change that will affect human health.

The loss of livelihood will increase psychosocial stress in the affected populations (McMichael et al., 2003a. Climate change and human health: Risks and responses).

A term has now been coined to explain the feeling of distress caused by environmental change - 'Solastalgia' (G. Albrecht, *Solastalgia, a new concept in human health and identity,* Philosophy Activism Nature 3:41-44 (2005).

Photo credit: *Photo credit: © Gil Moti / Still Pictures*

Summary: Impacts of climate on health

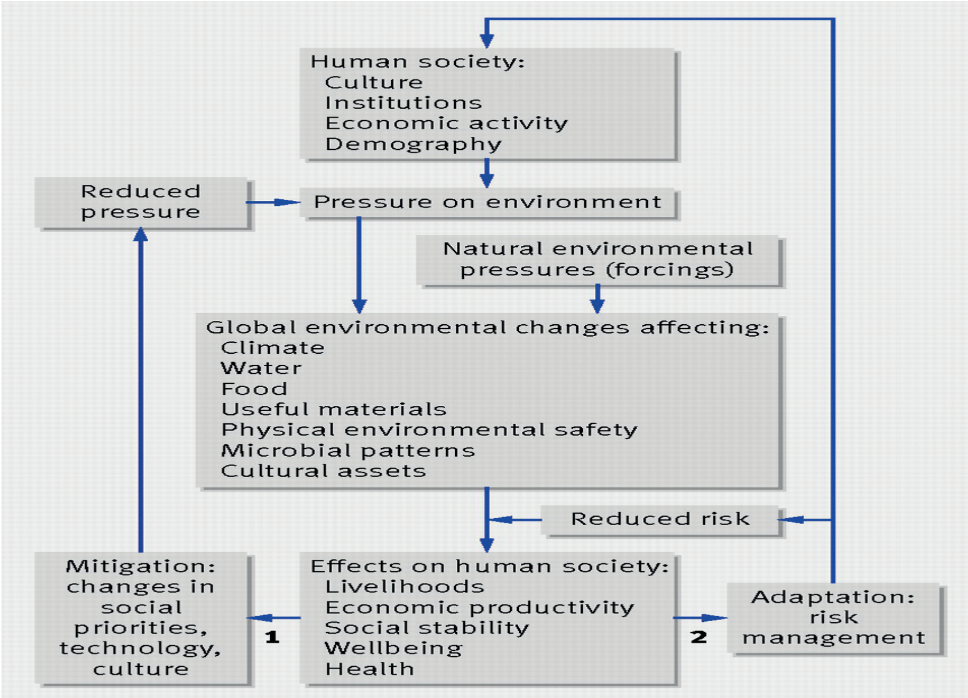
- Drought
- Hunger
- Vector-borne disease
- Heat-related mortality
- Flooding
- Water-borne disease
- Water scarcity
- Flooding: Glacial Lake Outburst Flood
- Sea-level rise
- Migration
- Psychosocial stress

In the last slides we've looked at the following climate change impacts that are affecting health. Hopefully this coverage will be helpful in your countries in being able to identify and manage these impacts.

36

To finish off Module 2, let's look at action the health sector can take to manage the impacts of climate change on population health.

Urgent action is needed



Urgent action is needed from the health sector, in collaboration with other sectors in order to respond to the risks to health posed by climate change.

As we have learnt, global environmental changes are affecting climate, which in turn will impinge on, in profoundly adverse ways, some of the most fundamental pillars of life such as food, air, and water.

The main drivers behind these global changes are both natural and, increasingly so, human pressure. The disruption of environmental factors will have the most significant impacts on health. By adapting, we will reduce those adverse impacts. At the same time, we need to reduce our pressure on the environment through mitigation measures.

Source: *McMichael, Global environmental change and health: impacts, inequalities, and the health sector, BMJ 2008;336:191,*

38

Action by the health sector

Adaptation action for the health sector:

Strengthen prevention, surveillance & early warning systems pertaining to climate sensitive diseases

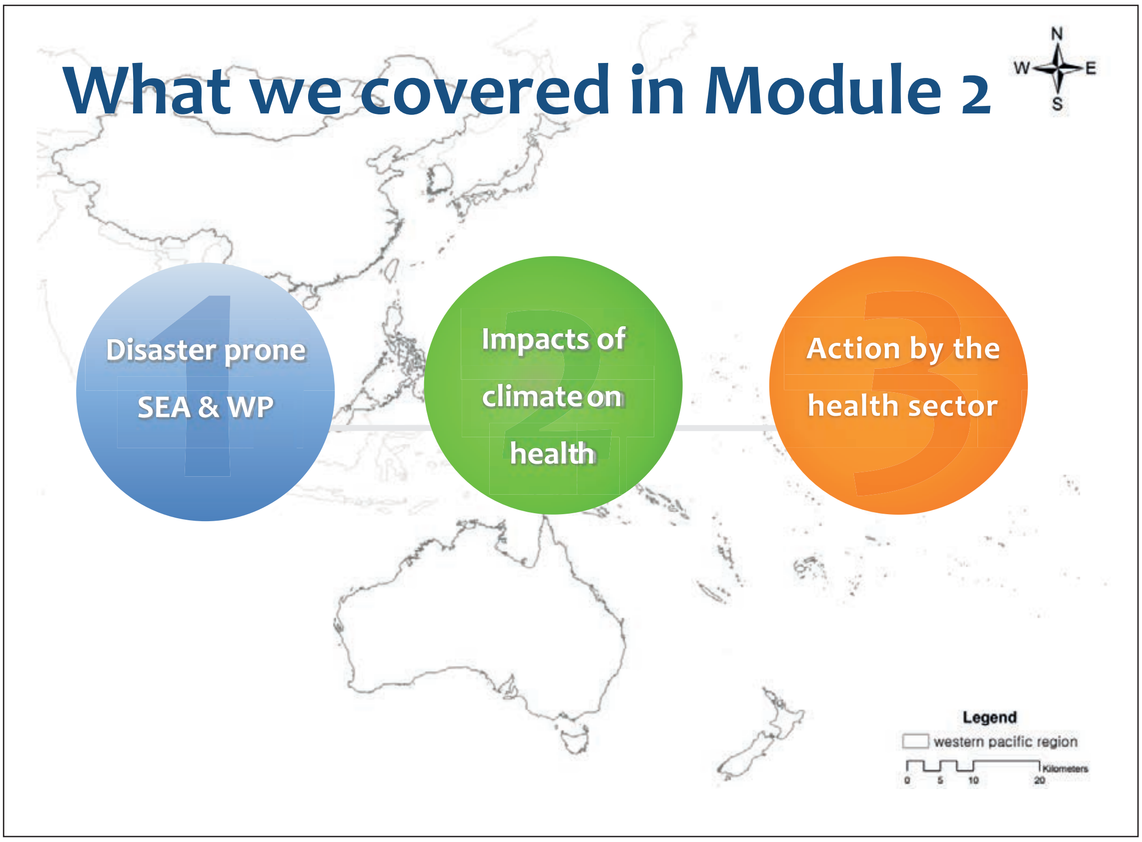
Mitigation action for the health sector:

Promote & support initiatives that protect health by reducing greenhouse gas emissions

In taking action, the health sector has two key response areas:

Adaptation (read)

And **mitigation - CLICK** to show mitigation action for the health sector (read text and discuss)



So, to wrap up, in Module 2 we looked at:

- The fact that South-East Asia and the Western Pacific are disaster-prone regions
- An overview of the main findings most relevant to health from the latest IPCC report, called the AR5
- Action the health sector can take to reduce the health impacts of climate change in SE Asia and the Western Pacific.

40

Learning from Module 2

- Health impacts of climate change will be felt globally
- Climate change will exacerbate current & underlying burden of disease
- Populations will be exposed differently depending on regions

The key messages from this module were: (CLICK to display each)

1. The health impacts of climate change will be felt by everyone, everywhere. Climate change does not respect borders.
2. Climate change will exacerbate current and underlying burden of disease. It won't bring anything remarkably new or different, rather it will worsen our current health issues, such as undernutrition, diarrhoeal disease, and infectious diseases.
3. People will feel the effects of climate change differently, depending on where they live. Some places will experience changes such as increasing intensity of cyclones, while others may experience longer-term changes, such as drought and drying.

41

Learning from Module 2

- The SEA & WP regions have large populations that are currently vulnerable to a number of climate-sensitive health stressors
- Current impacts are substantial & varied. These include:
  - sea-level rise, more frequent & intense extreme weather events, more hot days
  - Without adaptation & mitigation, climate change could result in a dramatically increased health burden in these regions

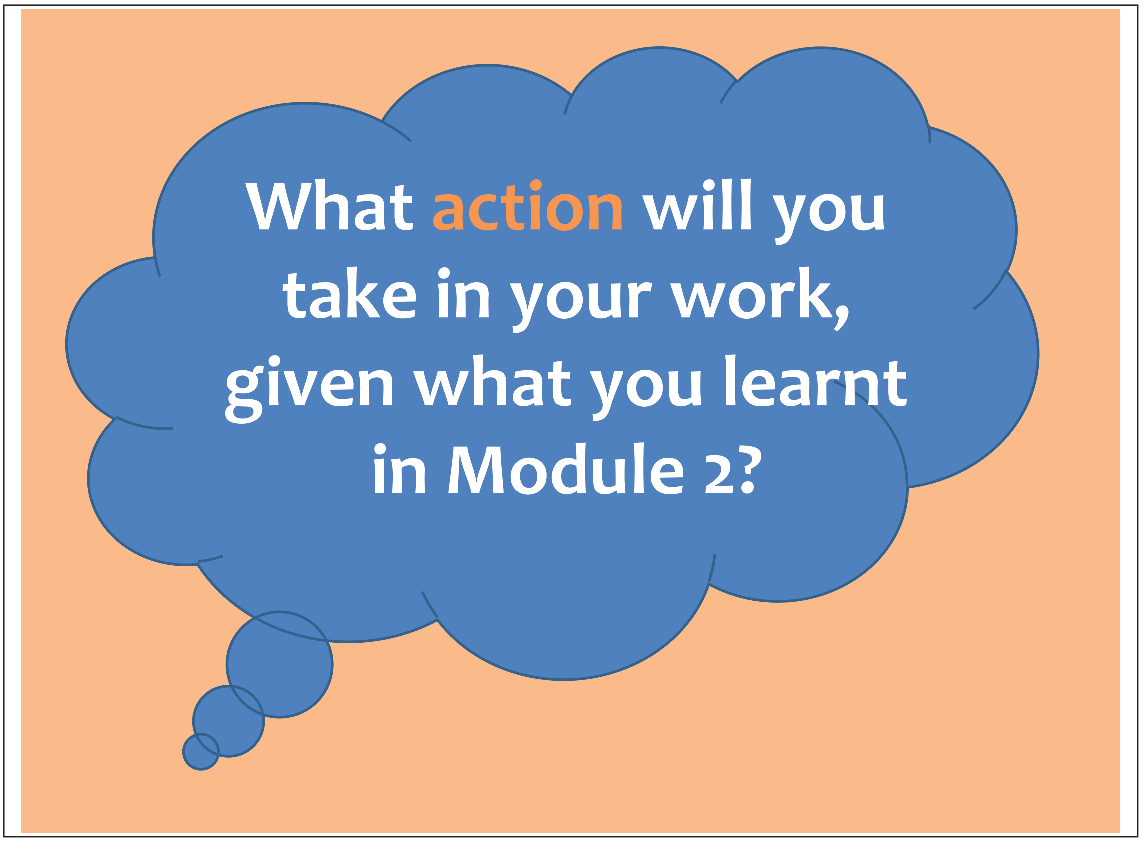
Other key messages were: (CLICK to display each)

4. Climate change will impact on health in the Asia Pacific region in a variety of ways, including more frequent and intense extreme weather events – such as storms/cyclones/floods, an increase in the number of hotter days, and sea-level rise.
5. Without adaptation & mitigation, climate change could result in a dramatically increased health burden in the regions.

Are there any questions on the learnings from Module 3?

Recommended reading: IPCC 2013 report Working Group II, Summary.

42



To finish off Module 2, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around population health and climate change.

Encourage quiet reflection (verbally if needed). At the end of 2 minutes: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 3

Policies & practice of mitigation & adaptation - Relevance to health

Key learning messages in Module 3

- Two climate change responses – mitigation and adaptation
- Many mitigation & adaptation activities are relevant to the health sector
- If emissions are reduced (mitigation), health of the population is improved (co-benefits/ win-win)
- The health sector plays an important role in adaptation - requires multi-sectoral collaboration
- Strong need for health sector to influence mitigation activities in other sectors.

Estimated length: 60 minutes

Structure of Module 3

Section	Slides	Activity (if any)
Key learning messages	2–3	
Module outline	4	
1. The basics of adaptation and mitigation, and their relevance to health	5–11	VIDEO 1: Really. Important. Science. Announcement', played on slide 6 (1.47 minutes). Embedded (but requires an Internet connection). VIDEO 2: Overview of the IPCC Fifth Assessment Report, played on slide 8 (12 minutes). Requires opening the webpage https://player.vimeo.com/video/89725715.
2. The options for mitigation and the co-benefits (or 'win-win') for mitigation and health	12–19	EXERCISE slide 17: Take 4 minutes to discuss other potential win-win options for health and mitigation at your table.
3. Framing mitigation and adaptation as risk management	20–30	
Module outline	31	
Learning from Module 1	32–33	
Learning reflection, action generation	34	

Required resources

- Data projector and slide changer
- Module 1 slides
- Internet connection

- Speakers/sound system
- Two videos: 'Really. Important. Science. Announcement' and 'Overview of the IPCC Fifth Assessment Report'
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 3

This module contains two videos:

- Really. Important. Science. Announcement' video, played on slide 6 (1.47 minutes)
- Overview of the IPCC Fifth Assessment Report, played on slide 8 (12 minutes)

Both videos can be played ONLY via an internet connection so before delivering this module, make sure you are connected to the internet.

The video on slide 6 is embedded. However to play the video on slide 8, you need to have this weblink open and loaded as a webpage: https://player.vimeo.com/video/89725715.

Ensure you are connected to speakers before you start the presentation, and that the volume is working and appropriate to be heard at the back of the training venue.

Key terms introduced in Module 3

- Mitigation
- Adaptation
- Co-benefits
- Renewable energy

References (in order of presentation)

- Climate Council. 2014. *Really. Important. Science. Announcement* video. https://www.youtube.com/watch?feature=player_embedded&v=HOD52WeFVms.
- Renew Economy. 2014. http://reneweconomy.com.au/2014/history-carbon-dioxide-emissions-83588.
- IPCC. Year unknown. https://player.vimeo.com/video/89725715.
- United Nations Foundation. 2014. *UN Climate Solutions Report in Numbers*. http://www.climasphere.org/
- Climate Commission. 2012. *The Critical Decade*.
- Lee, Shiroma, Lobelo, Puska, Blair, and Katzmarzyk. 2012. *Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy*. The Lancet 21 July 2012 (Volume 380 Issue 9838 Pages 219-229.
- McMichael 2008, *Global environmental change and health: impacts, inequalities, and the health sector, BMJ 336:191,*
- UK Climate Impacts Program. 2006. *Risk management: UK Climate Program*.
- IPCC. 2014. *Climate Change 2014 : Fifth Assessment Report*.
- Hii et al. (2012) Forecast of dengue incidence using temperature and rainfall.
- WMO/WHO. 2012. *Atlas of Health and Climate*.

Module 3: Policies & practice of mitigation & adaptation:

Relevance to health

Welcome to Module 3, where we're going to look at the policies and practice of mitigating and adapting to climate change, and how this is relevant to health.

This module contains two videos:

- *Really. Important. Science. Announcement' video, played on slide 6 (1.47 minutes)*
- *Overview of the IPCC Fifth Assessment Report, played on slide 8 (12 minutes)*

Both videos can be played ONLY via an internet connection so before delivering this module, make sure you are connected to the internet.

To play the video on slide 8, have this weblink loaded as a webpage: https://player.vimeo.com/video/89725715.

2

Key messages in Module 3

- Two climate change responses – mitigation & adaptation
- Many mitigation & adaptation activities are relevant to the health sector
- If emissions are reduced (mitigation), health of the population is improved (co-benefits/win-win)

These are the key messages we'll cover in Module 3:

CLICK to show each of the three key messages

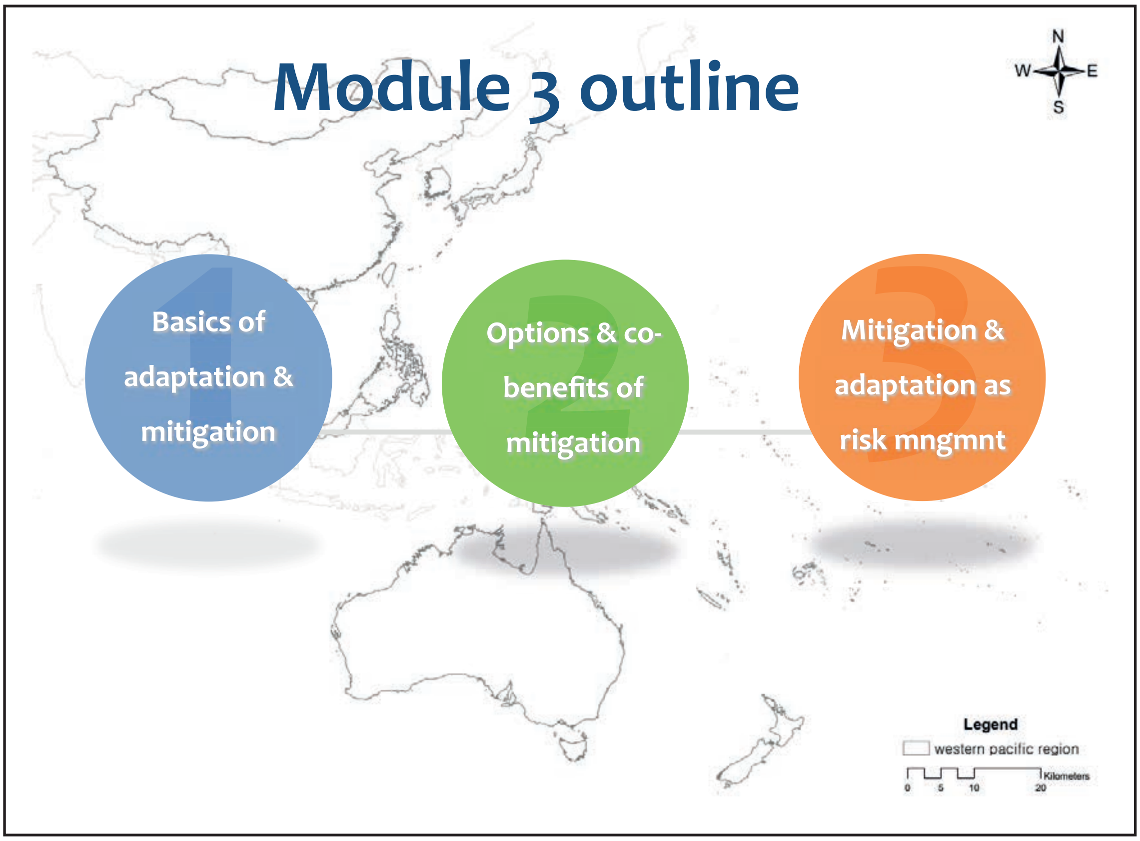
3

Key messages in Module 3

- The health sector plays an important role in adaptation - requires multi-sectoral collaboration
- Strong need for health sector to influence mitigation activities in other sectors

CLICK to show last two key messages

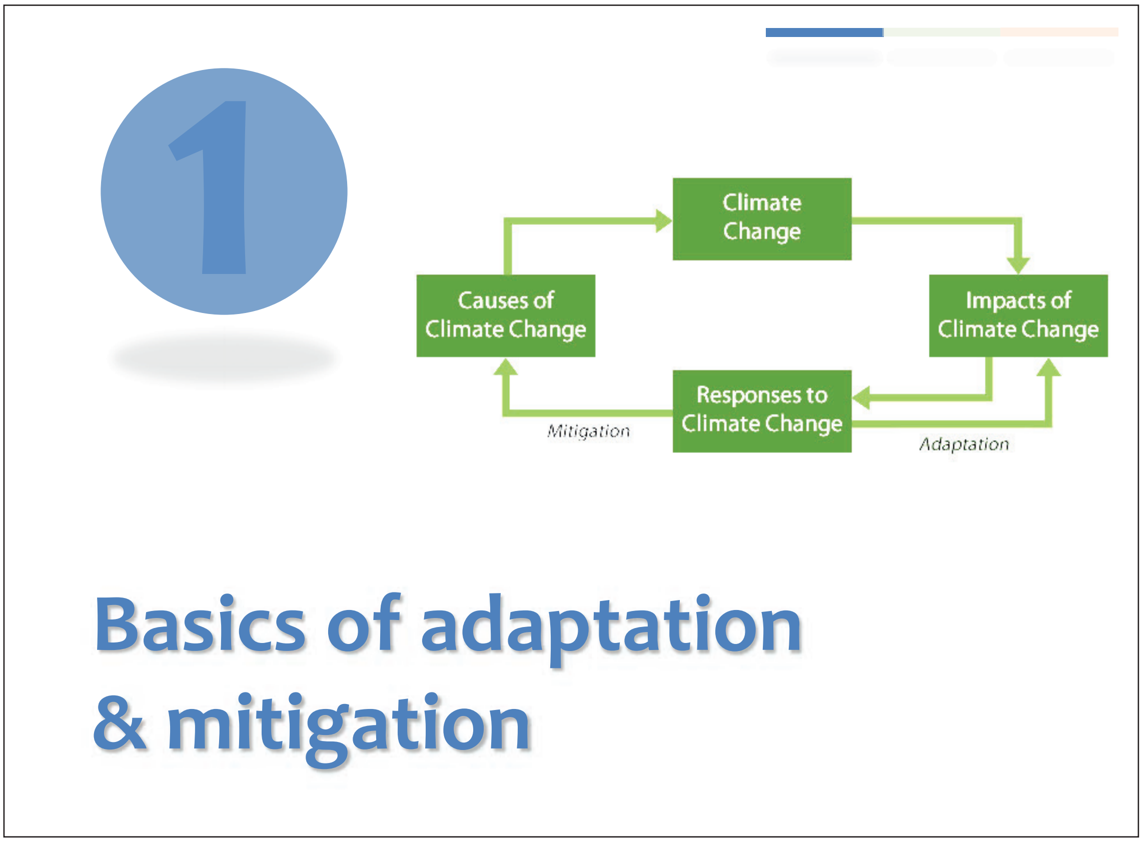
4



Here's what we're going to cover in Module 3:

1. The basics of adaptation and mitigation, and their relevance to health
2. Outline the options for mitigation and explain the co-benefits (or 'win-win') argument for mitigation and health
3. Framing mitigation and adaptation as risk management

5



Ok, let's get into our first focus area – the basics of adaptation and mitigation, and their relevance to health.

6

Really. Important. Science. Announcement.

This video is a refresher on basic climate change. It was made by the Climate Council in Australia and is **2 minutes** long. While you are watching this, have a think about how climate change is effecting your own community and country.

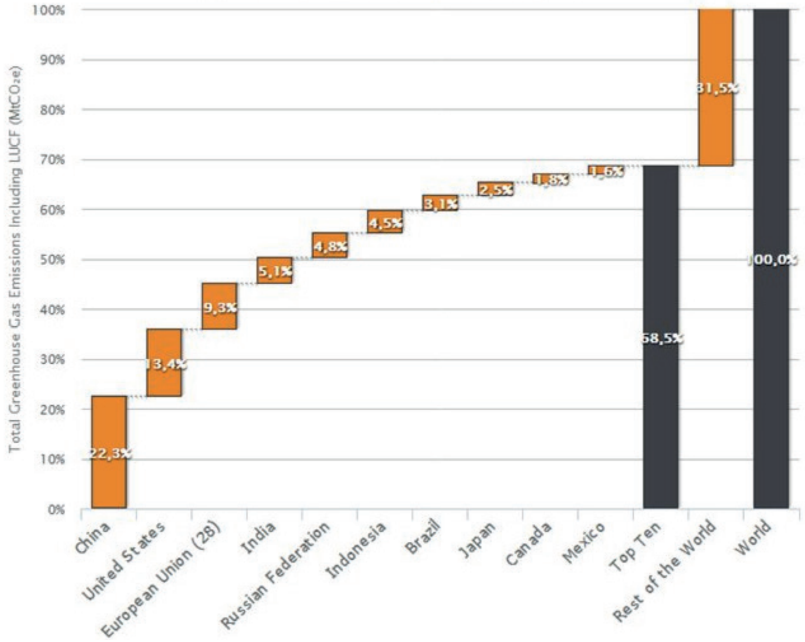
To play 'Really. Important. Science. Announcement' **video: Double click on the black box, then click on the red arrow.** NB you must be connected to the internet. Lasts 1.47 minutes.

Source: *Climate Council. 2014. https://www.youtube.com/watch?feature=player_embedded&v=HOD52WeFVms*

7

Developed countries have emitted most GHGs

Top 10 greenhouse gas emitters 2011



Source: Renew Economy (2014)

While we're looking at the basics of climate change, it's worth noting that, as shown in this graphic, high-income countries are responsible for nearly all atmospheric greenhouse gases.

This raises issues of environmental justice, including what are the responsibilities of high-income countries to help low- and middle-income countries adapt to the observed and projected impacts of climate change.

Source: *Renew Economy. 2014. http://reneweconomy.com.au/2014/history-carbon-dioxide-emissions-83588*

8

Overview of health & climate change
– Adaptation examples

This second video from the IPCC provides an overview of the findings of Working Group Two of the Fifth Assessment Report. This particularly focuses on adaptation examples. As you're watching, look for examples that are familiar to you or the context you work in.

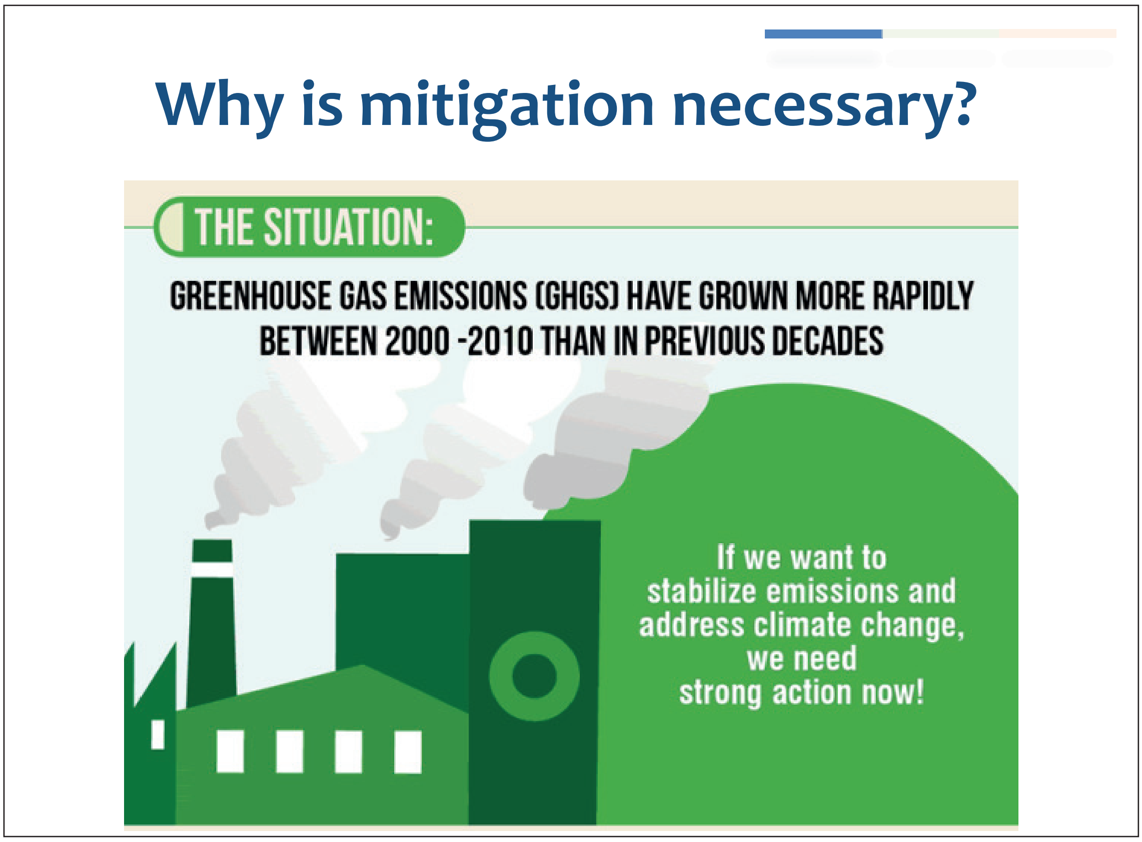
To play you must click out of this presentation and go to this already opened weblink and press play: *https://player.vimeo.com/video/89725715*

The video is **12 minutes** long

To summarise: **"Where there adaptation responses you were familiar with there? Yes? What were some of those?"**

Seek a handful of examples from people through raised hands or options being called out. Acknowledge people's responses and wrap up by saying that you hope some of the new adaptation options they saw in the video will also be helpful in their ongoing adaptation to climate change.

9

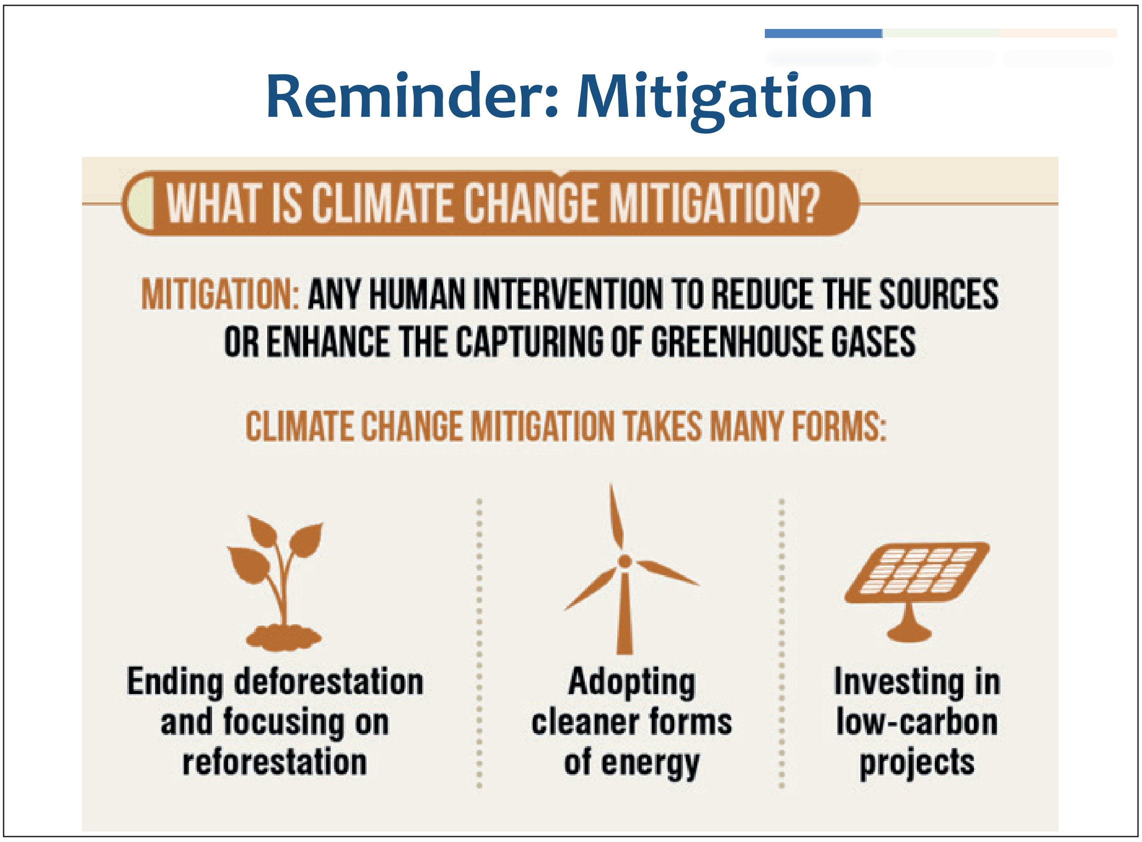


We've just looked at a range of adaptation examples. Let's remind ourselves of why these are necessary.

The startling statistic is that GHGs have grown more rapidly between 2000–2010 than in previous decades. Therefore we need to act strongly now, if we want to address climate change.

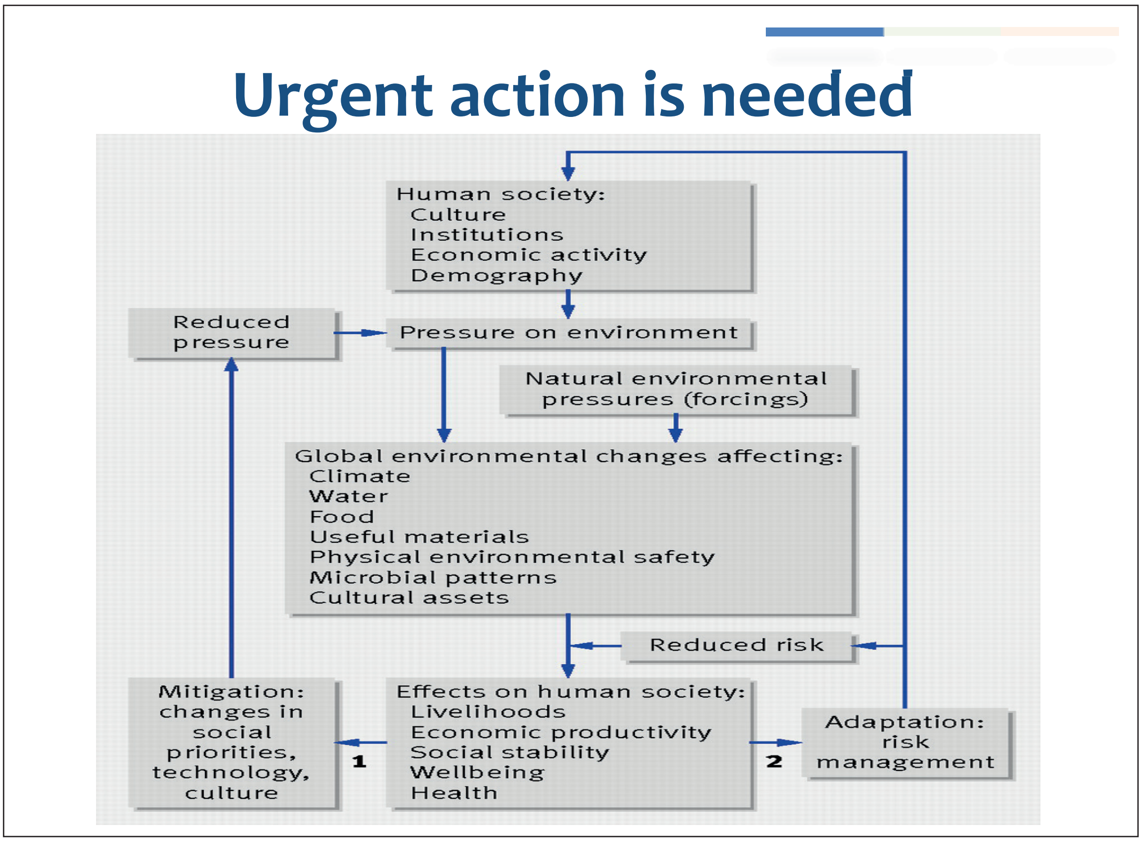
Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

10



A reminder on what mitigation is: Any human intervention to reduce the sources or enhance the capturing of greenhouse gases.

Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

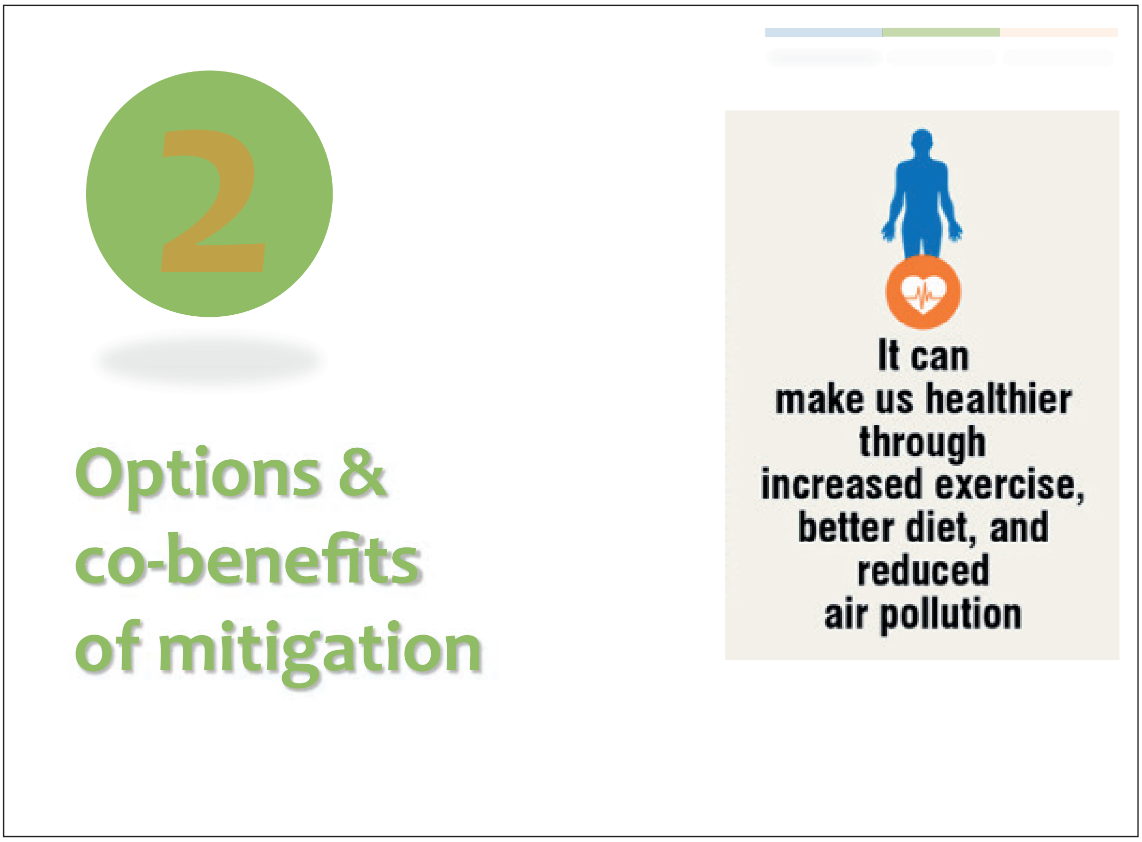


Just to remind ourselves of the need for urgent action - global environmental changes are affecting climate, which in turn will impinge on, in profoundly adverse ways, some of the most fundamental pillars of life: food, air and water.

The main drivers behind these global changes are both natural and, increasingly, human pressure. The disruption of environmental factors will have most significant impacts on health. By adapting we will reduce those adverse impacts. At the same time, we need to reduce our pressure on the environment, through mitigation measures.

Source: *McMichael, Global environmental change and health: impacts, inequalities, and the health sector, BMJ 2008;336:191,*

12



We've covered some of the basics related to adaptation and mitigation for climate change. Let's now look at what options are available to support mitigation, and some of the co-benefits they provide.

Mitigation options

- Renewable energy
- Reducing waste, methane recovery
- Active transport
- Energy efficient buildings, lighting & appliances
- Industry energy efficiency, heat & power recovery
- Best practice agriculture to increase soil carbon storage
- Land restoration
- Forestry & forest protection

THE UN CLIMATE SOLUTIONS REPORT IN NUMBERS

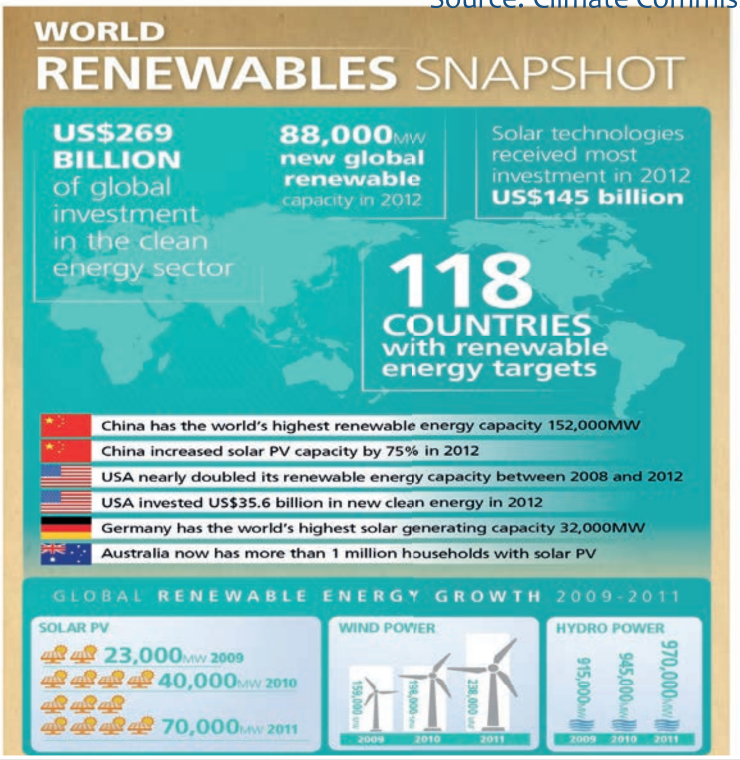
We'll look firstly at mitigation options.

The following slides show a range of mitigation options that also have health benefits. The content of these slides is important, but also important is the way that these slides are presented – the health community can learn from these different forms of communication and presenting in a clear, concise manner.

Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

Renewable energy

Source: Climate Commission (2012)



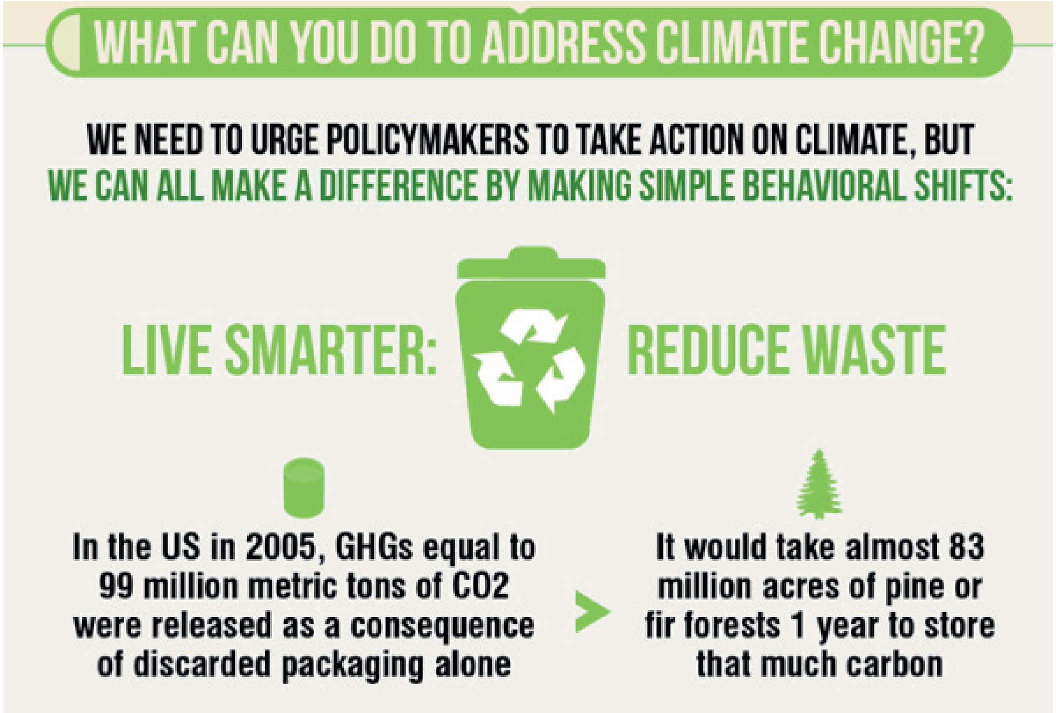
One clear mitigation option is the use of renewable energy.

This graphic shows that the world is making progress in relation to supporting the use of renewable energy. The figures are encouraging – globally there is 269 US$ billion invested in the clean energy sector, 118 countries have renewable energy targets, and solar technologies have received 145 billion US$ worth of investment.

Shifting to renewable energy and away from polluting fossil fuels also has health benefits. Estimates of the co-benefits of reducing air pollution from coal-fired power plants and transport suggest that the immediate health benefits will be significant. These co-benefits need to be included in a comprehensive assessment of mitigation options.

Source: *Climate Commission. 2012. The Critical Decade.*

Reduce waste



Reducing waste also helps mitigate climate change. The importance of reducing waste is shown in this image.

There are two approaches to reducing waste – one is through regulation (via governments/ global agreements, etc.), and the other is through individual behaviour change. Both are important.

Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

16

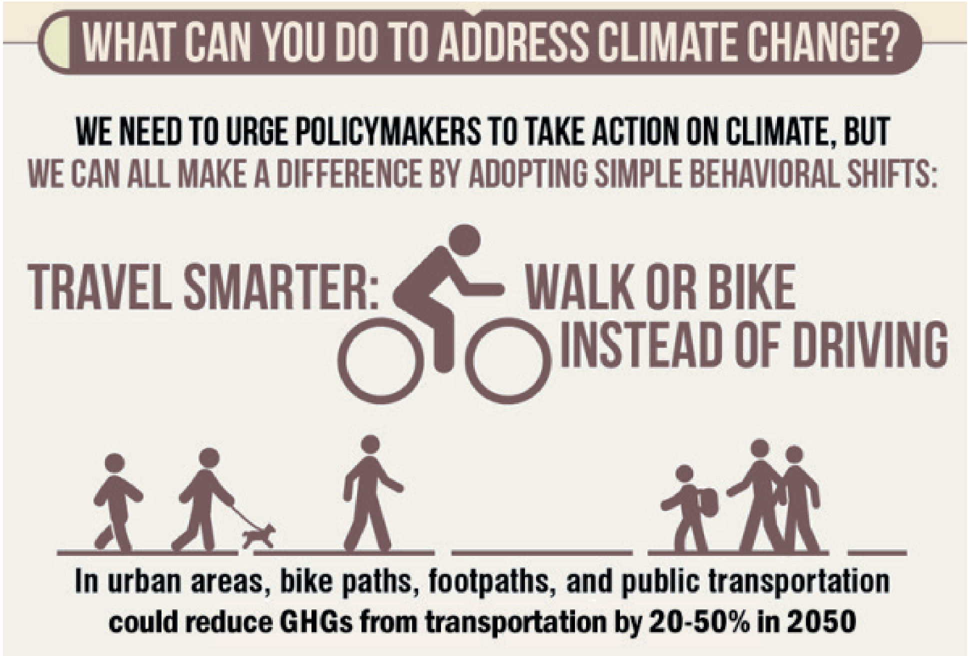
Reduce food waste

Reducing food waste is particularly important. Roughly 1/3 of the food produced in the world for human consumption is wasted – a terrible statistic.

Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

17

Use & promote active transport



A further option for mitigation is using and promoting active transport.

Inactivity causes 9% (range 5·1—12·5) of premature mortality, or more than 5·3 million of the 57 million deaths that occurred worldwide in 2008. If inactivity were not eliminated, but decreased instead by 10% or 25%, more than 533 000 and more than 1·3 million deaths, respectively, could be averted every year.

Physical inactivity causes 6% (ranging from 3·2% in south-East Asia to 7·8% in the eastern Mediterranean region) of the burden of disease from coronary heart disease, 7% (3·9—9·6) of type 2 diabetes, 10% (5·6—14·1) of breast cancer, and 10% (5·7—13·8) of colon cancer.

Mass marketing and availability of junk food and 'supersized' portions, (production of which also leads to GHG emissions) as well as sedentary lifestyles lead to obesity.

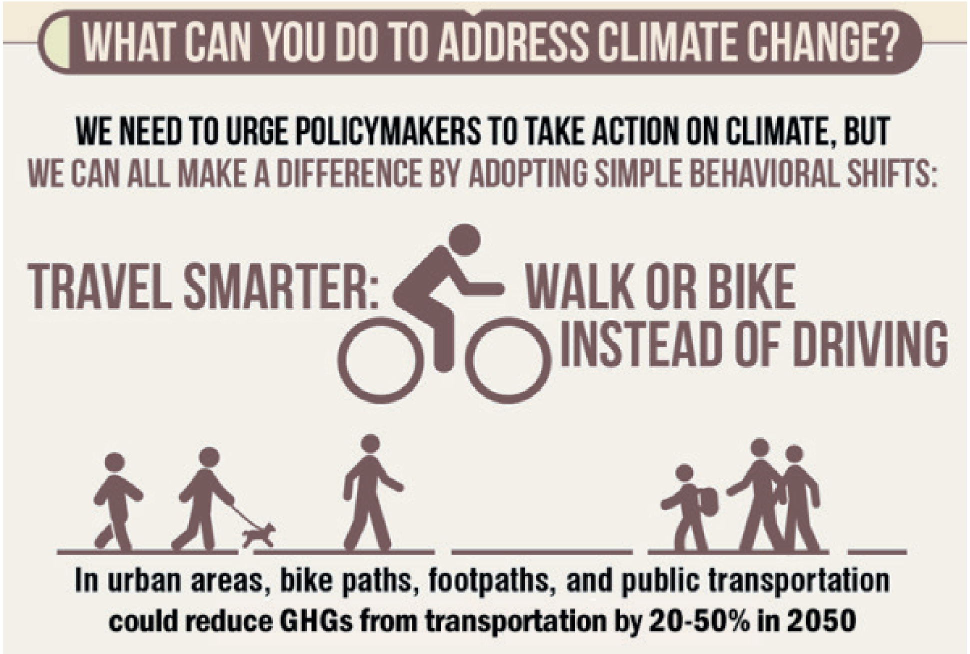
Urban planning and transport policies at the local level can be part of the answer. Short trips made in cars covering distances of less than 3 km. can be covered in 15 – 20 minutes by bicycle or in 30 - 50 minutes by brisk walking. This corresponds to the recommended daily dose of at least 30 minutes of regular, moderate-intensity physical activity.

This is a good example of the co-benefits or 'win-win' approach, where climate change mitigation can also result in improved health outcomes, and vice-versa.

Exercise: Take 4 minutes to discuss other potential win-win options for health and mitigation at your table.

17

Use & promote active transport



Give time count downs. At 3 mins 30 secs give final reminder. At 4 mins: ***What other win-win or co-benefit options did you come up with? Let's hear a few examples from different groups.***

Facilitate. Finish by acknowledging input, and that finding co-benefits from mitigation of greenhouse gas emissions is an important step to success in solving climate change and reducing health burdens.

Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

Reference: Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy

I-Min Lee, Eric J Shiroma, Felipe Lobelo, Pekka Puska, Steven N Blair, Peter T Katzmarzyk, The Lancet 21 July 2012 (Volume 380 Issue 9838 Pages 219-229 DOI: 10.1016/S0140-6736(12)61031-9)

18

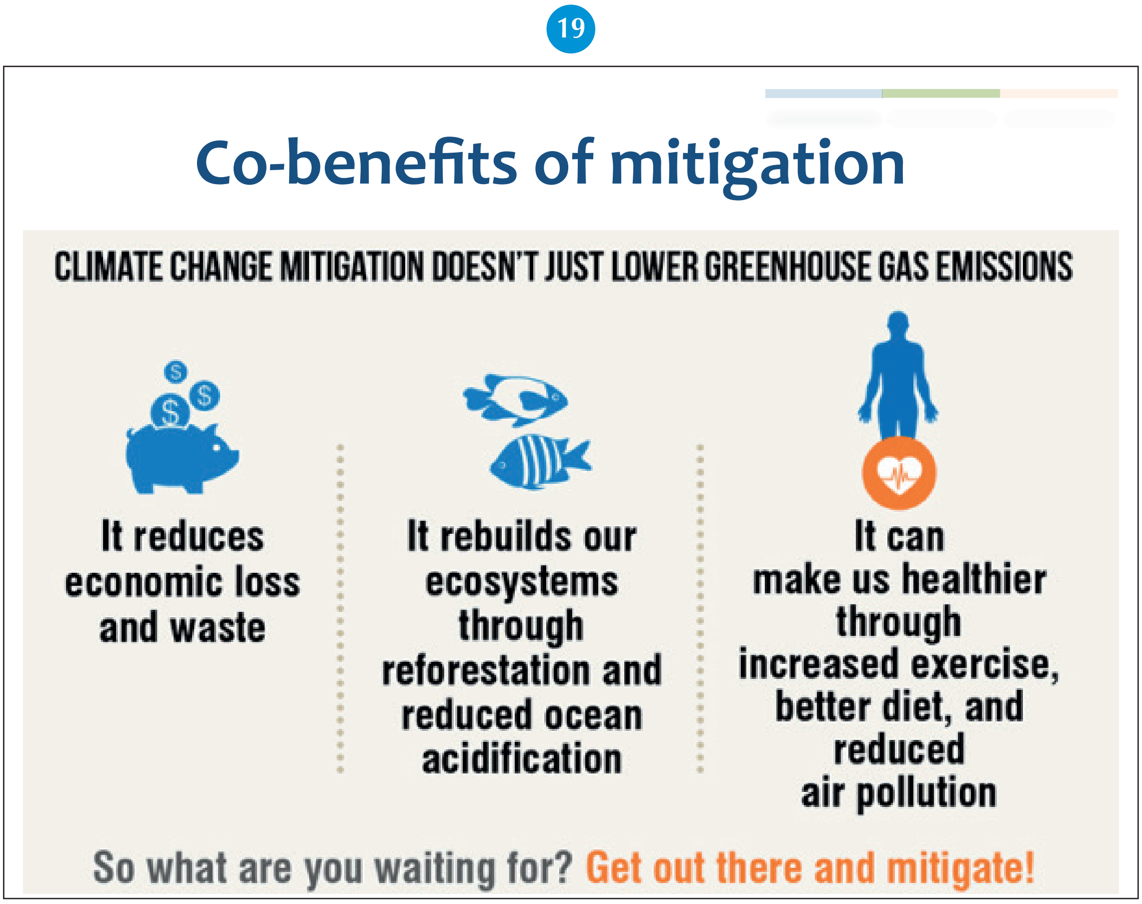
Summary: Mitigation options

- Renewable energy
- Reducing waste, methane recovery
- Active transport
- Energy efficient buildings, lighting & appliances
- Industry energy efficiency, heat & power recovery
- Best practice agriculture to increase soil carbon storage
- Land restoration
- Forestry & forest protection

So to conclude, specific mitigation options include:

> Energy – improved supply and distribution efficiency; fuel switching from coal to gas; renewable heat and power
>
> Waste – Landfill methane recovery; waste incineration with energy recovery
>
> Transport – More fuel efficient vehicles; hybrid vehicles
>
> Buildings – Efficient lighting and day lighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves
>
> Industry – More efficient end-use electrical equipment; heat and power recovery
>
> Agriculture – Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded land
>
> Forestry/forests – Afforestation; reforestation; forest management

Public health can itself make significant contributions to greenhouse gas emission reductions through more energy efficient infrastructure in hospital buildings and clinics, reducing waste, and a wide range of other actions.



The mitigation options we've discussed don't only have environmental benefits in reducing climate change – they have a wide range of co-benefits – win-wins in other words.

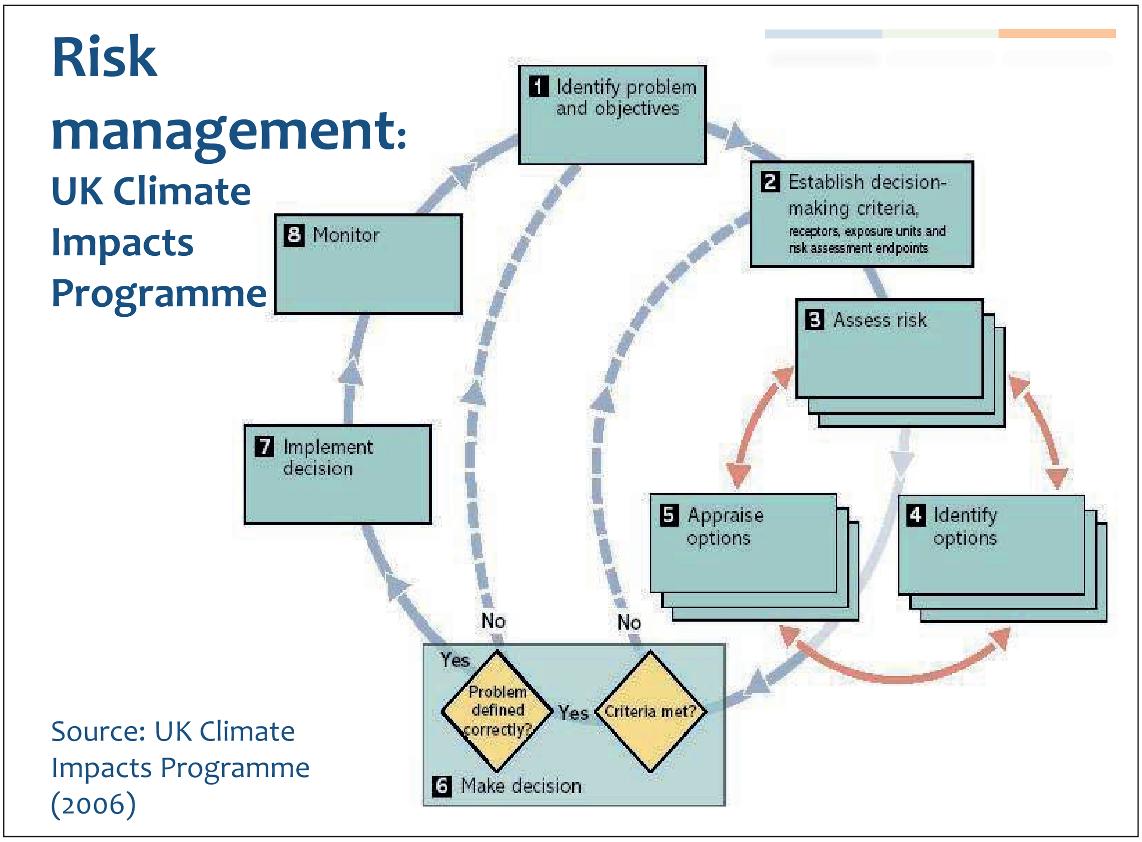
These include: (read off slide)

Source: *United Nations Foundation. 2014. UN Climate Solutions Report in Numbers. http://www.climasphere.org/*

20

We'll now finish off Module 3 by looking at mitigation and adaptation in terms of risk management.

21

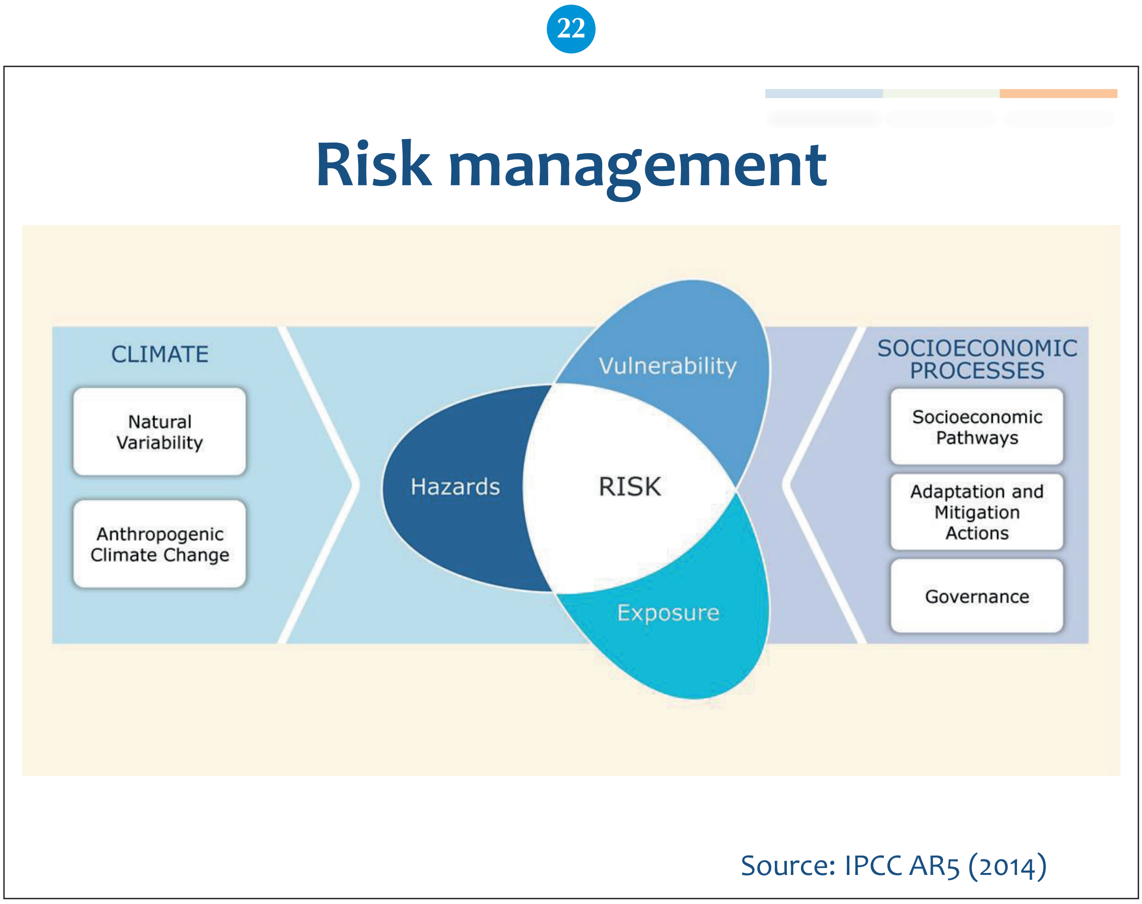


There are multiple frameworks for risk management; all have similar components. This framework was developed by the UK Climate Impacts Programme (www.ukcip.org) and illustrates the basic steps in managing climate risks.

Risk management should consider both adaptation and mitigation, as both are needed to effectively manage the immediate and longer-term risks of climate change.

As the diagram shows, you should start with identifying the problem and objectives – step 1, then establish decision-making criteria, assess the risk, identify and appraise option, implement the decision and monitor. During steps 3, 4, and 5, it is important to iteratively assess the risk of options so as to ensure that the problem is defined correctly. If it isn't, start again with the problem identification.

Source: *UK Climate Impacts Program (2006)*



This diagram is from the latest IPCC report (AR5). In it, we can see that risk is at the centre of the framework, and arises from the combination of vulnerability, exposure and hazards. The pressures indicated on the left and the right of the diagram influence these factors. Climate (natural variability and anthropogenic climate change) is of course one of the key determinants of hazards, and influences exposure and vulnerability. Socioeconomic processes on the right include socioeconomic pathways (e.g. development trajectories), action taken on adaptation and mitigation, and governance (e.g. types of decision-making that is occurring to respond to climate change, such as regulation of GHG emissions through a carbon tax); these strongly influence vulnerability and hazard. Future risks that individuals and communities face arise from the interactions of exposure, vulnerability and hazards, and are influenced by climate and development. This in turn determines the level of impacts from changes in the climate. This diagram highlights that we need to look at the system as a whole to understand risks and impacts. Although we can assess (e.g.) mitigation actions and exposure to weather events separately, it is the combination of all of these components shown in the diagram that gives us a holistic picture of the overall risks.

Source: *IPCC AR5 report (2014)*

23

Public health responses to the risks of climate change

- Reduce exposures
  - Legislative policies
  - Alterations in built environment
  - Alterations in natural environment
- Prevent onset of adverse outcomes
  - Early warning systems
  - Surveillance & monitoring
  - Vector control programs
  - Public education & outreach

There are a wide range of possible interventions to avoid, prepare for, and respond to the health risks of climate change; some of these address both mitigation and adaptation. Interventions will be discussed in more detail in a later module.

The first area of responses relate to reducing exposures.

A second response area (**CLICK** to show prevention options) is preventing the onset of adverse outcomes through steps such as… (read)

24

Public health responses to the risks of climate change

- Response / treatment
  - Medical training & awareness
  - Treatment
  - Emergency response

Residual climate change-related health impacts

Lastly, there are opportunities around response and treatment.

It is important to note that even with effective and timely implementation of interventions, there may be residual health impacts due to climate change. (**CLICK** to show).

25

Adaptation

Actions taken by individuals, institutions, & governments

- Anticipatory (actions taken in advance of climate change effects)
- Reactive (taken in response to experienced climate change effects)

The severity of impacts will depend on the capacity to adapt & its effective deployment

Adaptation includes the strategies, policies and measures undertaken now and in the future to reduce potential adverse health effects. A primary goal of building adaptive capacity is to reduce future vulnerability to climate variability and change. Adaptation actions will be taken at all levels, including our individual actions as well as programmes and activities implemented by national agencies and institutions. These actions can be proactive, anticipating adverse health outcomes, or in response to observed climate change. The severity of impacts actually observed will depend on the capacity to adapt and its effective deployment.

Also important to understand the 'adaptation baseline' – i.e.:

What is being done now to reduce the burden of disease? How effective are these policies and measures?

What could be done now to reduce current vulnerability? What are the main barriers to implementation (such as technology or political will)?

What measures should begin to be implemented to increase the range of possible future interventions?

Answering these questions will provide a picture of current programmes and activities to reduce the burden of climate sensitive-health outcomes, as well as what could be done to reduce the current and projected future risks of climate variability.

Questions for designing adaptation policies & measures

- Adaptation to what?
- What is currently being done to reduce the burden of disease?
  - How effective are these policies & measures?
  - Are additional interventions needed?
- What are the projections for the outcome?
  - Who is vulnerable?

These questions need to be addressed when designing adaptation policies and measures. Adaptation to what – is adaptation required to flooding, the spread of vector-borne disease, etc.? The policies and measures implemented must be specific to both the weather/climate hazard and the health outcome of concern.

CLICK: The effectiveness of interventions needs to be determined before improving current programmes or implementing new ones. Are there additional interventions that could reduce the current burdens of climate-sensitive health outcomes? Would a heat event early warning system be useful? Additional surveillance? Etc.

CLICK: Using projections of changes in climate and socioeconomic conditions, what are the likely impacts? Which population groups are likely to be at the highest risk? For example, aging of populations in developed countries is likely to increase population vulnerability to heat events.

27

Who will undertake the adaptations is another question that should be asked when designing adaptation policies and measures – individuals, communities, nations? Will the adaptation be reactive to climate change or proactive? How can the process be facilitated?

CLICK: When should the interventions be implemented? For example, there is concern about malaria spreading to highland areas of Africa. Surveillance systems should be established at the edges of the current distribution where changes in temperature and/or precipitation could provide a suitable climate for malaria vectors. Once surveillance has identified the presence of the vectors, then programmes to distribute treated bednets could be implemented.

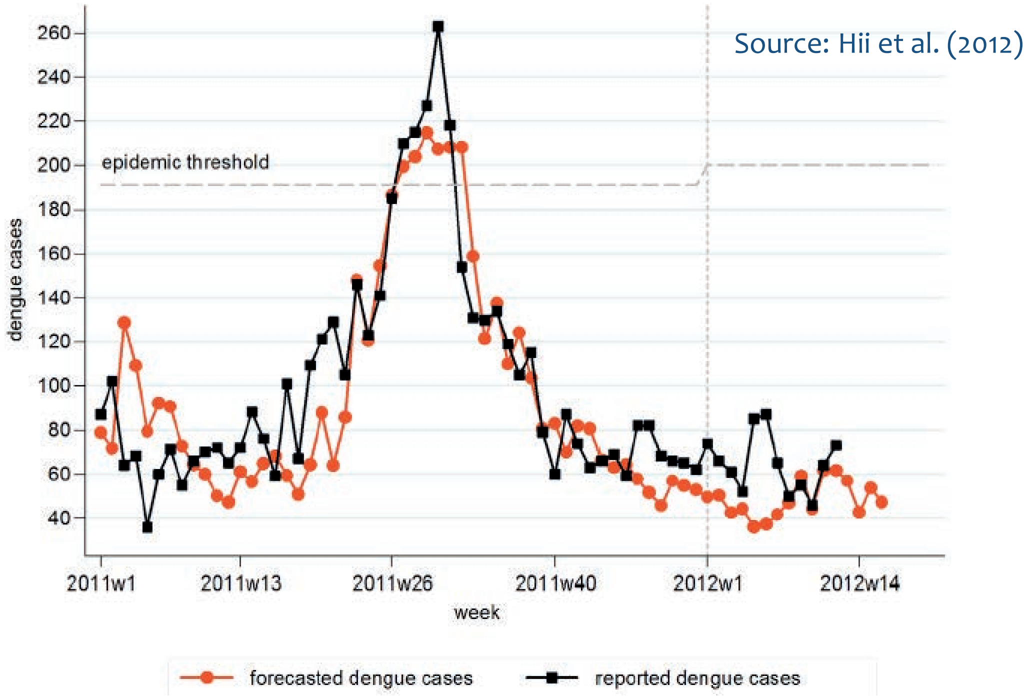
CLICK: The effectiveness of all interventions should be monitored and evaluated to ensure that public health funds are being used effectively and efficiently.

Finally, win-win or no-regrets strategies should be considered as a priority.

Here are some examples of adaptation measures to reduce the geographic spread and increased incidence of vectorborne diseases that are projected to occur in some areas. There are multiple categorization schemes for adaptation measures; this categorizes measures into those that are primarily decision support tools, those where technology development is needed, those requiring modification or implementation of surveillance and monitoring programmes, and those where infrastructure development would increase resilience to vector-borne diseases.

29

E.g.: Singapore dengue early warning system

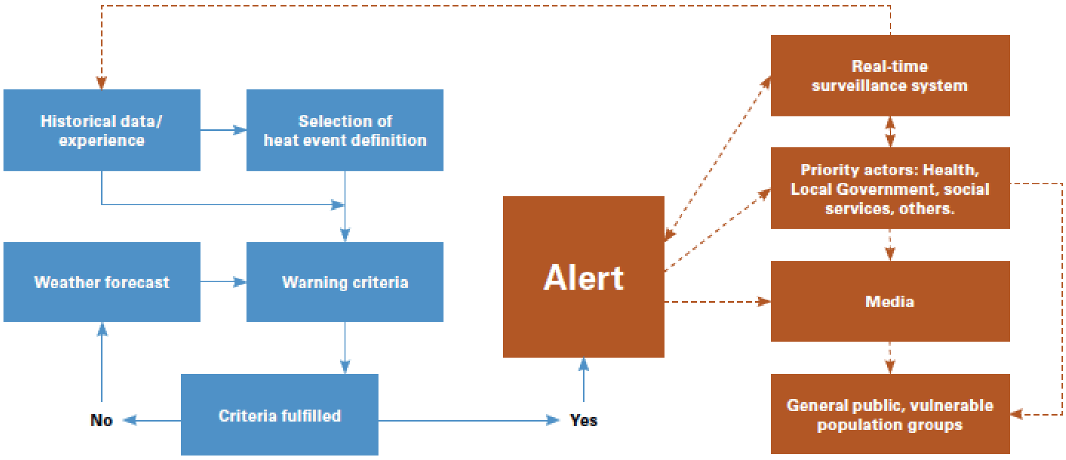


Here is an example of an early warning system in Singapore, which has been used to help the surveillance of dengue in the country.

The red line is forecasted dengue cases, while the black line represents reported dengue cases. We can see on the graph that the weekly forecasted dengue cases matched well with the reported cases, which means that the early warning system in Singapore is doing its job well.

Source: *Hii et al. (2012) Forecast of dengue incidence using temperature and rainfall.*

E.g.: Heat early warning system



Source: Atlas of Health & Climate, WMO/WHO (2012)

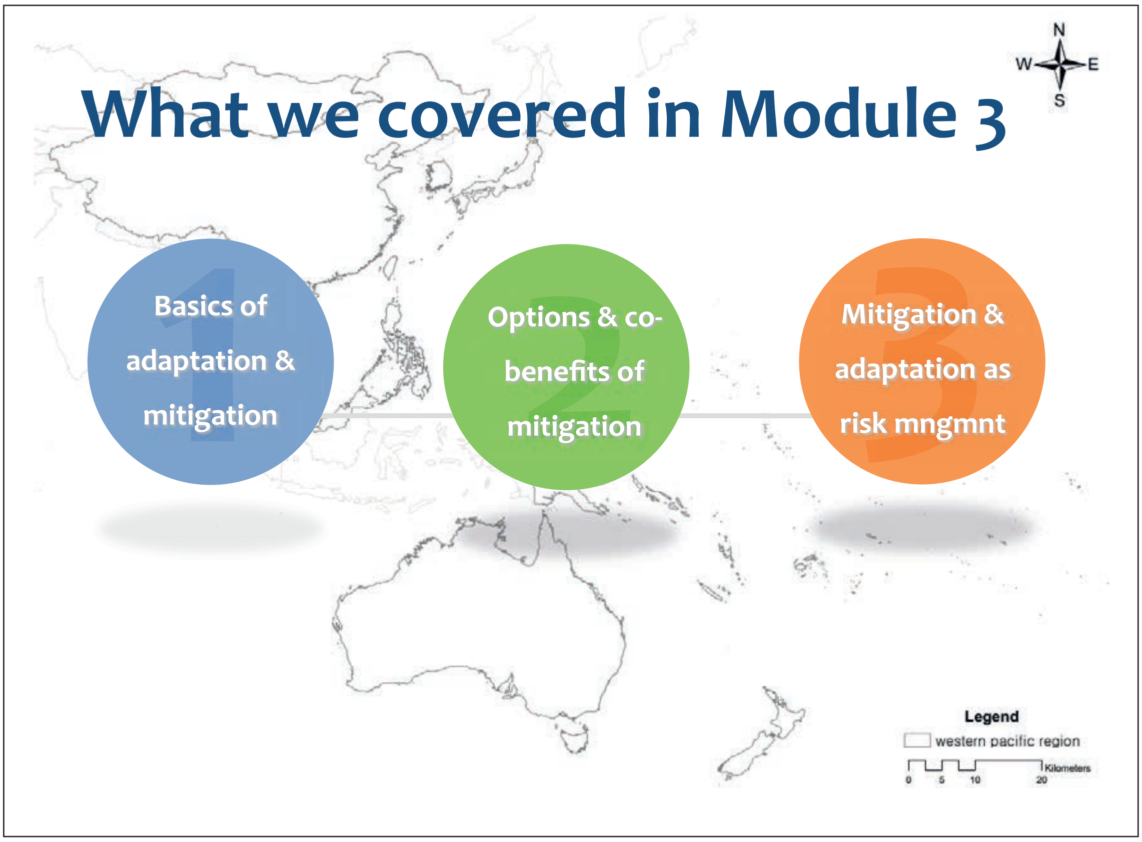
Here is another example of how an early warning system works – this time looking at heat.

An alert is activated if the criteria is fulfilled of a heat event, which then catalyses the four activities on the right hand side – real-time surveillance system, connecting with priority actors (health, local govt., social services, others), alerting the media, and ensuring that the general public and vulnerable groups are aware, so that appropriate measures are installed to support health.

Whatever tool is used, it's important to use a risk management process to manage the risks of climate change through mitigation and adaptation measures.

Source: *Atlas of Health & Climate, WMO/WHO (2012)*

31



So, we're now at the end of Module 3. We've covered:

1. Presenting the basics of adaptation and mitigation, and their relevance to health
2. Explaining the co-benefits (or 'win-win') argument for mitigation and health
3. Framing mitigation and adaptation as risk management.

32

Learning from Module 3

- Two climate change responses – mitigation & adaptation
- Many mitigation & adaptation activities are relevant to the health sector
- Strong need for health sector to influence mitigation activities in other sectors

The key learnings from Module 4 are: (read)

33

Learning from Module 3

- If emissions are reduced (mitigation), health of the population is improved (co-benefits/win-win)
- Health sector plays an important role in adaptation - requires multi-sectoral collaboration

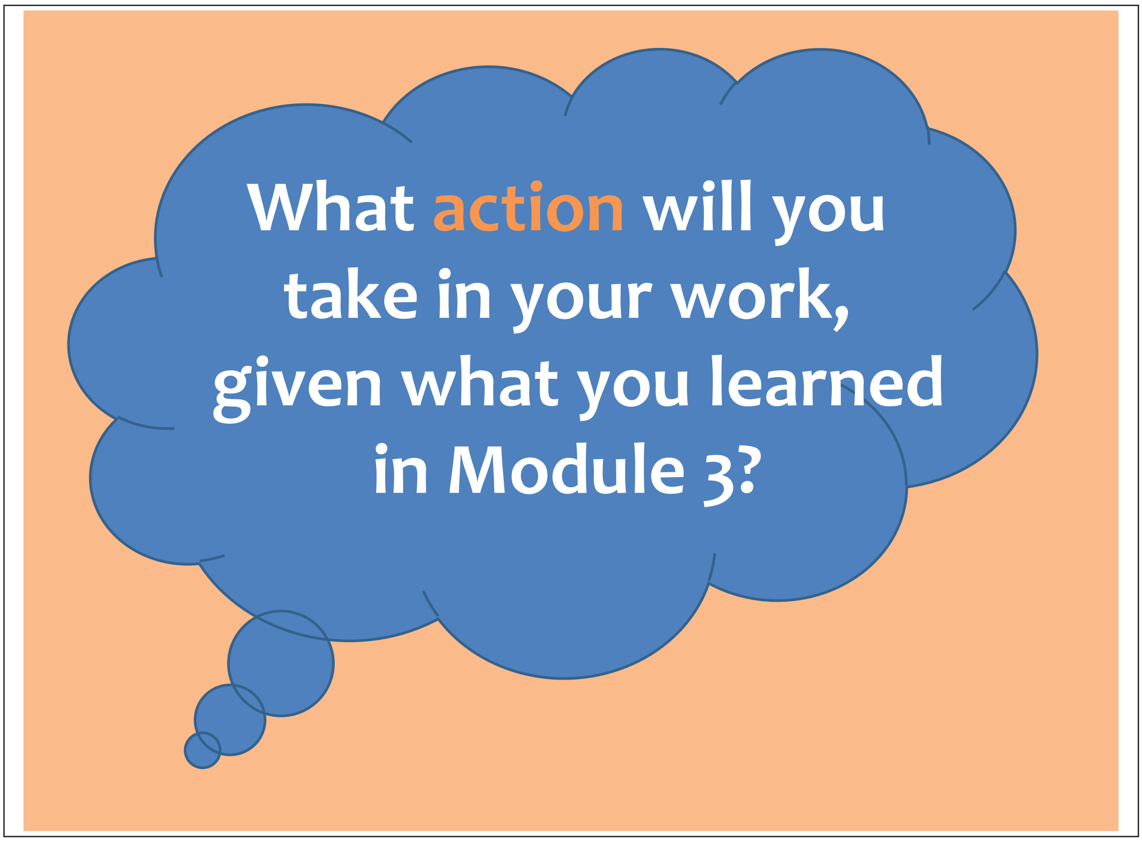
CLICK for last two key messages.

Some examples of how the health sector can play an important role in adaptation include:

- Awareness-raising
- Early warning systems
- Surveillance
- Health systems
- Infrastructure

Q: Are there any questions on the learning from Module 4?

34



To finish off Module 3, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learned around policies & practices for mitigation and adaptation to climate change.

Encourage quiet reflection (verbally if needed). At the end of 2 minutes: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 4

Assessment and prediction of the health impacts of climate change

Key learning messages in Module 4

- Observational studies are based on the time- and space-specific relationship between health effect and climate factor
- Time series studies and spatial studies are the principal methods of analyzing climate-relatedness of a specific health outcome
- Disease burden estimates model health impacts
- Weather-health relationship analysis is a basic step for predicting climate-related health effects, but it does not necessarily represent the climate effect on health
- Modelling is based on the established relationship between climate factors and a specific health effect
- Modelling is a useful tool for predicting future, but not without limits.

Estimated length: 70 minutes (possibly longer)

Structure of Module 4

Section	Slide numbers	Activity (if any)
Key learning messages	2–3	
Module outline	4	
1. Types of analysis of climate-related health effects	5–25	
2. Modelling the health impacts of climate change	26–37	
3. Uncertainties in analysis and modelling	38–41	
4. Changing vulnerability	42–45	
Module outline	46	
Learning from Module 4	47–48	
Learning reflection, action generation	49	

Required resources

- Data projector and slide changer
- Module 4 slides.

Instructions for delivery of Module 4

This is a long and technical module, requiring a high level of concentration from participants. While some participants may have a background in health assessment and epidemiology, for many the content is likely to be highly detailed. Section 1 is particularly long.

Given that no exercises are contained in Module 4, ensure that you check regularly for understanding of the material and that you ask participants if they have any questions. Acknowledge at a number of points as you go that while the material is detailed, it has significance for participants in showing them the detail behind how the impacts of climate change can be assessed and predicted, and therefore prepared for.

It's likely to also be worthwhile to have a stretch break during the module delivery, asking people to get up and stretch before sitting down again, or walk to the back of the room. You could also create a spontaneous learning reflection such as "Ok, a quick challenge. Turn to the person next to you and tell them how concept X could be applied in your workplace."

Key terms introduced in Module 4

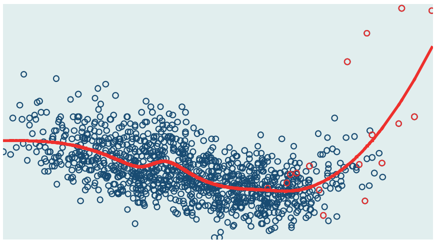
- Observational analysis
- Model-based analysis
- Episode analysis
- Regression analysis
- Seasonability
- Inter-annual variation
- Time series regression
- Lags
- Biological models
- Statistical models
- Future burdens
- Years of life lost (YLL)
- Disability-adjusted life years (DALYs)
- Premature mortality
- Uncertainties
- Changing vulnerability

References (in order of presentation)

- Allen BJ, 2002. *Birthweight and environment at Tari. PNG Med J 2002;45(1-2):88-98*
- Hashizume et al. (2010) : *Hashizume M, Faruque AS, Wagatsuma Y, Hayashi T, Armstrong B. Cholera in Bangladesh: climatic components of seasonal variation. Epidemiology. 2010 Sep;21(5):706-10. doi: 10.1097/EDE.0b013e3181e5b053.*

- Hales, Weinstein, Woodward (1996)*: Dengue fever epidemics in the South Pacific: driven by El Nino Southern Oscillation? Lancet 1996;348(9042):1664-1665*
- Hales et al. 6 August 2002. Lancet (online). http: //image.thelancet.com/extras/01art11175web.pdf.
- Friel et al. 2011. *Friel S, Bowen K, Campbell-Lendrum D, Frumkin H, McMichael AJ, Rasanathan K. Climate Change, Noncommunicable Diseases, and Development: The Relationships and Common Policy Opportunities. Annu Rev Public Health 2010;32: 133-147.*
- IPCC 5th Assessment Report, 2013
- Cheong, HK. 2015. (*These figures were drawn by Cheong based on the climate data from Korea Meteorological Agency and daily mortality data from Statistics Korea*)
- Woodruff et al. 2005. Climate change health impacts by 2100.
- Caminade et al. 2014. *Impact of climate change on global malaria distribution. Proc Natl Acad Sci U S A. 2014;111(9):3286-91. doi: 10.1073/pnas.1302089111.*

Module 4:
Assessment & prediction of the health impacts of climate change



In Module 4, we'll be looking at how the health impacts of climate change can be assessed and predicted in order to better manage outcomes.

2

Key messages in Module 4

- Observational studies are based on the time- & space-specific relationship between health effect & climate factor
- Time series studies & spatial studies are the principal methods of analyzing climate-relatedness of a specific health outcome
- Disease burden estimates model health impacts

These are the key messages we'll cover in Module 4: (CLICK to animate each of the three)

- Observational studies are based on the time- & space-specific relationship between health effect & climate factor
- Time series studies & spatial studies are the principal methods of analyzing climate-relatedness of a specific health outcome
- Disease burden estimates model health impacts.

3

Key messages in Module 4

- Weather-health relationship analysis is a basic step for predicting climate-related health effects, but it does not necessarily represent the climate effect on health
- Modelling is based on the established relationship between climate factors & a specific health effect
- Modelling is a useful tool for predicting future, but not without limits

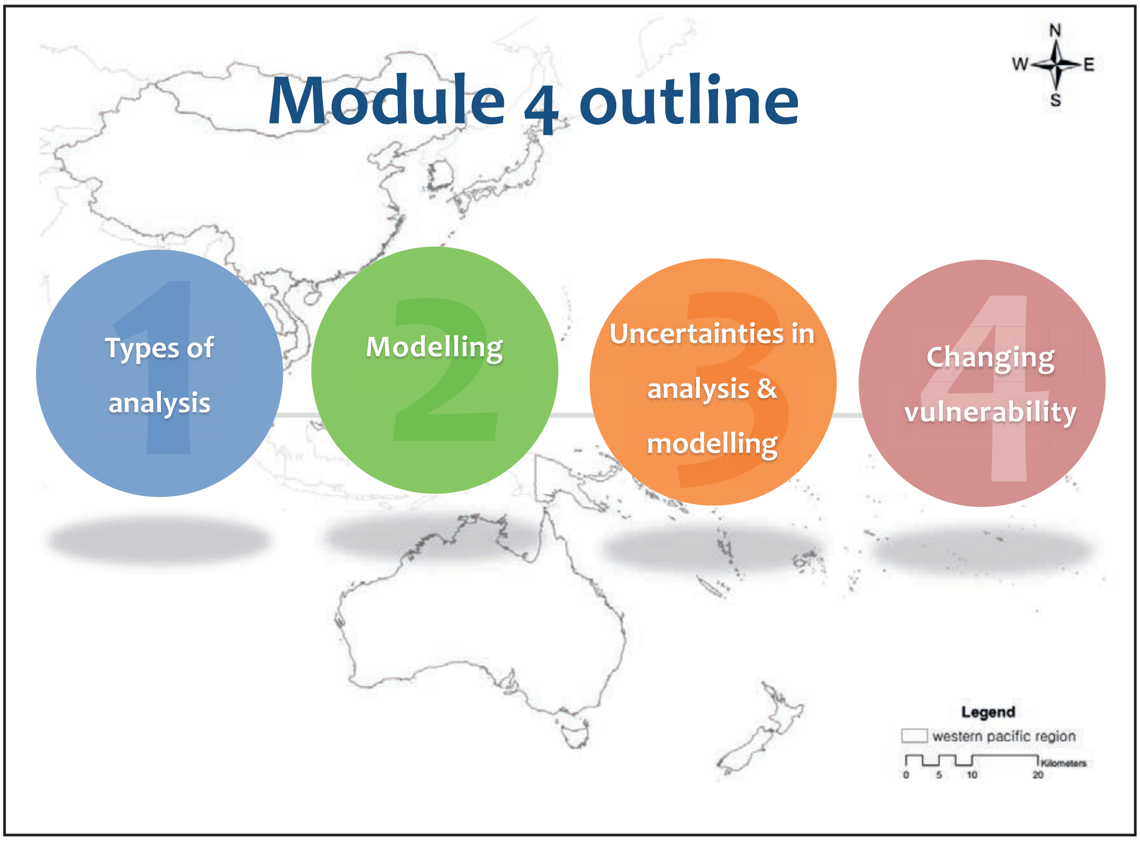
We'll also learn that:

- Weather-health relationship analysis is a basic step for predicting climate-related health effects, but it does not necessarily represent the climate effect on health
- Modelling is based on the established relationship between climate factors & a specific health effect
- Modelling is a useful tool for predicting future, but not without limits.

Trainer note:

The first key message on this slide originally read "Weather-health relationship analysis is a basic step for ***the*** *climate-related health effects, but it does not necessarily represent the climate effect on health", which doesn't make grammatical sense to me. Note that I have changed this to "Weather-health relationship analysis is a basic step* ***in predicting*** *climate-related health effects, but it does not necessarily represent the climate effect on health".*

4



Here's how we'll break up Module 4:

1. First we'll look at: Types of analysis of climate-related health effects
2. Modelling the health impacts of climate change
3. Uncertainties in analysis and modelling
4. Changing vulnerability.

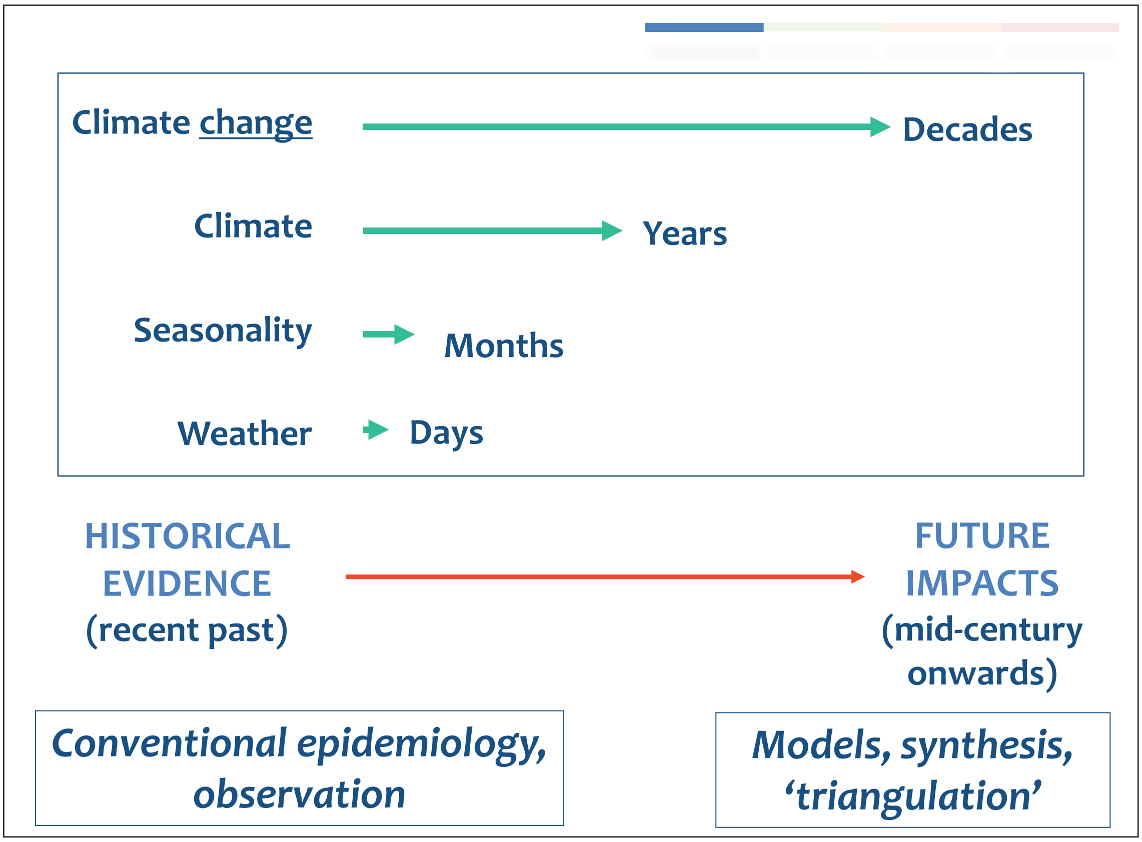
5

1

Types of analysis of climate-related health effects

Let's start by looking at different types of analysis that are available for understanding the effects of climate on health.

6



The distinction between studies of weather-related effects and those relating to climate change are illustrated here.

Climate change evolves over decades, and has the potential to bring about a variety of change in the environment and the response of human and other populations.

Climate is measured in a few decades, and seasonality in months or a few years.

Most epidemiological studies concentrate on changes occurring over a few days to weeks and rely on observation of past events.

To understand the impact of future climate change necessarily entails some form of modelling, usually combining evidence on short-term weather-health relationships derived from epidemiological studies of past events with models of future climates derived from global circulation models.

A great many assumptions are made in such modelling, including the probably unrealistic assumption that the health effects of climate change can be adequately represented by today's short-term weather-health relationships extrapolated to future climatic patterns.

7

Types of analysis

OBSERVATIONAL

1. **Episodes or event analysis:** heat wave, flood, drought, cyclone, El Niño…
2. **Time-series analysis:** mortality/morbidity *vs.* temperature/precipitation
3. **Seasonality:** diarrhoea, aero-allergens, vector-borne diseases
4. **Changes in geographical distribution:** temperature/precipitation *vs.* vector borne diseases (VBDs)

The types of study that are used to investigate climate-health — or rather weather-health – relationships may be divided into observational studies of past weather patterns, and modelling studies that try to predict changes by combining epidemiological data with climate predictions.

The simplest type of observational study is the study of individual, extreme, meteorological events: deaths and injuries during severe wind storms, floods, heat waves, droughts.

Time-series studies use data for longer periods, and attempt to define more general relationships between, for example, temperature and mortality, but observation of daily or weekly data over several years.

Some analyses focus on the length of the season within each year that health events occur, for example the timing and duration of periods of aero-allergens (pollens), the seasonal patterns of diarrhoeal illness or vector-borne diseases.

Changes in the geographical distribution of disease are often of interest in relation to vector-borne disease, such as malaria and dengue, but require extensive data about disease occurrence over time and space.

8

Types of analysis

MODEL-BASED

1. **Health burdens:** risk assessments
2. **Decision analysis** of health impact of policy options

Model-based studies include ones that try to predict future burdens by assuming current weather-health patterns applied to future worlds with altered climate, and decision-analysis studies that look at the potential risks and benefits of particular health protection measures.

9

Short-term changes: two approaches

- **Episode analysis**
  - transparent
  - risk defined by comparison to local baseline

- **Regression analysis** of all days of year (time-series)
  - uses full data set
  - requires fuller data & analysis of confounders
  - can be combined with episode analysis

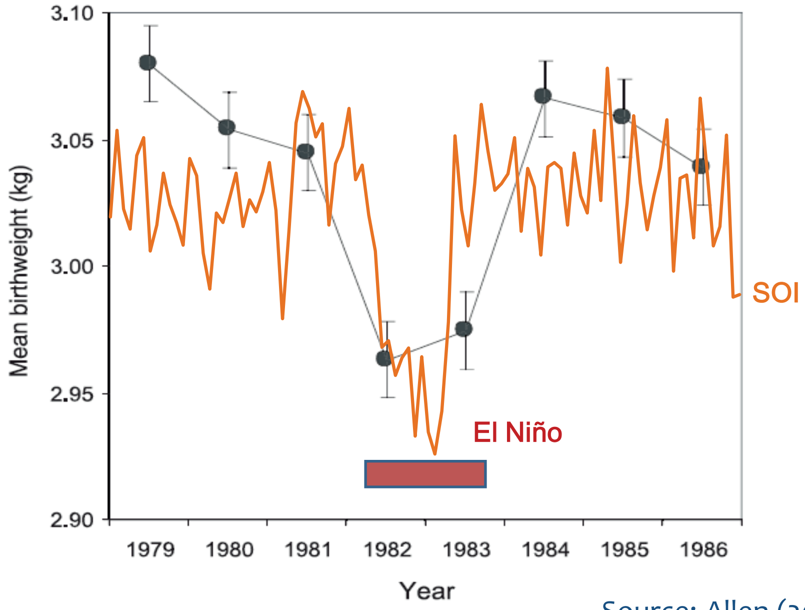
Let us now turn our attention to the epidemiological study of short-term weather-health events. There are two main approaches, which are closely-related to each other.

Episode analyses focus on single events that can be defined in terms of date: a period of a heat wave, date of a flood, etc. The principles of analysis are very simple: to examine the change in the occurrence of health events (deaths, hospital admissions, cases of infectious disease etc.) during or after the event compared with some appropriate pre-event baseline.

The second approach is really an extension of the episode analysis, in which data are assembled for a much longer time-period and analysed to determine the general relationship between meteorological parameters and health adjusting for time-varying confounders. It is a more complex form of analysis, which can incorporate elements of the episode analysis.

10

Mean annual birth weight 1979–1986, Tari, Southern Highland, Papua New Guinea

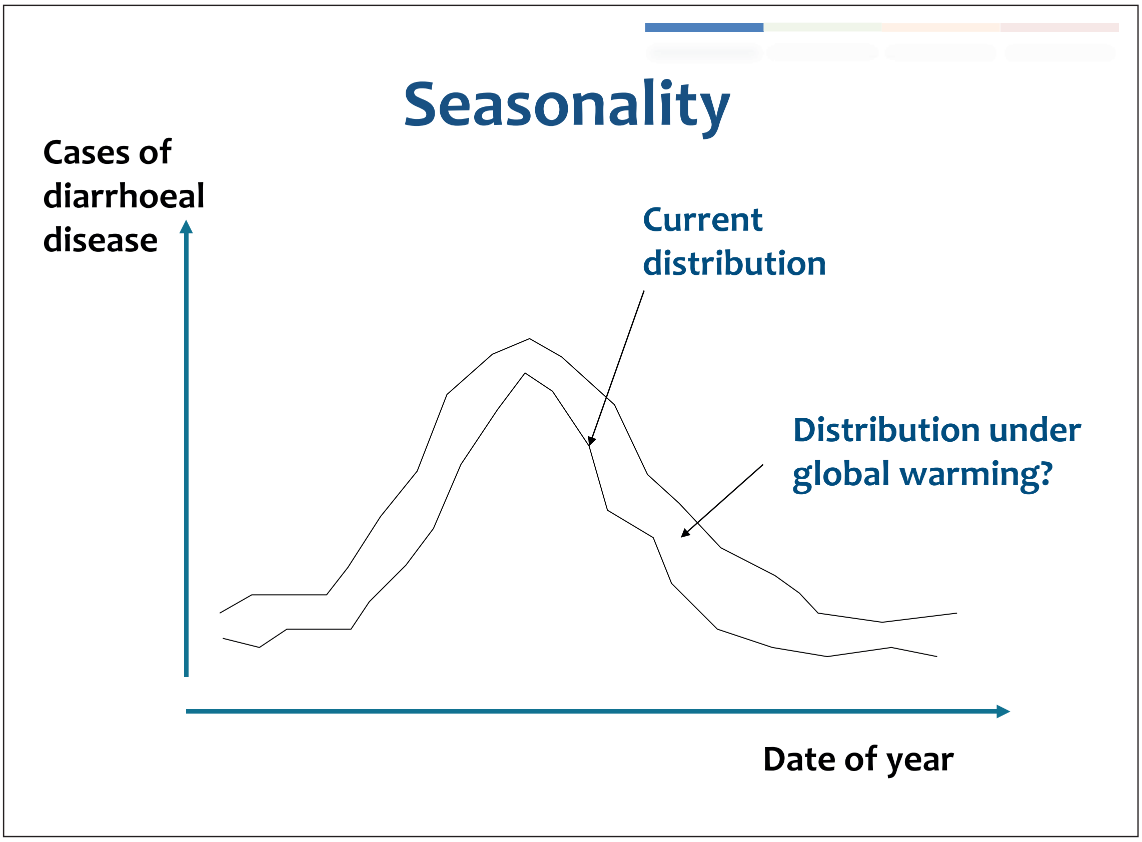


Source: Allen (2002)

This is a typical episodic event following severe climate variability. Black line shows a mean birth weight of babies born in a town in Southern Highland Province, Papua New Guinea. There is a prominent drop in the birth weight between 1982 and 1983. These years coincide with the years of most powerful El Niño episode in 20th Century. Prolonged drought in the highland may provoked poor nutrition of less privileged group of population group, women and children, in this traditional town. Time interval of a long-term event such as drought is longer, over months to years. In general, episodic analysis is based on much shorter time interval, usually days.

Source: *Modified from Allen BJ. Birthweight and environment at Tari. PNG Med J 2002;45(1-2):88-98*

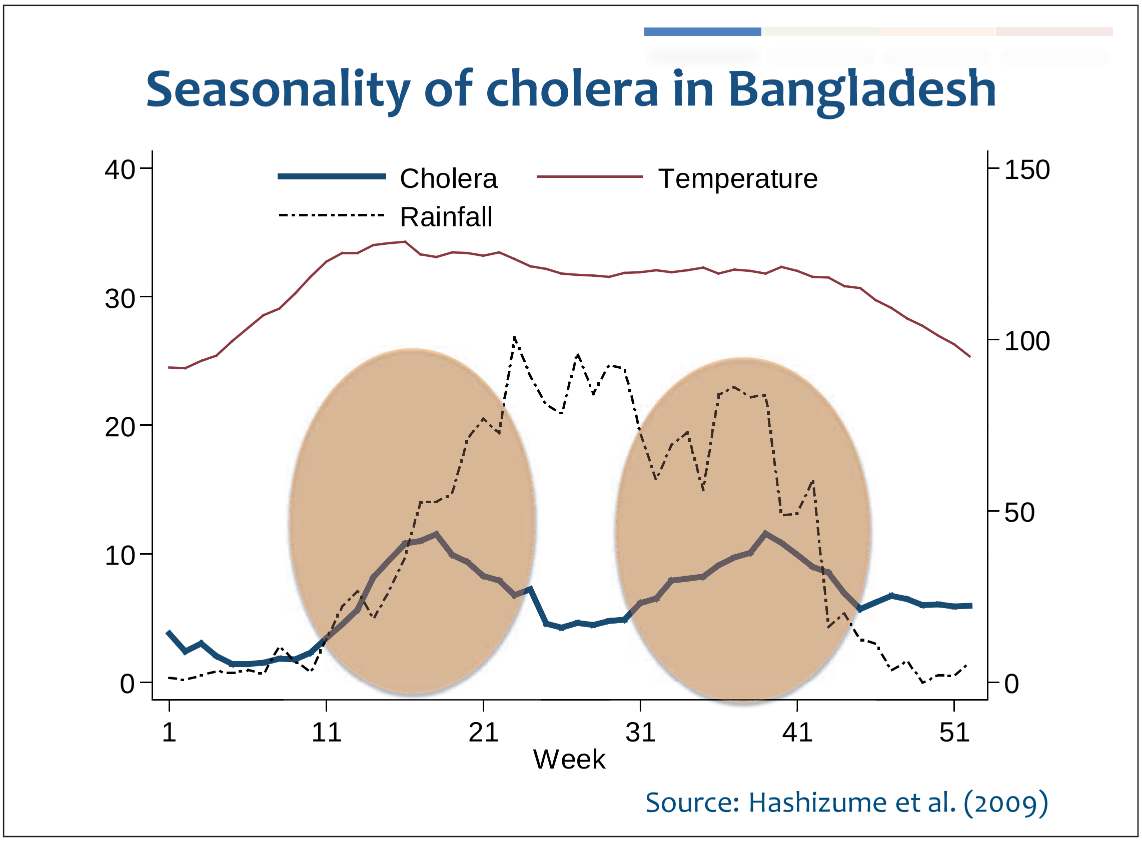
11



Another variant is studies which focus not on the determinants of daily count of death or illness, but on the seasonal distribution – a widening perhaps in the period of the year with raised frequency of occurrence.

Such questions have been of interest for aero-allergens (pollen seasons) and the spread of some forms of diarrhoeal disease, which tend to occur in conditions of higher temperature favouring the replication of the pathogenic organism outside the host.

12

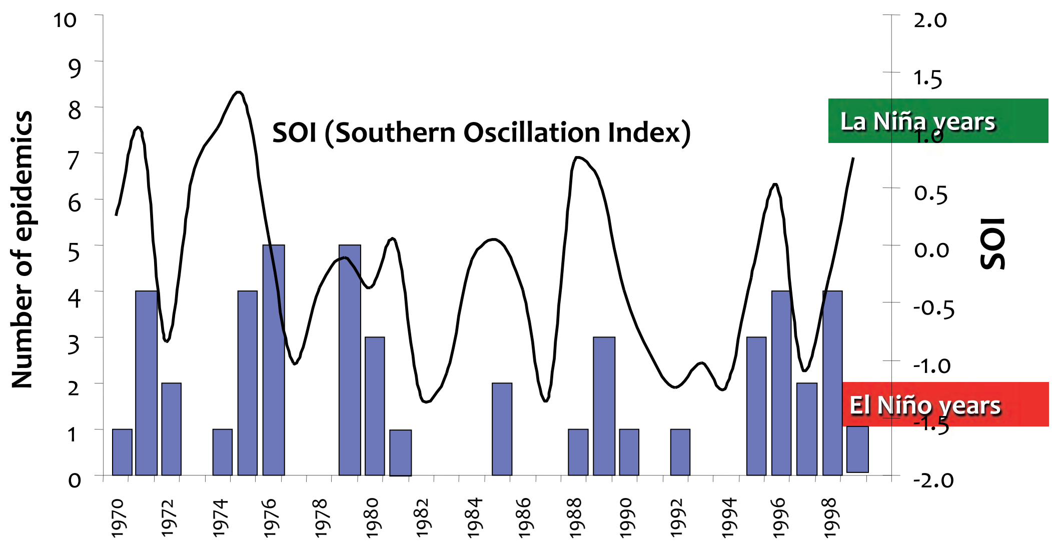


The incidence of cholera shows a bimodal seasonal distribution in Dhaka, Bangladesh: the first peak (April–May) occurs before the monsoon, and the second (September–October) occurs at the end of the monsoon, suggesting that weather factors could play a role in a different way. Later, late-monsoon peak may present a typical water- and food-borne outbreak related with a contamination of coastal sea water. Earlier, pre-monsoon peak, however, may present a active person-to-person transmission related with a shortage of water for hygiene as consequence of prolonged dry period.

Source: *Hashizume M, Faruque AS, Wagatsuma Y, Hayashi T, Armstrong B. Cholera in Bangladesh: climatic components of seasonal variation. Epidemiology. 2010 Sep;21(5):706-10.*

13

Inter-annual variation: example of dengue epidemics in the South Pacific, 1970–1998



Source: Hales & Woodward (1999)

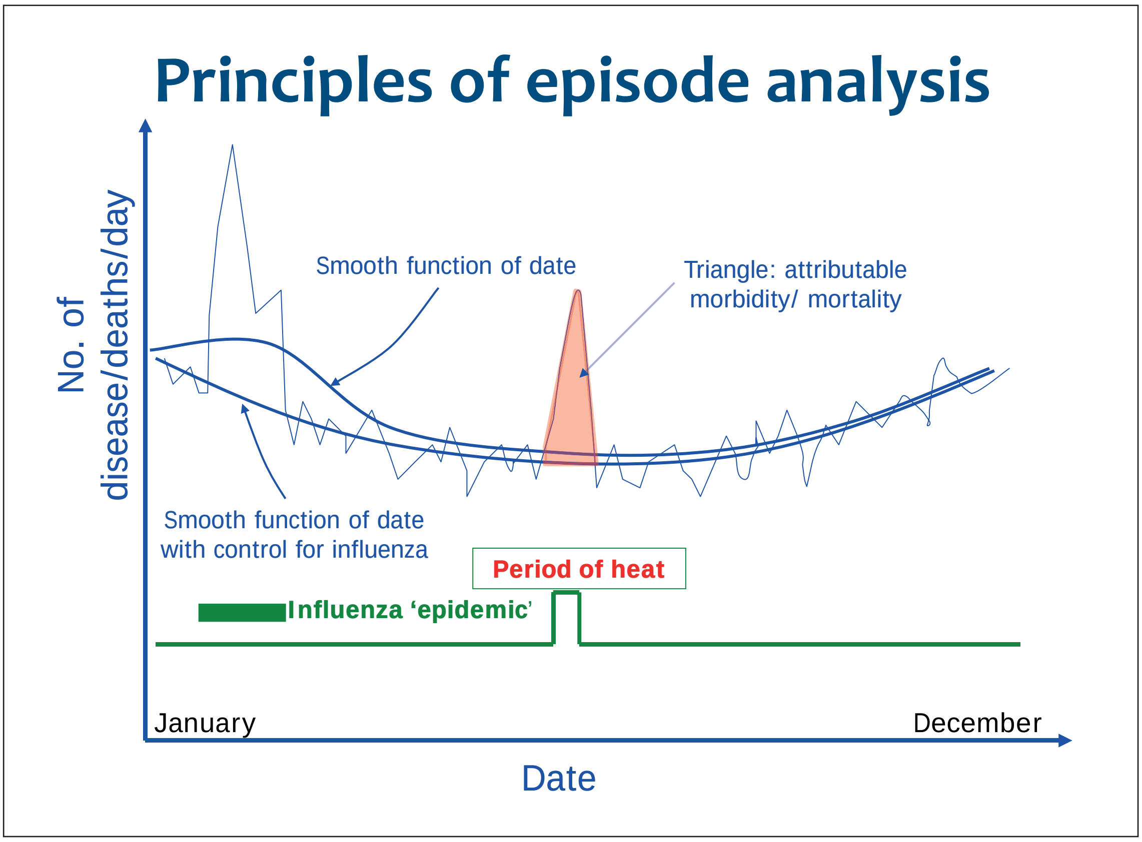
Variants on the daily time-series study include ones that look at inter-annual variations in health events, notably the occurrence of vector-borne disease.

An example, shown here, is a study by Hales and Woodward, of the variation in dengue epidemics in the South Pacific in relation to the Southern Oscillation Index, which defines El Niño and La Niña years.

This type of study aims to identify correlations with broad scale meteorological conditions as reflect by markers such as the SOI. Such studies tend to control for few other time-varying parameters.

Source: *Hales S, Weinstein P, Woodward A. Dengue fever epidemics in the South Pacific: driven by El Nino Southern Oscillation? Lancet 1996;348(9042):1664-1665*

14



Consider the stylized graph above, which represents diagrammatically the pattern of health endpoints that occur across a year. This might be a year in the temperate northern hemisphere that runs from January (far left) to December (far right).

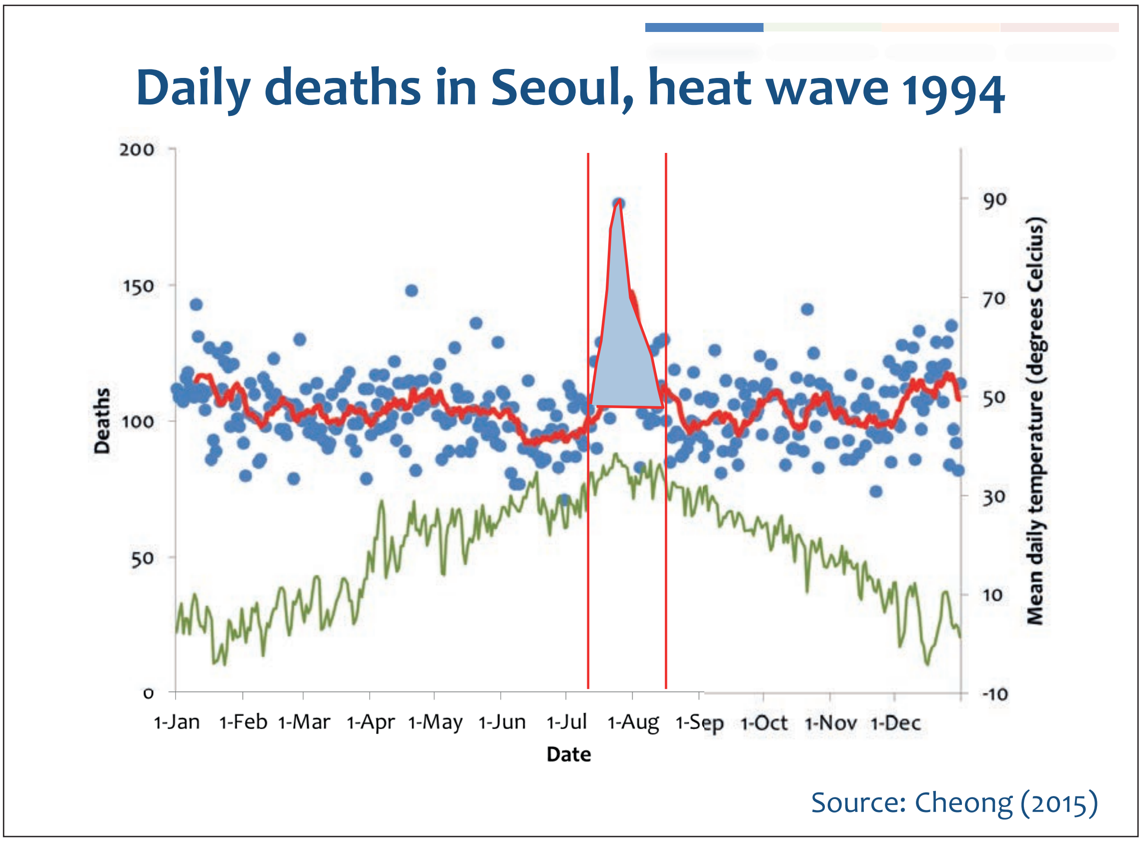
The jagged blue line represents the daily number of deaths. Note that there is short-term (day-to-day) variation in deaths, which in part reflects random variation, but also the effect of risk factors that vary over the short-term, such as outdoor temperature. There is also a smooth underlying variation in the average number of deaths (highest far left and far right) which is meant to represent seasonal fluctuation. Finally there are two obvious peaks of death, one in the centre which indicates a heat wave effect (the timing of which is indicated by the green trace), and one near the left which represents the effect of a small influenza epidemic, whose timing is indicated by the red bar.

The number of deaths attributable to the heat wave can be thought of as the area under the peak in mid year which coincides with the period of high temperatures. That is, it is the area under within the peak but above the expected (= average) number of daily deaths for the time of year.

This average may be represented by the dotted blue line, which is a moving average of deaths across the year. However, the first dotted blue line is dragged up a bit by the effect of the influenza outbreak, so a better baseline is represented by the second dotted blue line in which the effect of the influenza period has been taken into account.

The deaths attributable to the heat wave may therefore be thought of as the area of the approximately triangular shaped area shown in light blue, whose base is the second dotted blue line. This, essentially, is the basis of all methods that try to calculate attributable health events (deaths, hospital cases, etc.) in episode analysis.

Source: *unpublished document*



This graph shows the actual pattern of daily deaths in Seoul, South Korea, during the heat wave of 1994.

As in the stylized example shown in the previous slide, it shows the daily variation in deaths, the seasonal fluctuation and the very obvious sharp peak in deaths occurring at the height of outdoor temperatures shown by the lower trace.

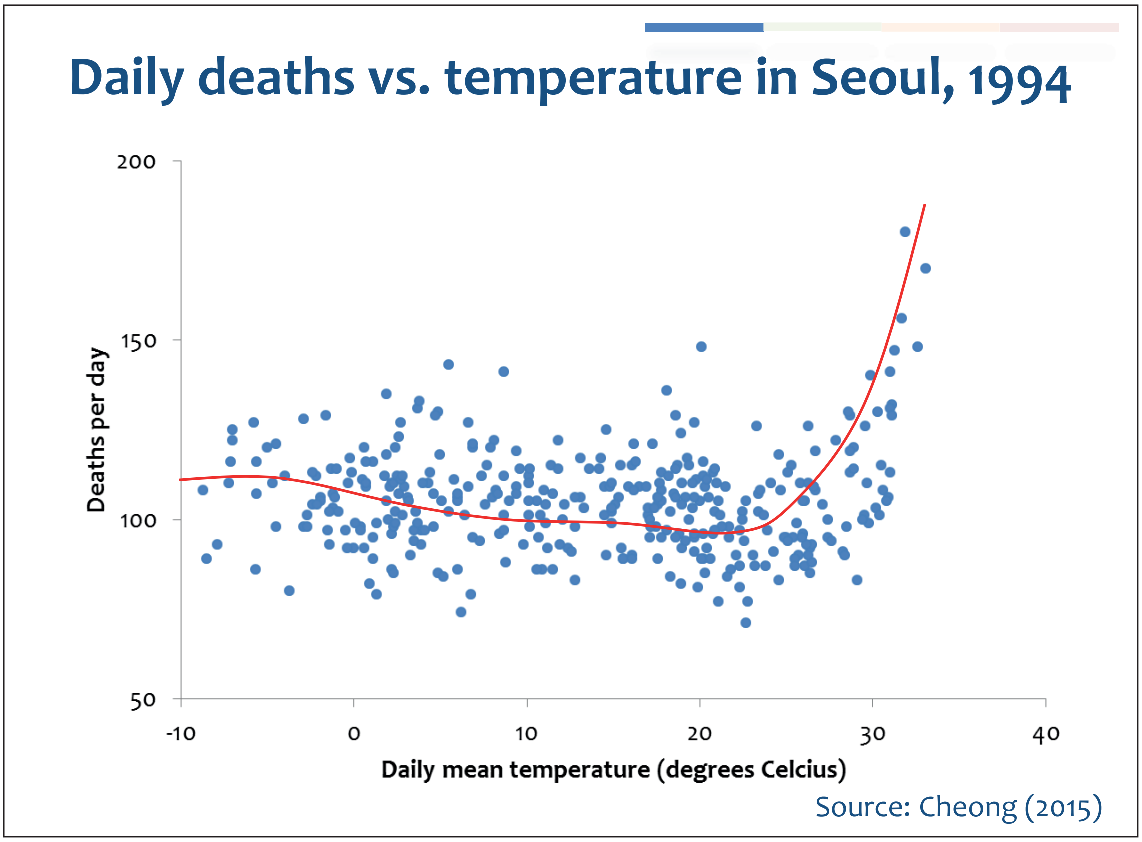
In this graph, the dates of the beginning and end of the 2004 heat wave have been added as vertical dashed lines, and the moving average of deaths to the left and right of that period have been calculated and are shown as the continuous red line.

The attributable deaths during the period of the heat wave are thus represented by the grey shading.

Note:

1. The definition of the beginning and end of the heat wave are somewhat arbitrary, as they may be defined in a variety of ways – e.g. in terms of absolute temperature, or by exceedance of a percentile (say the 98th) of the usual temperature distribution, or in terms of a continuous run of hot days, etc. Different definitions could give slightly different dates for the beginning and end of the heat wave. Observe that occasional days before and after the heat wave as defined here were actually hotter than those of the heat wave itself.
2. As stated, this method counts deaths only during the period of heat, whereas some may be delayed (lagged) by a day or two.

Source: *Cheong, HK. 2015. (These figures were drawn by Cheong based on the climate data from Korea Meteorological Agency and daily mortality data from Statistics Korea)*



In this graph, the daily deaths for 1994 and two earlier years are presented as a function of temperature rather than date. The red line shows a smoothed function to indicate the underlying pattern of the temperature-mortality relationship which includes:

- a temperature region (around 15 to 20 Celsius) where daily mortality is lowest: the 'minimum mortality' temperature band
- a gradual rise in mortality with colder temperatures (to the left of the minimum mortality temperature range)
- a steeper rise in mortality at hotter temperatures (to the right of the minimum mortality temperature range).

This type of plot is more informative in indicating the overall nature of the temperature-mortality relationship, rather than just the change in deaths during a particular period of heat as shown in the previous slide.

Source: *Cheong, HK. 2015. (These figures were drawn by Cheong based on the climate data from Korea Meteorological Agency and daily mortality data from Statistics Korea)*

17

Episode analyses: interpretation

- Common sense, transparent
- Relevant to PH warning systems

But

- How to define 'episode'?
  - relative or absolute threshold
  - duration
  - composite variables
- Uses only selected part of data
- Most sophisticated analysis requires same methods as for regression of all days of year

The approach used in episode analyses has two major advantages: its transparency and its relevance to public health warning systems – it suggests the sort of impact that might be expected of a similar heat wave in future.

However, it has several disadvantages: the difficulties in defining what a heat wave period is, and the fact that it uses only part of the data and does not provide further evidence about the broader relationship between temperature and mortality (or other health endpoint) as alluded to in the previous slide.

A more detailed form of analysis is represented by time-series studies.

Time-series regression

- Short-term temporal associations
- Daily/weekly
- Suitable for episodes or effects of local fluctuations in meteorological parameters
- U- or V-shape of temperature-response function
- Different lags

Time-series studies of health endpoints in relation to meteorological parameters typically use data from across several years and they analyse the short-term associations at the daily or weekly level.

Thus, they are usually a form of regression analysis in which the outcome is the daily count of deaths (or other health endpoint), and the explanatory factors daily weather variables. They are suitable for analysing the general relationship between e.g. temperature and mortality, which can include quantification of the effect of specific episodes of heat, etc.

Results for studies of temperature-mortality relationships usually show U- of V-shaped curves (as described earlier), with 'thresholds' for cold and heat effects. Such analysis are normally adjusted for time-varying confounding factors, and they can take account of time-lags.

19

Lags

- Heat impacts short: 0-2 days
- Cold impacts long: 0-21 days
- Vary by cause-of-death
  - CVD: prompt
  - respiratory death: slow
- Should include terms for all relevant lags

One of the additional features is the need for and the ability to allow for time lags.

Thus can be done in the regression analysis simply by including terms to represent the values of the meteorological variables for yesterday, the day before that, the day before the day before yesterday and so on. For example, we might write, T[t-i] to indicate the temperature on day t-i (i.e. a lag of i days).

Empirically it is found that heat effects are generally quite prompt, so if it is hot today, people die to day or tomorrow, or perhaps the day after. But evidence of an effect of heat lagged by more than a few days is very rare.

Cold effects, in contrast, can be delayed by up to several weeks, so that cold today may continue to have an effect on mortality in two or three weeks time.

For cold effects in particular, the time lag appears somewhat different for different causes of death. Cardiovascular deaths occur comparatively promptly, peaking within a few days, while respiratory deaths continue to rise for around two weeks.

In any time-series regression analysis, is it good practice to include terms to capture all time lags that may be relevant for a particular exposure and cause of death.

20

Summary of time-series

- Provide evidence on short-term associations of weather & health
- Robust design
- Repeated finding of direct heat + cold effects
- Some uncertainties over PH significance
- Uncertainties in extrapolation to future (No historical analogue of climate change)

In summary, time-series studies provide evidence about the general relationships between weather parameters and health outcomes, based on short-term effects.

The fact that they effectively compare the population with itself day by day provides considerable advantage in interpreting the effect of weather-heath relationships.

Such studies have found evidence of heat and cold effects in nearly all populations studies to date.

There are, however, some uncertainties about the public health significance of this evidence because it relates only to short-term effects (=exacerbation and acute effects predominantly on the frail?), and because of the possibility of the harvesting phenomenon.

As later slides indicate, there are also considerable uncertainties in extrapolating the evidence of time-series studies to the future, as their evidence is not directly about climate change or even climate.

21

Changes in geographical distribution of disease

(1) BIOLOGICAL MODELS

- Use of (laboratory derived) biological evidence

(2) STATISTICAL MODELS

- Analyses of disease prevalence or vector abundance in relation to geographical factors

A second category of studies relevant to questions of climate change and health are ones relating to the geographical distribution of disease – for example, changes in malaria.

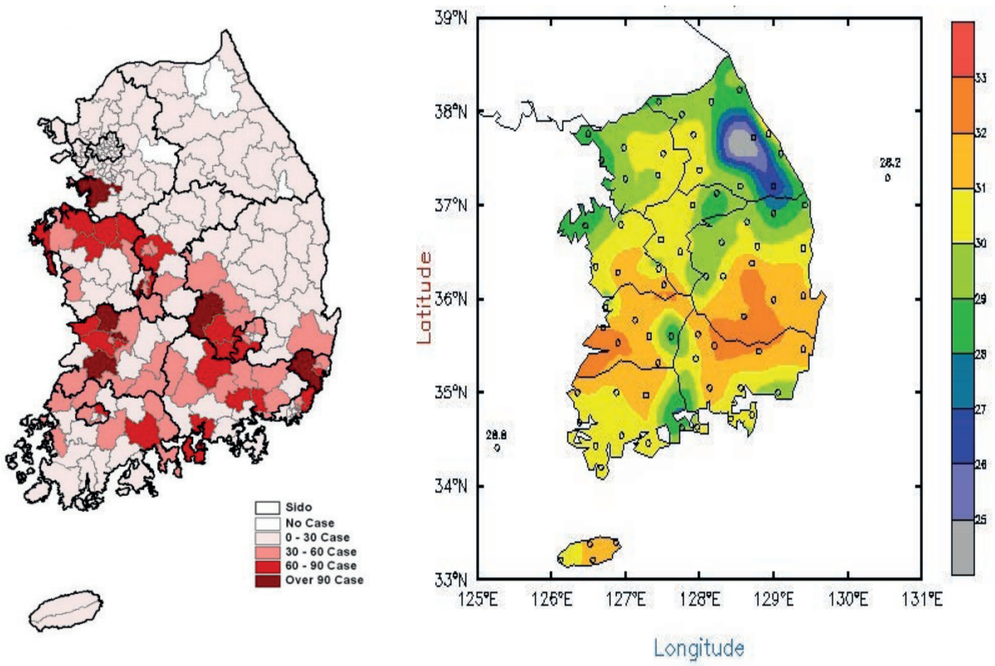
Often, the questions are about predicting future patterns of spread, and thus entail disease modelling. In very broad terms, two different approaches are used for quantifying the risk associated with particular climatic conditions.

The first uses data, obtained from laboratory studies, to quantify the biological behaviour of the mosquito vector and the parasite under different temperature and/or other meteorological conditions. From such data, it is possible to identify the type of conditions that favour transmission of disease and to place some quantification on this. These are often described as biological models, for obvious reasons.

A second approach uses observed data on disease and disease vectors from field stations around the world and relates them to local climatic conditions. Using data from multiple sites, it is possible to construct regression equations to explain the probability of disease occurrence as a function of temperature and other climatic conditions. This is often referred to as the statistical approach.

22

Scrub typhus & temperature

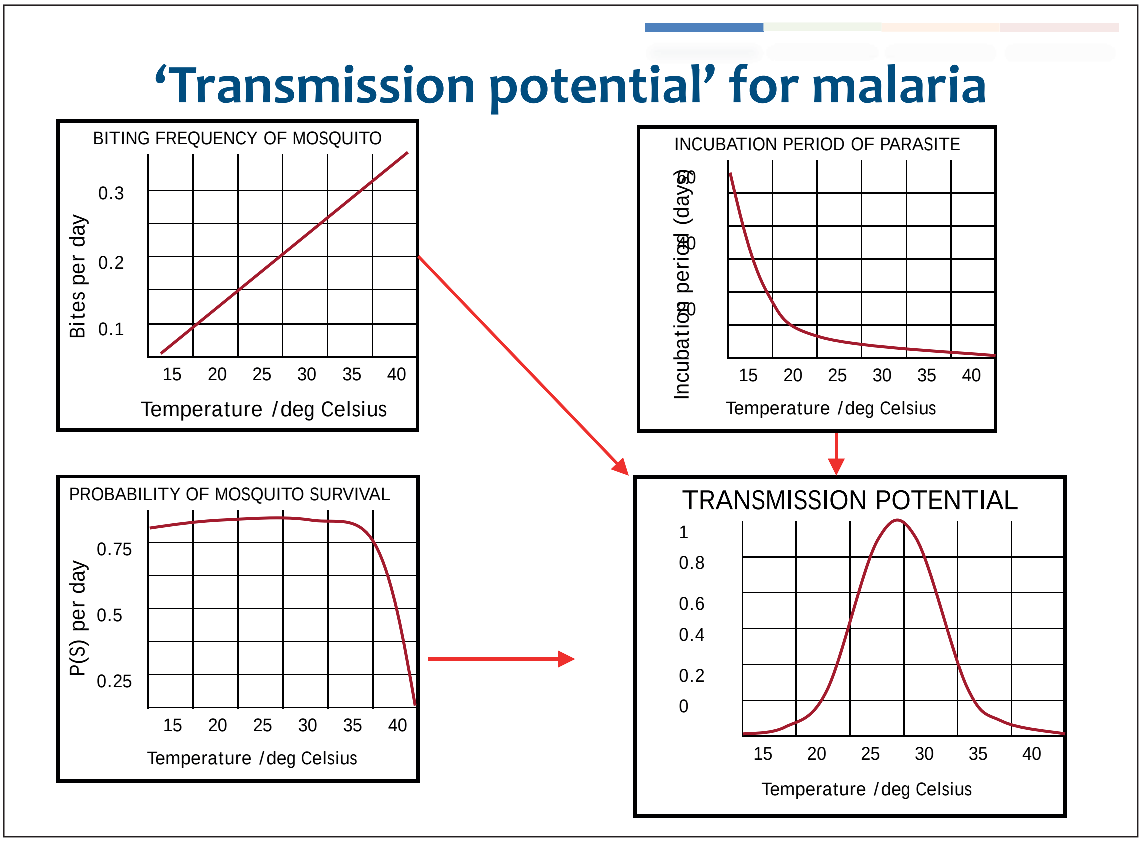


Geographic distribution of a specific disease usually represents the distribution of factors that is related with the vector ecology. Health map of scrub typhus in Korea shows a good correlation of disease report with the distribution of temperature, which reflect a condition for the proliferation of vector mites.

Source: *Figure on the left : Distribution of scrub typhus cases by county, 2007. Korea Centers for Disease Control and Prevention. Available from http://www.cdc.go.kr/CDC/info/CdcKrInfo0403.jsp?menuIds=HOME001-MNU1134-MNU1153-MNU0046&cid=3226*

Figure on the right : *Korea Meteorologic Agency*

23



On the top left is biting frequency of the mosquito, on the right the incubation period of the parasite, and on the bottom left the probability of mosquito survival.

The survival of the vector and the frequency with which it bites both show some temperature dependence. Similarly, the incubation period of the parasite can be quantified.

Combining all three functions allows the calculation of a ‘transmission potential’ on the bottom right, which provides a quantified measure of the relative potential for transmitting malaria under specific temperature conditions.

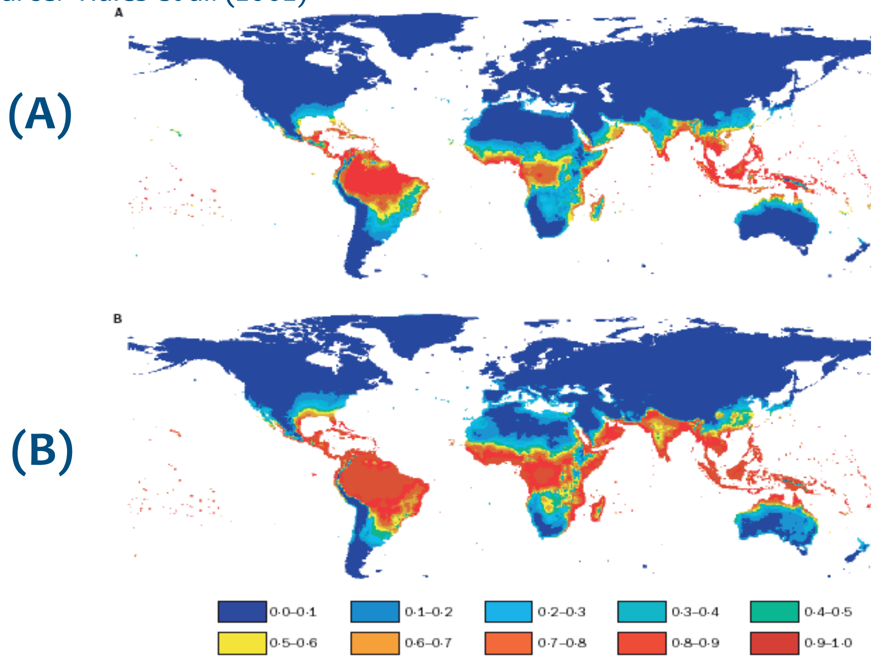
On its own, this sort of approach can provide evidence about the possible change in disease transmission if temperatures increase under climate change, but the actual effect on the geographical distribution of disease depends on many factors other than the climate/weather. Biological models alone therefore provide only a partial answer, and must be interpreted in the light of other evidence about the determinants of disease, such as the effect of socio-economic development.

(Source unknown)

24

Estimated population at risk of dengue fever: (A) 1990, (B) 2085

Source: Hales et al. (2002)



Statistical models are likewise limited if based only on evidence about climatic associations, without taking into account data on other modifying factors and the complex biology of the vector and disease.

Thus, maps such as this one, which use statistical evidence combined with climate scenarios to derive estimates of the possible change in the distribution of disease, must be interpreted as a guide only. The real picture is likely to be much more complicated and influenced by a multitude of factors.

This is an area where ongoing research should help to provide improved, multi-factorial models based on a combination of biological understanding and statistical evidence.

Source: *Hales et al. Lancet (online) 6 August 2002. http: //image.thelancet.com/extras/01art11175web.pdf*

25

Conclusions

- Most methods of 'climate' attribution based on analysis of weather-health associations: episode analysis, time-series, seasonality, inter-annual variations
- Relevance to climate change limited by uncertainties over multiple effect-modifiers – changes in vulnerability of population & health
- Modelling intrinsic to assessment of likely future burdens & the effect of adaptation options, but entails many uncertainties

In conclusion, a variety of methods may be used to try to understand the influence of the climate/weather on health. Most such studies focus on weather-health relationships, and have only partial bearing on the effect of climate change for several reasons, including:

The fact that climate change may give rise to many forms of change additional to the effects quantified in studies of short-term weather-health relationship.

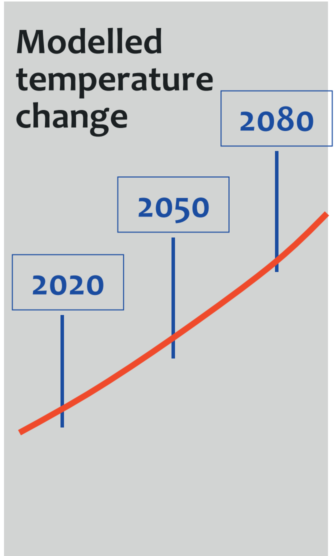
The fact that many changes will occur over time in factors other than the climate itself, and these changes are likely to have important influence on the vulnerability to weather effects and hence on the burden of climate change-attributable disease.

Models of climate change impacts on health are intrinsic to the assessment of adaptation and mitigation options, but they entail many uncertainties and their evidence should be treated with caution.

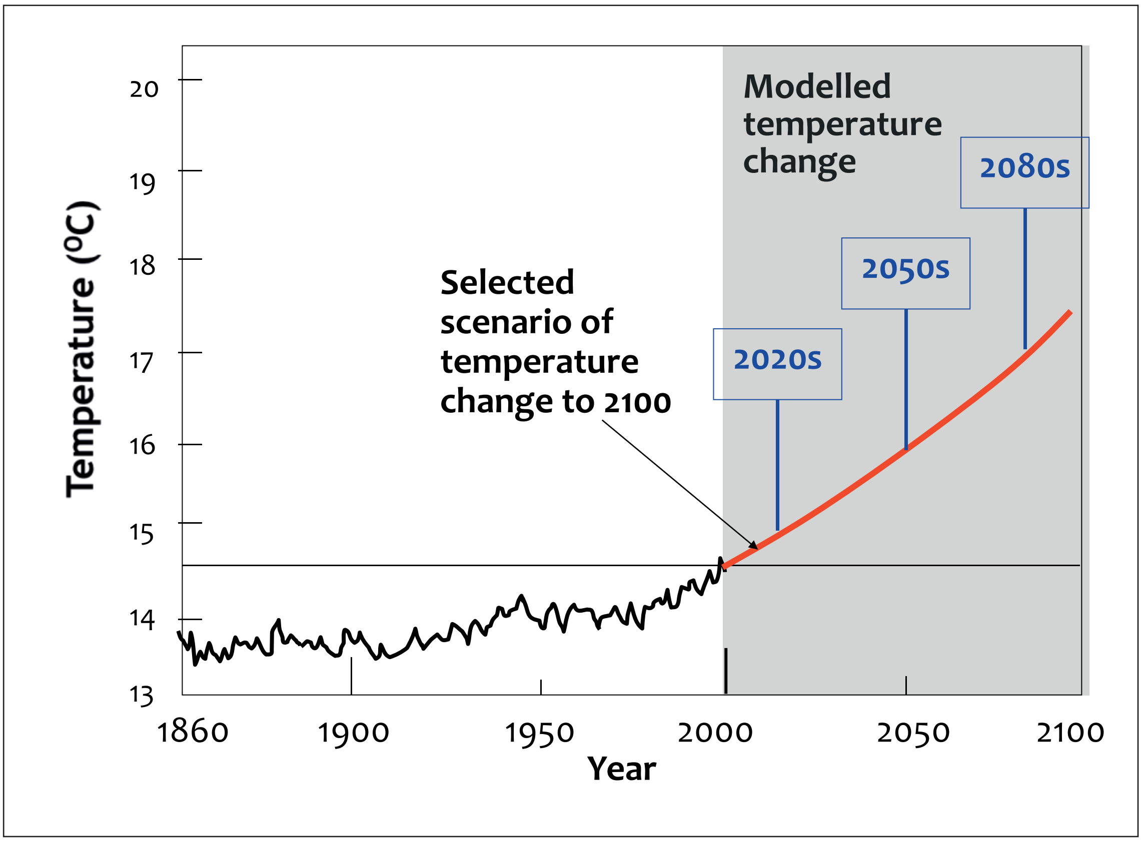
Recommended further reading: 2007 IPCC report: The Physical Science Basis, pages 37 to 43 (T.S 3.1.2 and T.S 3.1.3; FAQ 6.2 page 114

26

Modelling the health impacts of climate change



We've looked at different analysis types in the first section of this module. Next we'll cover how the health impacts of climate change are modelled.



Projecting the health impacts of climate change presents challenges different from considering the future impacts of other risk factors. The "exposure" (in terms of changing temperature and precipitation patterns) will change over time, with high uncertainty about the rate and extent of impacts in a particular region. In addition, there will be significant changes in the demographic structure of most populations, technologies in 2100 will differ from those of today, and socioeconomic development may change the world as much as from 1900 to today. Standard epidemiologic analyses are not designed to deal with these complexities.

28

Estimating future health impacts of climate change

- Expert judgment
- Simple extrapolation
- Mathematical/statistical modeling
  - Bivariate
  - Multivariate
  - Fully integrated

The potential future health impacts of climate change can be estimated using:

Expert judgment that considers current health burdens, the driving forces for those burdens, and trends that are likely to affect the health burdens over time. For example, the warming associated with climate change will provide opportunities for more rapid replication of many water- and foodborne pathogens. Rural areas in mountainous areas without sustainable access to improved sanitation can be expected to experience an increase in diarrheal diseases if no additional interventions are implemented.

Current trends can be extrapolated to future periods, assuming no major changes in those trends due to climate change or socioeconomic development. For example, continued increases in temperature could result in the mosquitoes that carry dengue fever, malaria, and other vector-borne diseases to continue to expand their geographic range in mountainous areas.

Models, based on biological properties of disease transmission dynamics or on statistical associations between environmental variables and health outcomes, are being increasingly used to gain insights into how climate change could affect future patterns of climate-sensitive health outcomes. Models range from simple (i.e. considering only one key variable that will change with climate change, such as temperature extremes), to fully integrated models that incorporate all known processes of significance.

29

Mathematical/statistical models

- Simplified representation of a more complex, dynamic relationship
  – Reduce complexities & background noise to a simpler mathematical representation
- Necessarily 'wrong' (incomplete, simplified), but useful for:
  – Insights into processes
  – Indicative estimates of future impacts
  – Enhancing communication to peers, public & policy-makers

Models are simplified representations of complex, dynamic relationships. Models aim to identify key processes for the association between climate change and health, to further insights into how changing weather patterns could affect the geographic range, seasonal length, and incidence of health outcomes. The goal of a "good" model is to provide insights into possible future changes in health outcomes with enough confidence for decision-makers to plan for possible interventions to avoid, prepare for, and effectively respond to the health risks of climate change. For example, several models suggest that a changing climate will provide an opportunity for various vector species to increase their geographic range in mountainous areas in the coming decades. Public health institutions and agencies can use that information to plan for where and when to alter current surveillance programmes.

30

Models

- **Models are useful**
  - Particularly if the relationship is strong or involves a clear threshold above which an outcome event is very likely
  - Consistent framework for structuring scientific knowledge
  - Explore interactions & feedbacks
- **Models do not predict**
  - Limited knowledge of all factors driving an outcome
  - Policy-makers must understand that models estimate changes in probability
  - Models are difficult to validate

As noted in the slide, models provide consistent frameworks for exploring interactions and feedbacks, but do not predict what will happen because of limited knowledge of all factors that affect an outcome, including how those factors will change over temporal and spatial scales.

The general circulation models that are used to project climate change rely on scenarios of how many people there will be in the world, how wealthy they will be, and what kinds of technology they will use.

31

Future burdens: risk assessment

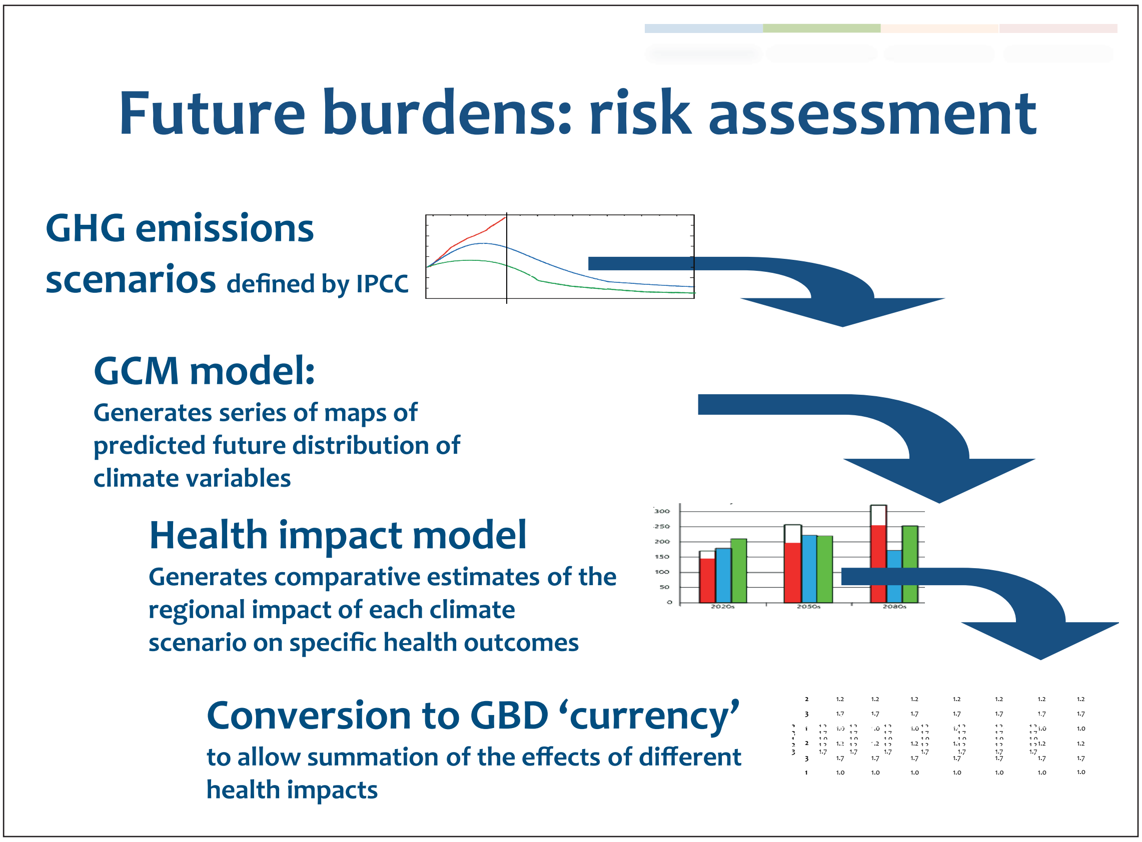
- To demonstrate the potential nature & size of health burdens that may arise under climate change
- To provide evidence on the measures needed to protect human health
- To provide comparative evidence about the possible effect (on health) of alternative adaptation &/or mitigation policies

Whether based on studies of a temporal or geographical nature, there is often interest in attempting to calculate future burdens of disease under climate change scenarios. There are various reasons for doing this, including:

1. To demonstrate the potential nature and size of health burdens that may arise under climate change as a background to policy development
2. To provide evidence on the measures needed to protect human health
3. To provide comparative evidence about the possible effect (on health) of alternative adaptation and/or mitigation policies.

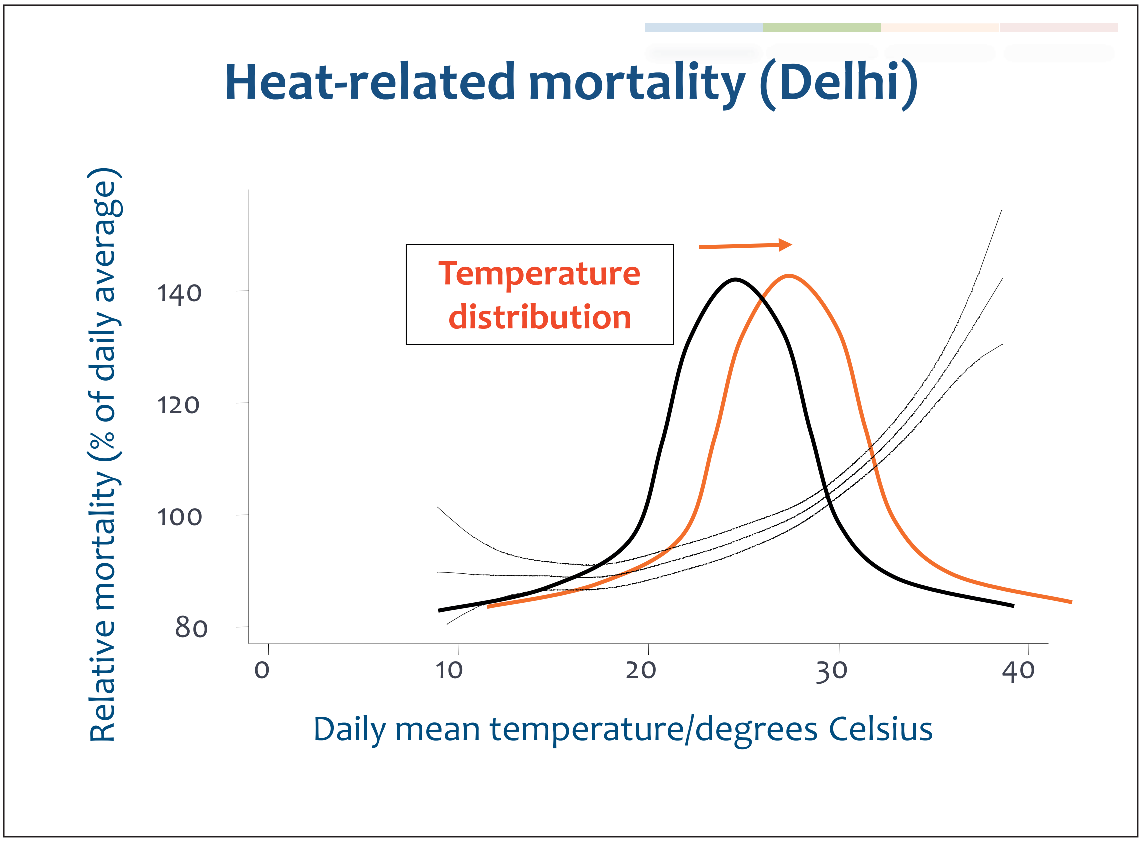
Indeed, the World Health Organization has undertaken an assessment of current climate change burdens through the Comparative Risk Assessment initiative, and this may shortly be extended to consider future climate change impacts.

32



The basis of the future burdens approach is very simple in principle:

1. obtain scenario-based evidence about the future distribution of climate patterns under assumptions of greenhouse gas emissions;
2. define relevant climate sensitive health endpoints that may be affected by such change;
3. derive evidence on the strength of relevant exposure-response functions (e.g. temperature-mortality); and
4. compute burdens of disease in terms of years of life lost (YLL), disability-adjusted life years (DALYs) and premature mortality, by combination of (i) to (iii).



Consider the graphs shown in this slide. The plot of relative risk of mortality vs. temperature is based on quantitative evidence of the exposure-response function for heat in the Delhi population. The attributable burden of heat death can be calculated by multiplying the excess risk at each temperature by the frequency with which each temperature occurs. If the current temperature distribution is shifted to the right under climate change, the change in heat-attributable burden can be obtained by comparing the burden calculations obtained from the new temperature distribution (dashed line) with those obtained from the current temperature distribution (solid line).

This, in essence, is the process used to compare any burdens of diseases under different scenarios of climate change.

Scenarios

Coherent, internally consistent depictions of pathways to possible futures based on assumptions about economic, ecological, social, political & technological development.

- Scenarios include:
  - Qualitative storylines that describe assumptions about the initial state & the driving forces, events & actions that lead to future conditions
  - Models that quantify the storyline
  - Outputs that explore possible future outcomes if assumptions are changed
  - Consideration of uncertainties

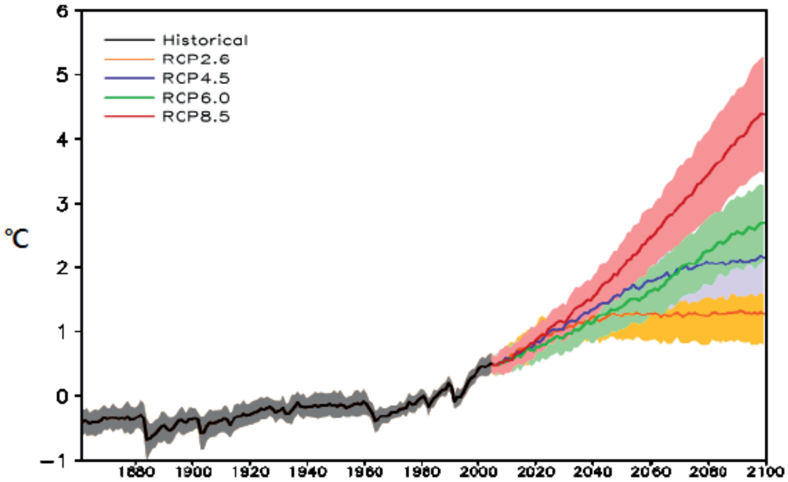
Scenarios have been developed for the Intergovernmental Panel on Climate Change (IPCC) of pathways to future worlds. The definition of a scenario is provided, as well as the components of a scenario. IPCC scenarios will be discussed on subsequent slides.

Goals of scenarios

- To provide policy relevant analyses of possible consequences of mitigation policies
- To better understand the potential impacts of climate variability & change
- To facilitate the development & implementation of effective & efficient adaptation strategies, policies & measures to reduce negative impacts

Scenarios have been used for the three goals listed. Much of the analysis with scenarios has focused on the first bullet – understanding the possible consequences of mitigation policies. There has been increasing use of scenarios to project the health impacts of climate change, as summarized in the Human Health chapter of the IPCC 5th Assessment Report. There has been limited use of scenarios to explore adaptation options, although there is increasing interest in doing so.

Representative concentration pathways (RCP)



Scenario	Temperature rise (°C)			
	2046-2065		2081-2100	
RCP 2.6	1.0	(0.4 - 1.7)	1.0	(0.3 - 1.7)
RCP 4.5	1.4	(0.9 - 2)	1.8	(1.1 - 2.6)
RCP 6.0	1.3	(0.8 - 1.8)	2.2	(1.4 - 3.1)
RCP 8.5	2.0	(1.4 - 2.6)	3.7	(2.6 - 4.8)

IPCC adopted a new greenhouse gas concentration trajectories called RCP from its AR5 in 2013, which is based on the radiative forcing and replacing previous scenario, SRES (Special Report on Emissions Scenarios). Four representative pathways; RCP2.6, RCP4.5, RCP6.0, and RCP8.5; are named after a possible range of radiative forcing in the year 2100 relative to pre-industrial values.

RCP8.5: One high pathway for which radiative forcing reaches >8.5 W m–2 by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250);

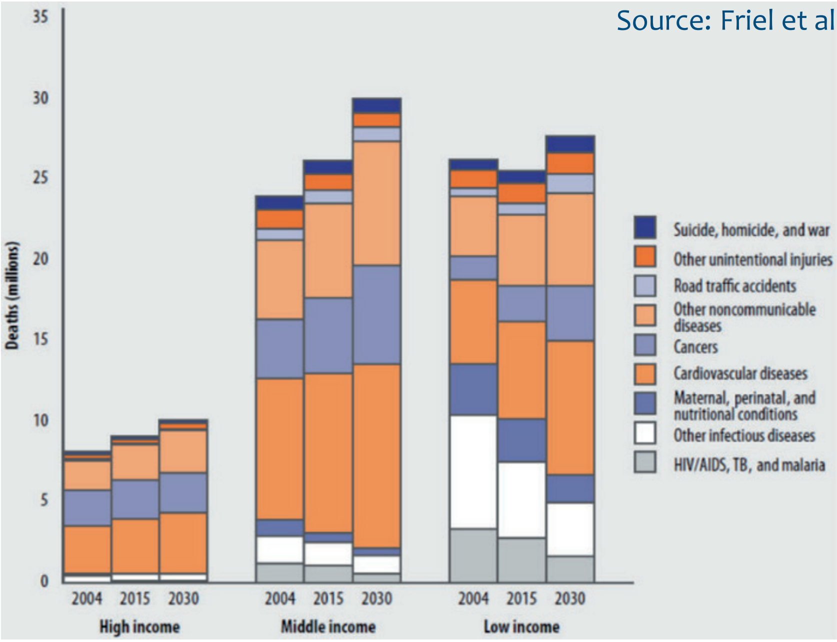
RCP6.0 and RCP4.5: Two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 6 W m–2 and 4.5 W m–2 after 2100 (the corresponding ECPs assuming constant concentrations after 2150);

RCP2.6: One pathway where radiative forcing peaks at approximately 3 W m–2 before 2100 and then declines (the corresponding ECP assuming constant emissions after 2100).

Source: *IPCC 5th Assessment Report, 2013*

Projected deaths by cause, according to national income level

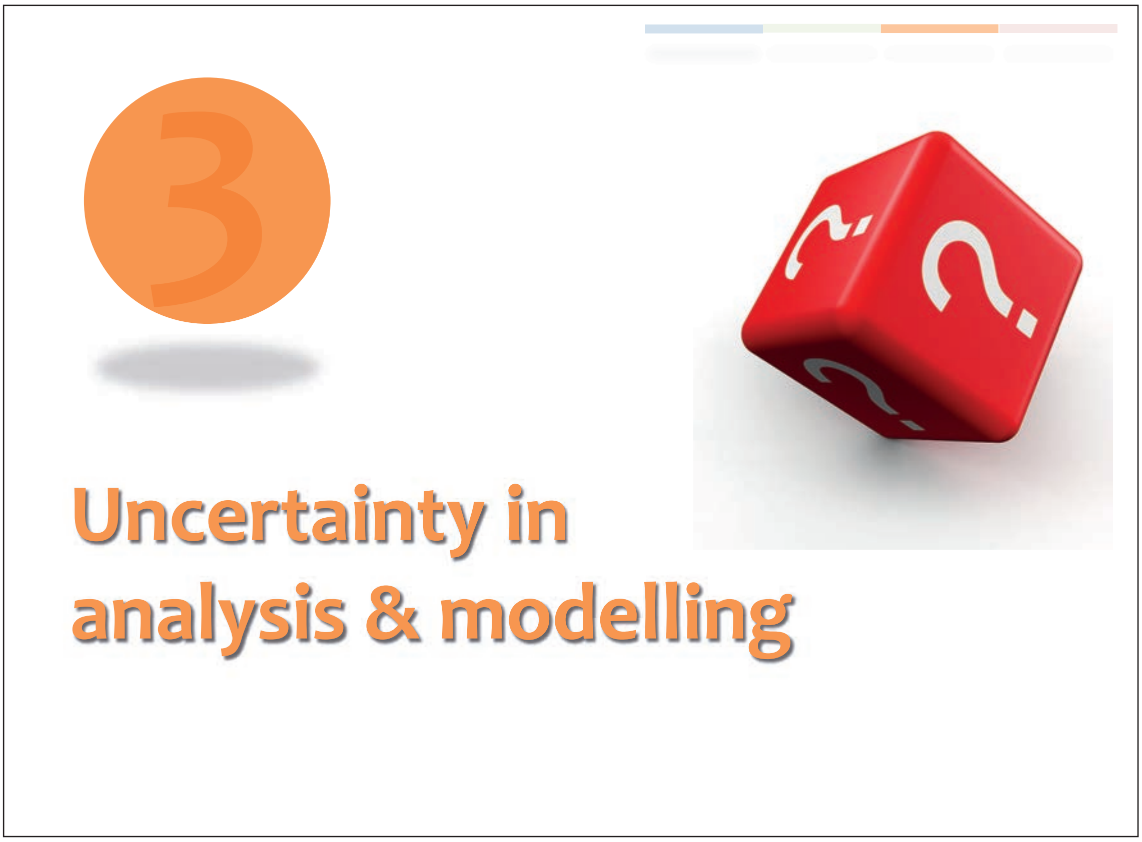
Source: Friel et al. (2011)



Health effects of climate change is not just predicted by climate factor only. In prediction of the health effects in the future, it should be based on the basic determinants of health, including socioeconomic status of the community. This figure shows a prediction of various causes of deaths at present and in the future up to 2030, stratified by national income level.

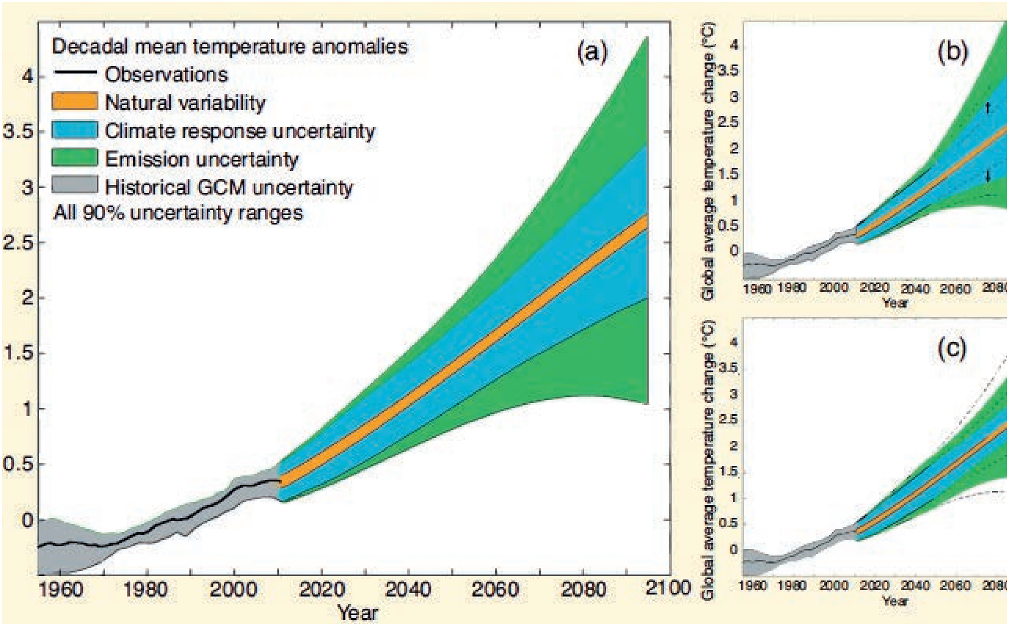
Source: *Friel S, Bowen K, Campbell-Lendrum D, Frumkin H, McMichael AJ, Rasanathan K. Climate Change, Noncommunicable Diseases, and Development: The Relationships and Common Policy Opportunities. Annu Rev Public Health 2010;32: 133-147.*

38



Uncertainty is an important aspect of modelling that needs to be understood, so let's look at that briefly now.

Relative importance of different uncertainties & their evolution in time



From the graph:

(b) Climate response uncertainty can appear to increase when a new process is discovered to be relevant, but such increases reflect a quantification of previously unmeasured uncertainty, or (c) can decrease with additional model improvements and observational constraints. The given uncertainty range of 90% means that the temperature is estimated to be in that range, with a probability of 90%

Source: *IPCC AR5, Working Group I p. 141*

40

As you can imagine, there is a wide range of uncertainties associated with these scenarios, from whether the full range of possible futures was captured, to uncertainties about assumed rate and extent of change in demographics, economic growth, etc., to uncertainties about the consequences of current and future policy choices.

41

Uncertainties

- **EXTRAPOLATION**

(going beyond the data)

- **VARIATION**

(in weather-health relationship -- largely unquantified)

- **ADAPTATION**

(we learn to live with a warmer world)

- **MODIFICATION**

(more things will change than just the climate)

It is important to keep in mind various cautions about the sort of calculations shown in the previous slide. There are many reasons why the calculations may not give an accurate picture of the actual future burdens. Among the key factors are the following:

1. Extrapolation. Almost by definition, these calculations often have to extrapolate exposure-response functions beyond the range of current exposures (temperatures, rainfall patterns etc.), and it is difficult to know how risks may look under those extreme conditions.
2. There is often very great variation in the shape of exposure-response functions in different populations which may arise for many reasons. Without better understanding of the reasons for those variations, it is difficult to be confident how patterns may look in future under climate change.
3. Adaptation. Populations will, of course, learn to adapt to climate change which may well reduce the impacts that might otherwise be expected from current observation.
4. Effect modification. A whole variety of factors have the potential to influence vulnerability to climate sensitive diseases. These include very broad factors such as levels of socio-economic development, and more specific factors such as housing quality. As yet, we have little quantification of the degree to which such factors modify the risks of climate-sensitive diseases, and thus how important they may be in determining future burdens.

For these and other reasons, estimates of future burdens should be treated as broadly indicative only. Remember also that current epidemiological studies mainly focus on short-term influences and extrapolations based on them are unlikely to capture all forms of health effect relevant to climate change.

42

To finish off Module 5, I'd like to briefly cover some of the changing sources of vulnerability to climate change, and how these affect analysis and modelling.

43

Changing vulnerability

- Changes in population
  - Demographic structure (age)
  - Prevalence of weather-sensitive disease
- Environmental modifiers
- Adaptive responses
  - Physiological habituation (acclimatization)
  - Behavioural change
  - Structural adaptation
  - PH interventions

Vulnerability to climate change is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. (IPCC. 2013. AR5).

The factors that influence vulnerability to climate change are multiple, and it is worth remembering that over the long term there may be dramatic changes in some of these factors, just as there may be in the climate itself.

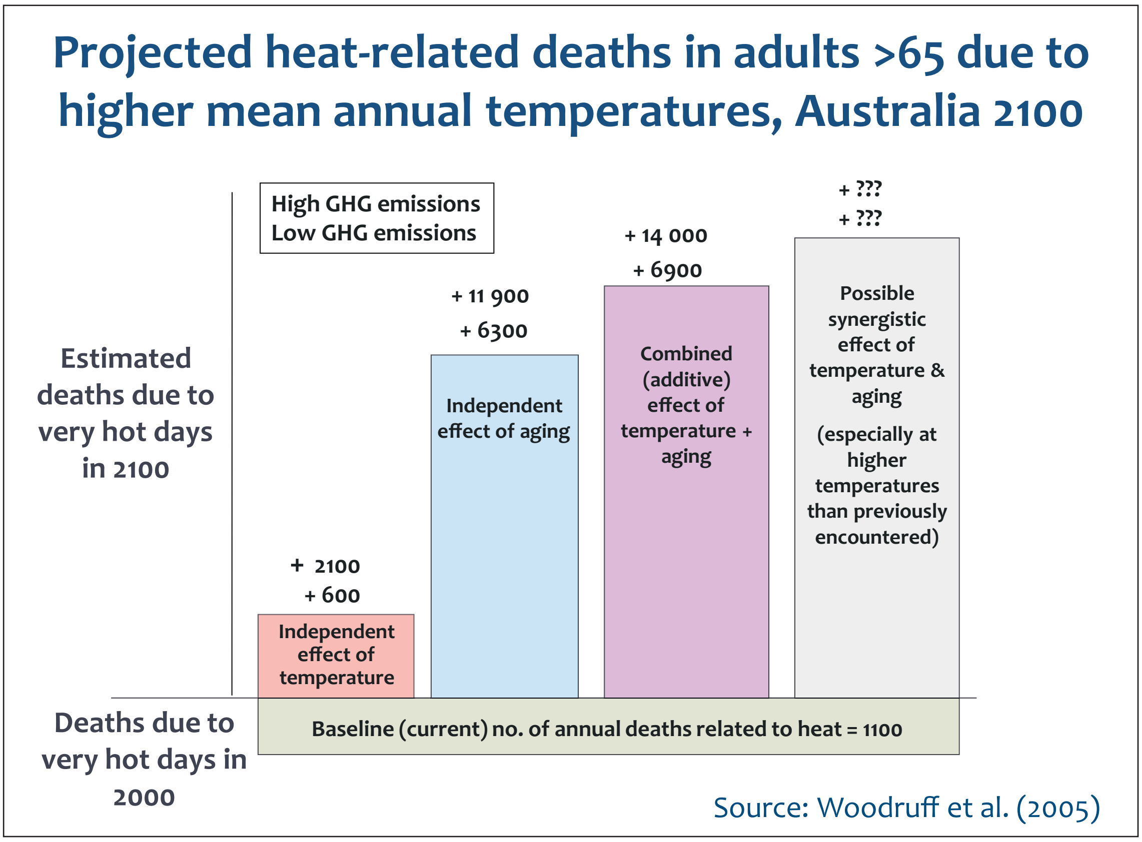
The population may change (typically growing older, and often changing the prevalence of climate-sensitive disease as the epidemiological patterns change – often towards more chronic disease).

There may also be deliberate environmental changes, such as flood protection.

Then there are the various categories of adaptation, which may include: physiological habituation (acclimatization – 'getting used to' the new climatic conditions), behavioural changes (learning to behave in ways that reduce risks of adverse effects), structural adaptation (infrastructure and other changes to meet new conditions, e.g. wider use of air conditioning in homes), and public health interventions, including ones specifically aimed at protecting vulnerable members of the community through warning systems and direct support/protection.

These various forms of adaptation may considerably modify the scale of impact for particular climatic changes by comparisons with what might be expected on the basis of simple extrapolation from current epidemiological evidence.

44



Three examples of the use of scenarios are provided in this and the following slides.

Woodruff et al. used scenarios in their modeling of projected heat-related deaths in older adults due to higher mean annual temperatures under low and higher greenhouse gas emission scenarios. From a baseline of 1100 annual deaths related to heat, and considering only the independent effect of temperature, very hot days in 2100 were projected to increase the number of deaths by 600 under a scenario of lower greenhouse gas emissions and by 2100 under a scenario of higher emissions. These projections held demographic change constant.

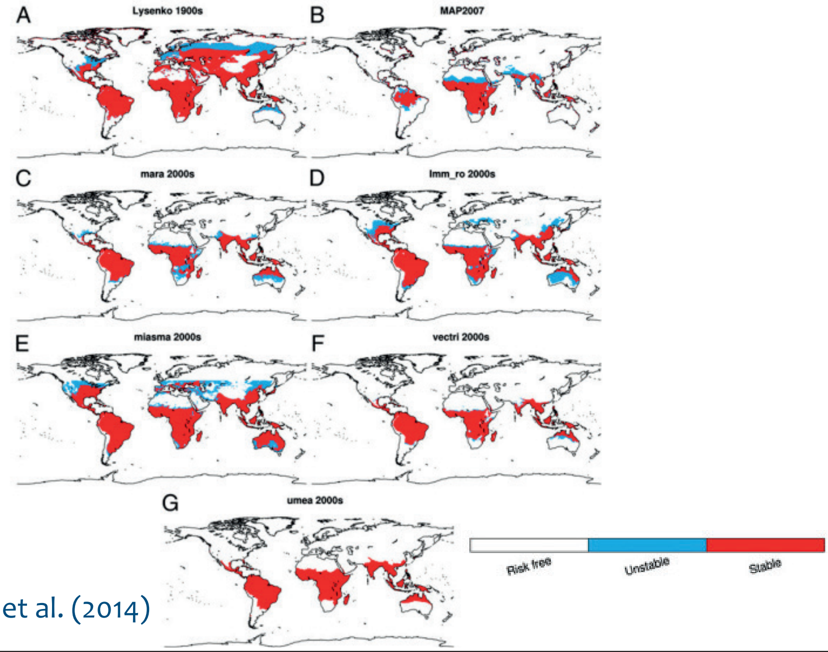
The second bar shows the independent effect of an ageing population on projected numbers of deaths (i.e. temperature was held constant). The increased number of deaths projected for the higher emission scenario is due to a larger population.

The third bar shows the combined (additive) effect of temperature and aging.

The fourth bar speculates that if there are synergistic interactions between higher temperatures and aging, that the number of deaths in 2100 may be higher than the additive effects of temperature and aging.

Source: *Woodruff et al. 2005. Climate change health impacts by 2100.*

Observed & simulated malaria distribution for five malaria models

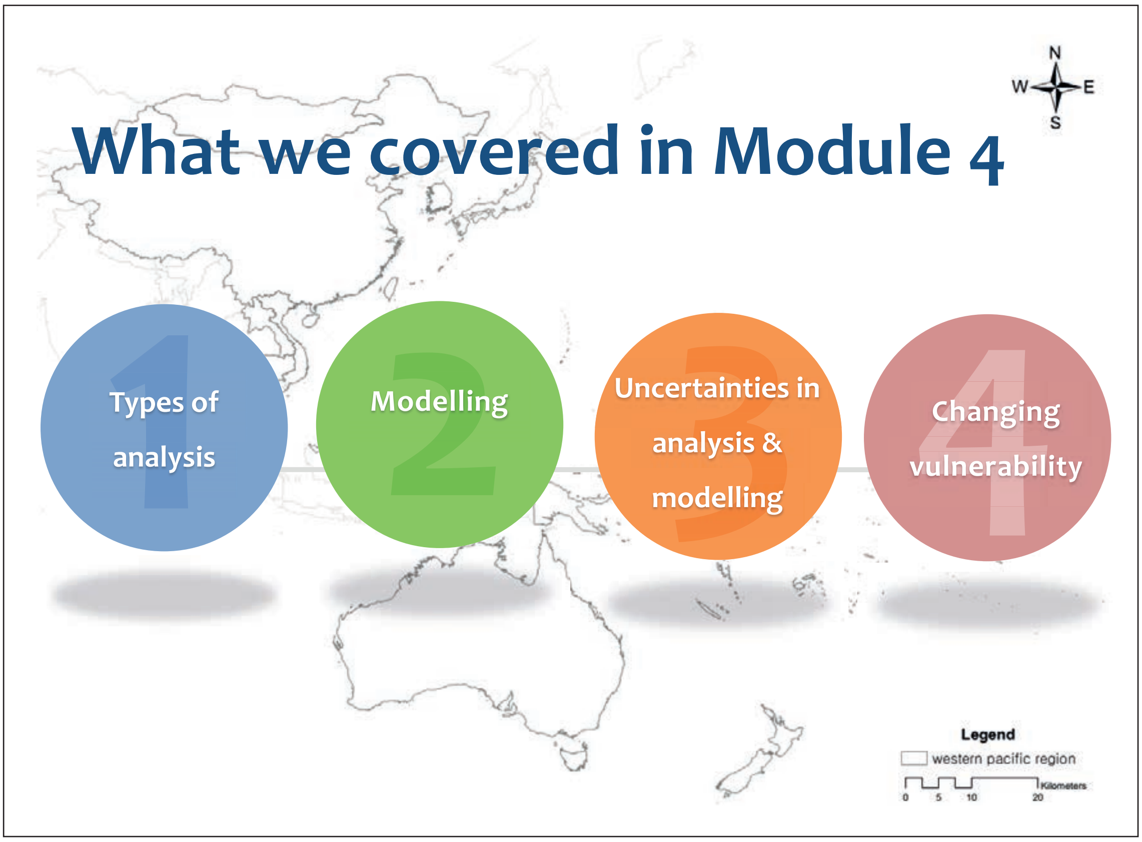


Source: Caminade et al. (2014)

Observed (*A* and *B*) and simulated malaria distribution (three categories: risk-free in white, unstable/epidemic in blue, and stable/endemic in red) for five malaria models (*C*, *D*, *E*, *F* and *G*). For the observation (*A* and *B*) all endemic subcategories (hypoendemic, mesoendemic, hyperendemic, and holoendemic) have been included in the stable category. The 1900s data (*A*) are based on ref. 38 (considers all plasmodium infections), and the 2000s data (*B*) are based on ref. 14 (considers only *P. falciparum* infections). For the simulations, unstable malaria is defined for a length of the transmission season (LTS) ranging between 1 and 3 mo, and suitable is defined for LTS above 3 mo (based on TRMMERAI control runs for the period 1999–2010; *SI Appendix*, Fig. S11 shows the CRUTS3.1 control runs). The TRMMERAI runs are constrained to span 50°N–50°S owing to the TRMM satellite data availability. For the UMEA malaria model only estimates of stable malaria were available.

Source: *Caminade et al. 2014. Impact of climate change on global malaria distribution. Proc Natl Acad Sci U S A. 2014;111(9):3286-91. doi: 10.1073/pnas.1302089111.*

46



Here's what we covered in Module 4:

1. Types of analysis of climate-related health effects
2. Modelling the health impacts of climate change
3. Uncertainty
4. Changing vulnerability

Learning from Module 4

- Observational studies are based on the time- & space-specific relationship between health effect & climate factor
- Time series studies & spatial studies are the principal methods of analyzing climate-relatedness of a specific health outcome
- Disease burden estimates model health impacts

These were the key messages we covered in Module 4: (CLICK to animate each of the three)

- Observational studies are based on the time- & space-specific relationship between health effect & climate factor
- Time series studies & spatial studies are the principal methods of analyzing climate-relatedness of a specific health outcome
- Disease burden estimates model health impacts

48

Learning from Module 4

- Weather-health relationship analysis is a basic step for predicting climate-related health effects, but it does not necessarily represent the climate effect on health
- Modelling is based on the established relationship between climate factors & a specific health effect
- Modelling is a useful tool for predicting future, but not without limits

We also learnt that:

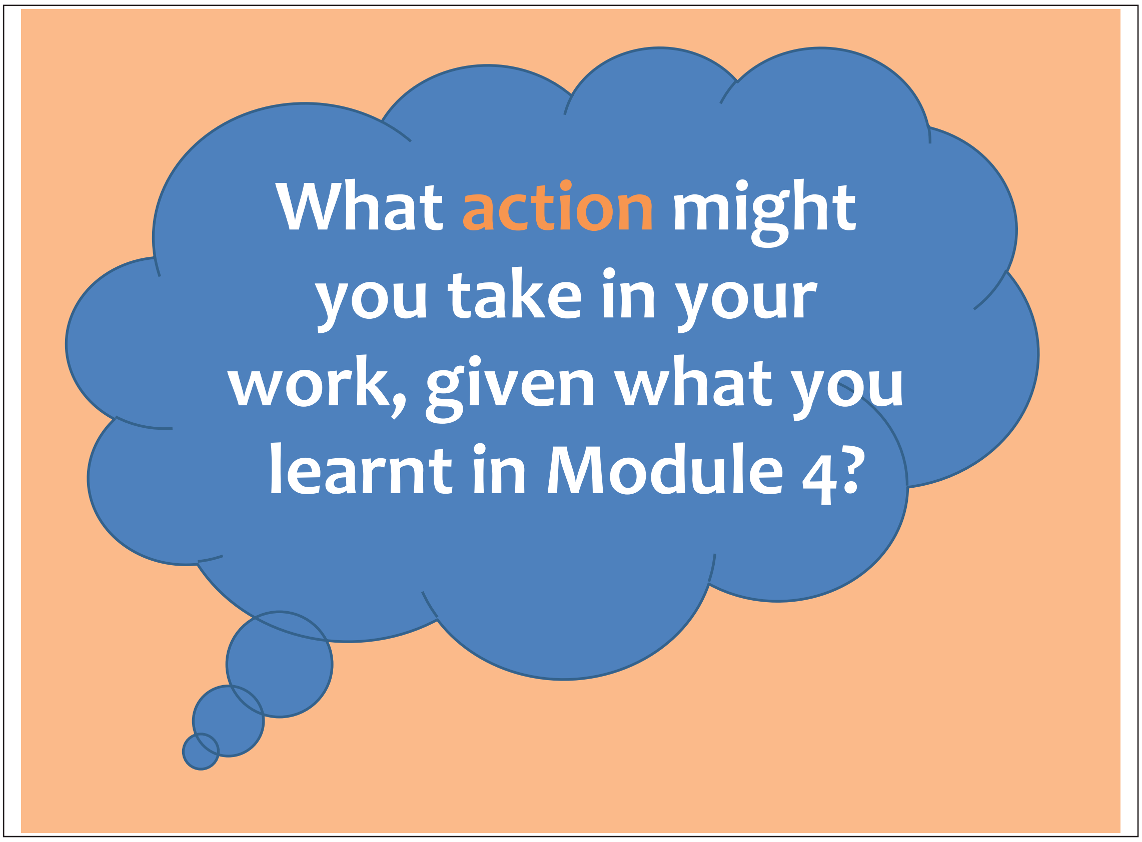
- Weather-health relationship analysis is a basic step for predicting climate-related health effects, but it does not necessarily represent the climate effect on health
- Modelling is based on the established relationship between climate factors & a specific health effect
- Modelling is a useful tool for predicting future, but not without limits

Q: Are there any questions on any of these key learnings?

Trainer note:

The first key message on this slide originally read "Weather-health relationship analysis is a basic step for the climate-related health effects, but it does not necessarily represent the climate effect on health", which doesn't make grammatical sense to me. Note that I have changed this to "Weather-health relationship analysis is a basic step in predicting climate-related health effects, but it does not necessarily represent the climate effect on health".

49



To finish off Module 4, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around the assessment & prediction of health impacts of climate change.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes**: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 5

Thermal extremes

Key learning messages in Module 5

- Extreme thermal events cause excess morbidity and mortality
  - All adverse health outcomes are preventable
  - Worker productivity likely to be adversely affected
- Climate change is projected to increase health risks with more, more severe, and longer heatwaves
  - Larger and older populations could increase the risk for additional adverse health impacts
- Adaptation can reduce current & future risks in morbidity & mortality due to temp extremes.

Estimated length: 60 minutes

Structure of Module 5

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Understanding thermal extremes	4–13	EXERCISE on slide 10: What thermal extremes are you observing in your country? Have you noticed any health impacts from thermal extremes? 4 minutes in groups of 2, standing
2. Identifying thermal extremes	14–24	
3. Who is vulnerable to thermal extremes	25–29	
4. How to assess the risks and impacts of thermal extremes	30–33	
5. Potential impacts of thermal extremes	34–39	
Module outline	40	
Learning from Module 5	41	
Learning reflection, action generation	42	

Required resources

- Data projector and slide changer
- Module 5 slides
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 5

Some of the detailed concepts related to predicting the health impacts of thermal extremes may be complex for some participants, such as 'excess' outcomes, odds ratios or relative risk estimates. Ensure understanding by watching body language, asking if anyone has any questions and, if needed, testing for comprehension.

Key terms introduced in Module 5

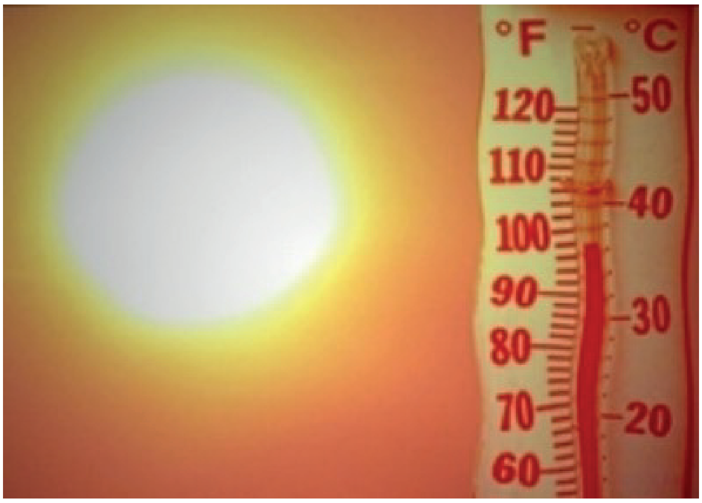
- Events vs. seasons
- Excess health outcomes
- Thermal extremes
- Fixed threshold criteria
- Relative threshold criteria
- Mortality displacement distributed lag model
- Early warning & response systems for thermal stress.

References (in order of presentation)

- IPCC. 2007. Technical Summary. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
- International Federation of Red Cross and Red Crescent Societies. 2003. *Indian heat wave claims almost 2,000 lives.* ReliefWeb. http://reliefweb.int/report/bangladesh/indian-heat-wave-claims-almost-2000-lives.
- IPCC SREX. 2012. Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
- Li et al. 2014. *Association between high temperature and mortality in metropolitan areas of four cities in various climate zones in China: a time series*. Environmental Health 2014; 13:65. http://www.ehjournal.net/content/13/1/65.
- EM-DAT- The Emergency Disaster Database. 2008. The International Disaster Database. << http://www.emdat.be/>>
- Guo et al. 2012. *Effects of temperature on mortality in Chiang Mai city, Thailand: a time series study*. Environmental Health 2012; 11:36. http://www.ehjournal.net/content/11/1/36.
- US EPA. 2006. Excessive Heat Events Guidebook, http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf
- NASA. 2008. Southern Asia Heat, http://earthobservatory.nasa.gov/IOTD/view.php?id=5603
- Heat wave in southern India, 2003, http://earthobservatory.nasa.gov/IOTD/view.php?id=3522&eocn=image&eoci=related_image

- Kalkstein, L. 2002. Personal communication with the author.
- David Mills, et al. Online Resource 6. Mortality Displacement Impacts in Health Impacts Assessment of Projected Extreme Temperatures
- Diffenbaugh, NS and Giorgi, F. 2012. *Climate change hotspots in the CMIP5 global climate model ensemble*. Climatic Change 2012. DOI 10.1007/s10584-012-0570-x.
- Murari et al. 2014. *Intensification of future severe heat waves in India and their effect on heat stress and mortality*. Reg Environ Change 2014. DOI 10.1007/s10113-014-0660-6.
- Dunne et al. 2013. *Reductions in labor capacity from heat stress under climate warming*. Nature Climate Change 2013; 3:563-566. DOI: 10.1038/NCLIMATE1827.

Module 5:
Thermal extremes



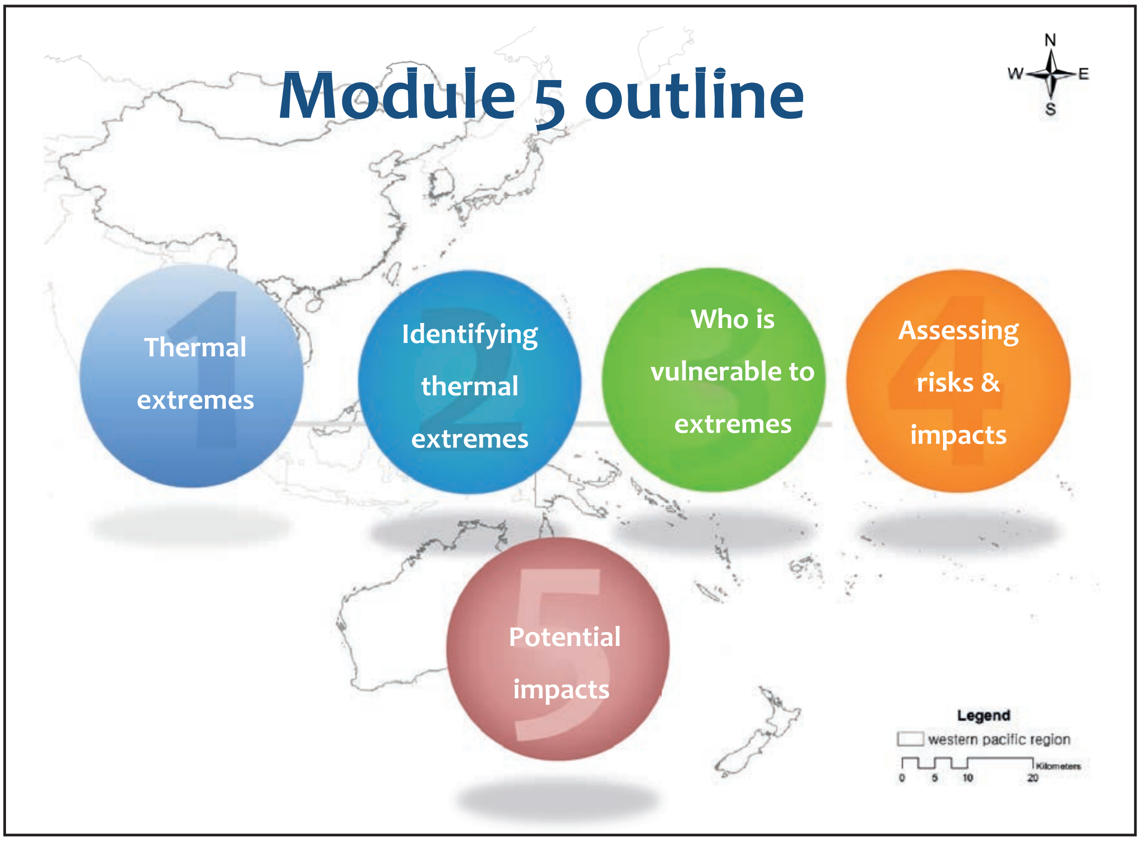
2

Key messages in Module 5

- Extreme thermal events cause excess morbidity & mortality
  - All adverse health outcomes are preventable
  - Worker productivity likely to be adversely affected
- Climate change is projected to increase health risks with more, more severe, & longer heatwaves
  - Larger & older populations could increase the risk for additional adverse health impacts
- Adaptation can reduce current & future risks in morbidity & mortality due to temp extremes

This slide notes some of the key concepts that we'll cover in Module 5

3



This module's goal is to help you start to think about:

- What defines an extreme thermal event;
- Who is at greatest risk during these events;
- How should the health impact of these events be measured;
- How climate change could affect the future risk of these events.
- These elements will build to a consideration of how adaptation measures, particularly early warning and response programmes for extreme thermal events, could help reduce future adverse health outcomes.

We'll therefore break things down into these five sections in Module 5:

1. Understanding thermal extremes
2. Identifying thermal extremes
3. Who is vulnerable to thermal extremes
4. How to assess the risks and impacts of thermal extremes
5. Potential impacts of thermal extremes.

4

1

Understanding thermal extremes

5

Key concepts

Events vs. seasons

Thermal extremes focus on relatively short-lived weather conditions (generally days) that are in the 'tails' in distributions summarizing annual or seasonal weather

Excess health outcomes

Defined as the difference in the number/rate of outcomes during thermal extremes compared with what would be expected if the event had not occurred. This is assumed to reflect the health impact of the extreme temperatures.

A critical element when evaluating thermal extremes is to remember the differences between short-term weather anomalies vs. longer-term changes in seasonal conditions. Thermal extremes, including extremely cold and heat, are by definition relatively rare. What is extreme in one location is not necessarily extreme elsewhere, hence the need for local definitions of what constitutes an extreme event.

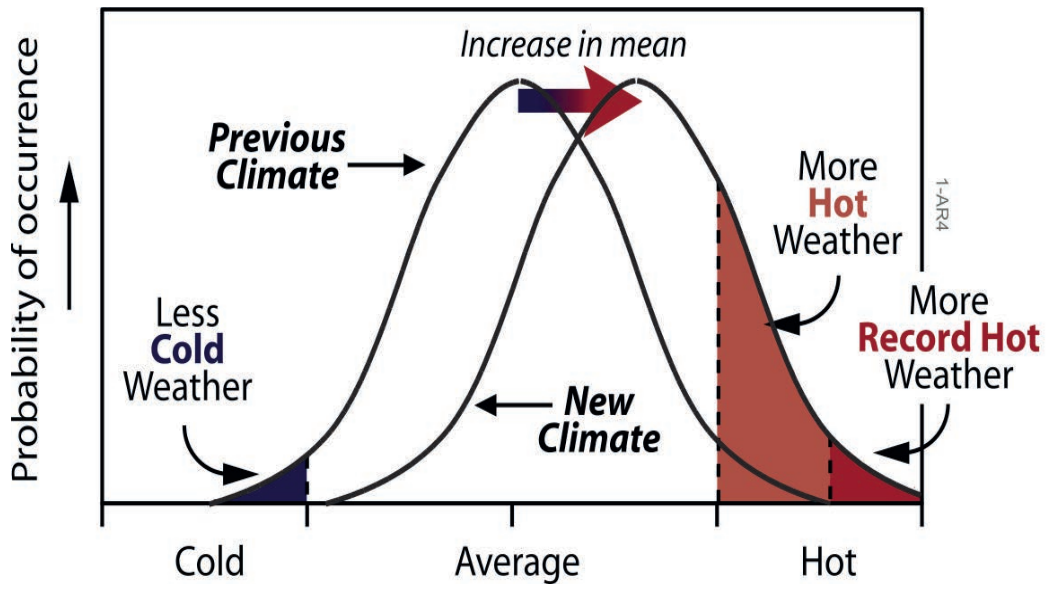
CLICK *to show 'Excess health outcomes'.* Excess health outcomes also is a critical concept. Death certificates and visits to health care providers rarely include temperature extremes as an underlying cause, so it is difficult to determine the exact number of adverse health events. Instead, the number of excess health outcomes determines the impact of an event; this is the difference in the number or rate of outcomes during the event, compared with what would have been expected if the event had not occurred. Not all observed health outcomes during an event should be attributed to the weather conditions.

Differences from that baseline during and shortly after the extreme thermal event provide a means to measure the event's severity and an opportunity to evaluate who was most vulnerable to the event.

6

Climate change: temperature distribution shifts to more heat

Source: IPCC (2007)



This schematic shows how climate change could increase not only mean temperatures, but also more record hot weather and less record cold weather. This figure assumes the variance remains the same, the only change is a shift in mean temperatures.

However, observations indicate that both the mean and variance of temperature are changing. This means the curve is being flattened and extended further to the right, resulting in even more hot and record hot weather. At the same time, the risk of very cold weather remains.

Source: *IPCC 2007. Technical Summary. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

7

The 2003 heatwave in India

- Temperature climbed as high as 50°C, some 10° degrees higher than normal
- Heat waves claimed more than 1,900 lives across India, 70 in Pakistan & 40 in Bangladesh in three weeks
- Of the 1900 in India, Andhra Pradesh alone saw over 1300 deaths
- Women, children & the elderly were among the most who died

Heatwaves cause excess mortality in every country that has analyzed data, including countries not traditionally thought of as places where heatwaves would be a concern. As shown on the slide, a heatwave occurred in India in 2003 that resulted in more than 1900 excess deaths.

Higher temperatures increase the occurrence of heat-related illnesses such as heat exhaustion and heat stroke, and exacerbate existing conditions related to circulatory, respiratory, and nervous-system problems. An increase in heatwaves, particularly in urban areas, could significantly increase deaths. Higher overnight temperatures during heatwaves are a concern for human health, as cooler temperatures at night offer much-needed relief from the heat of the day.

Source: *International Federation of Red Cross And Red Crescent Societies. 2003. 'Indian heat wave claims almost 2000 lives'. ReliefWeb,* **http://reliefweb.int/report/bangladesh/indian-heat-wave-claims-almost-2000-lives**

8

The 2003 heatwave in Andhra Pradesh

Temperatures in Andhra Pradesh India soared to 54°C & took a toll of at least 3000 lives

Photo: Refugee Study Centre

Recent analyses show that human-induced climate change is increasing the frequency, intensity, and duration of heatwaves (IPCC SREX 2012).

Eighteen heatwaves were reported in India between 1980 and 1998. A heatwave in 1988 caused 1300 deaths (De et al. 2004), while another one in 2003 caused more than 3000 deaths (Government of Andhra Pradesh 2004). High mortality occurred in rural populations and among the elderly and outdoor workers.

Photo credit: *Refugee Study Centre (RSC), http://www.rsc.ox.ac.uk/*

IPCC SREX. 2012. Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

9

Impacts of thermal extremes

It's too hot to work for cart pullers in New Delhi

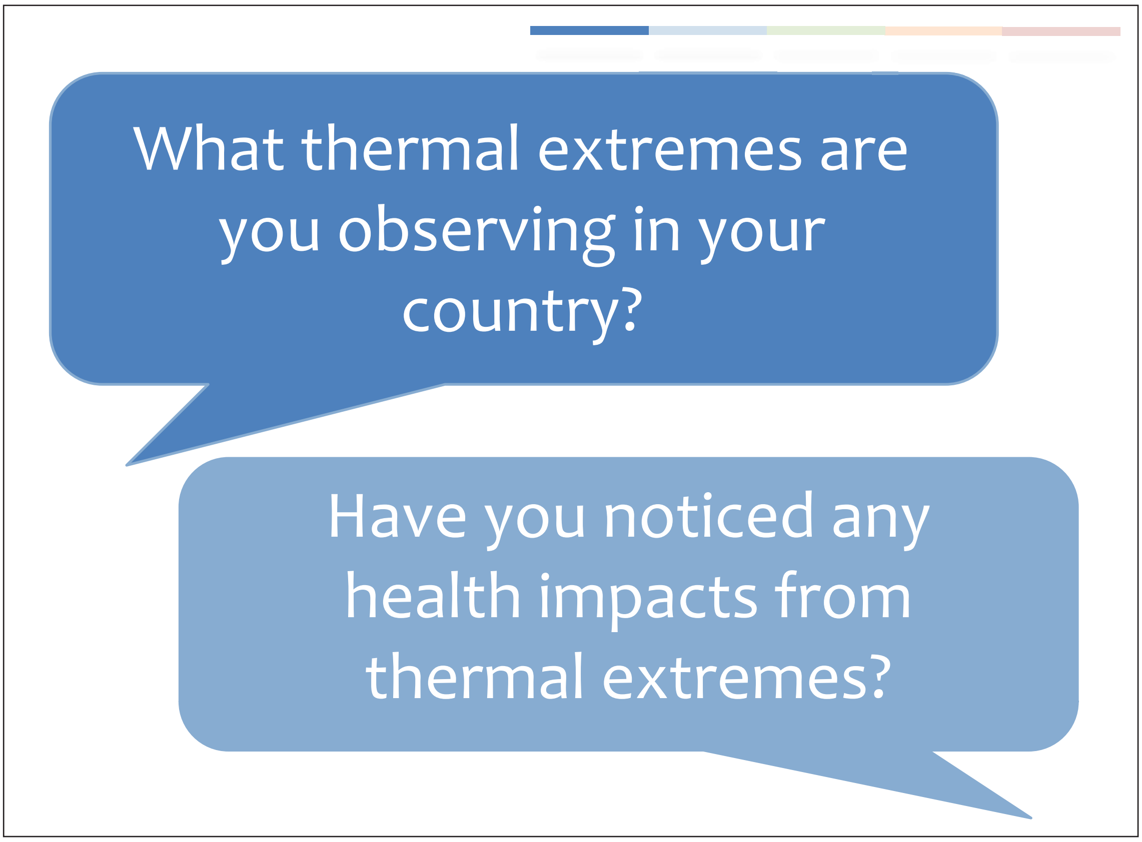
Photo: CBS News (2002)

The health impacts of thermal extremes are not limited to mortality. There are significant adverse social impacts with reduced worker productivity.

Photo: BBC News (2000)

These images are from heat events in India. This slide also points out that while there is a tendency to focus on the mortality impact of thermal extremes, these events also have significant impacts on morbidity and can reduce productivity as people limit activities in an attempt to control exposure to the heat.

10



We've looked at an example for India. I'm interested in recent thermal extremes you might have experienced in your own countries, and any impacts you're seeing.

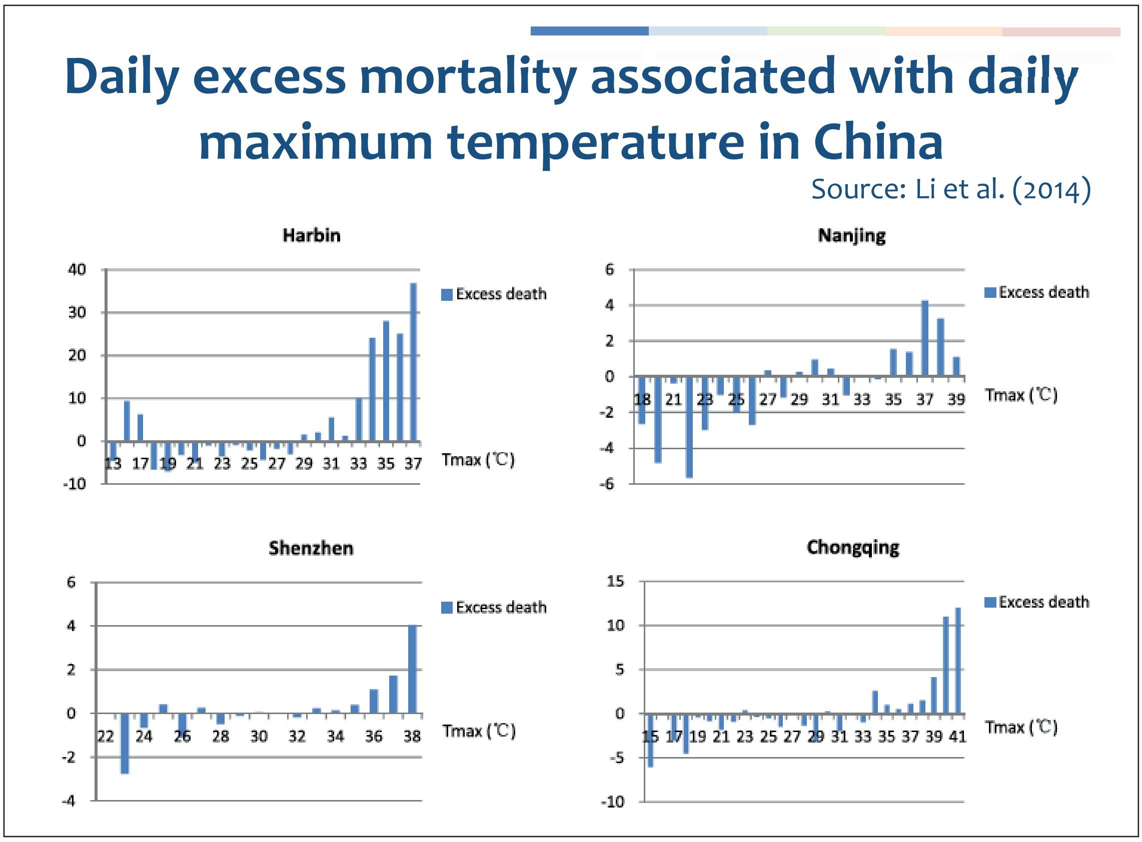
Please find someone a nearby table to chat with, ideally someone from a different region or country from yourself, and discuss these two questions over the next **4 minutes**. This is a good opportunity to stand and stretch while you talk, if anyone would like to have a standing discussion.

Give time reminder: **3 mins** – "You have another minute to finish off your discussion."

4 mins – "Ok I'll ask you to go back to your seats"

Q: Did you learn about thermal extremes that are occurring in other people's countries or region? Would anyone like to share what they learnt from someone else? Gather 3 – 4 quick examples. Thank those who presented.

11



Here's another example, this time from China.

These figures show the mean daily excess mortality associated with daily maximum temperature in four Chinese cities: Harbin, Nanjing, Shenzhen, and Chonguing. The increase in mortality with increasing temperature is evident, as is the variability across regions in the temperature thresholds at which mortality begins to increase significantly.

The temperature thresholds for all-cause mortality were 29°C, 35°C, 33°C and 34°C for Harbin, Nanjing, Shenzhen and Chongqing, respectively. After adjusting for potential confounders including air pollution, strong associations between daily maximum temperature and daily mortality from all-cause, cardiovascular, endocrine and metabolic outcomes, and particularly diabetes, were observed in different geographical cities, with increases of 3.2-5.5%, 4.6-7.5% and 12.5-31.9% (with 14.7-29.2% in diabetes), respectively, with each 1°C increment in the daily maximum temperature over the threshold. A stronger temperature-associated mortality was detected in females compared to males. Additionally, both the population over 55 years and younger adults aged 30 to 54 years reported significant heat-mortality associations.

Source: *Li et al. Association between high temperature and mortality in metropolitan areas of four cities in various climate zones in China: a time series. Environmental Health 2014;13:65. http://www.ehjournal.net/content/13/1/65*

12

Mortality impacts of thermal extremes: vulnerable countries

MOST PEOPLE KILLED BY EXTREME TEMPERATURE DISASTERS

Rank	Territory	Value	Rank	Territory	Value
1	Greece	3.8	11	India	0.26
2	Cyprus	2.7	12	Pakistan	0.20
3	Albania	0.8	13	Russian Federation	0.18
4	Mexico	0.4	14	Romania	0.18
5	Afghanistan	0.4	15	Serbia & Montenegro	0.15
6	Lithuania	0.4	16	Jordan	0.11
7	Poland	0.4	17	Kyrgyzstan	0.08
8	Croatia	0.3	18	Uruguay	0.08
9	United States	0.3	19	Spain	0.07
10	Bangladesh	0.3	20	Peru	0.06

*people killed per million people per year 1975-2000**

Source: EM-DAT (2008)

India and Bangladesh are among the countries most vulnerable to extreme thermal conditions.

Using population estimates that are consistent with the time period covered by these tables (India 1050 million and Bangladesh 144 million), these results suggest roughly 273 heat-related deaths per year for India and 43 for Bangladesh.

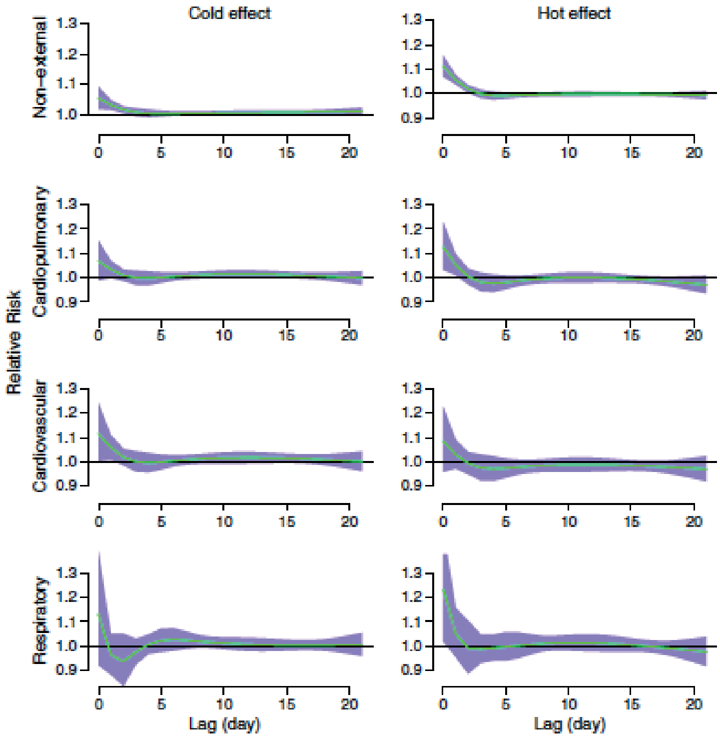
Critical features of these events include that they do not follow a predictable temporal distribution and that impacts can vary widely by event. While across India there is relatively consistent reporting of extreme heat events each year, the number deaths and location of the events vary widely.

Source: *EM-DAT Emergency Disaster Database, 2008. The International Disaster Database. << http://www.emdat.be/>>*

13

Chiang Mai, Thailand:

Estimated cold & hot effects of mean temperature on cause-specific mortality



Source: Guo et al. (2012)

These graphs illustrate several issues with studying the impacts of thermal extremes:

Hot and cold extreme temperatures increase mortality even in a warm city such as Chiang Mai.

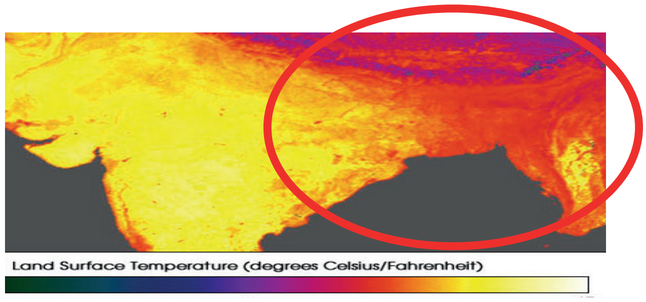
The study found non-linear effects of temperature on all mortality types and age groups, with excess deaths starting to occur on the same or subsequent day of an extreme even. Generally, the hot effects on various cause of mortality and age groups were short-term, while the cold effects lasted longer. There often was a decrease in mortality several days after an event, so-called mortality displacement, that reflects that some of the deaths during the event were in individuals who would have died within a short time period anyway. This displacement needs to be taken into consideration when estimating total excess mortality from an event; the reduction in deaths needs to be included in any analysis.

The relative risk of mortality associated with cold temperatures (19.35°C, 1st %ile of temperature) relative to 24.7°C (25th %ile of temperature) was 1.29 (95% confidence interval (CI): 1.16, 1.44) for lags 0–21. The relative risk of mortality associated with high temperature (31.7°C, 99th %ile of temperature) relative to 28°C (75th %ile of temperature) was 1.11 (95% CI: 1.00, 1.24) for lags 0–21.

Source: *Guo et al. Effects of temperature on mortality in Chiang Mai city, Thailand: a time series study. Environmental Health 2012;11:36. http://www.ehjournal.net/content/11/1/36*

14

2



How to identify thermal extremes

Let’s now look at how you identify thermal extremes

15

Identifying extreme thermal conditions

- Evaluating meteorological data against established criteria (e.g. threshold temperatures, comfort indices, historical distributions)
- Analyzing observed health impacts
- Combining meteorological & health impact assessment

There are several approaches for identifying extreme thermal events, as listed on the slide.

The results of using different approaches as well as their relative advantages and drawbacks are presented in the following slides.

16

Meteorological options to identify extreme thermal conditions

Fixed threshold criteria

Extreme thermal conditions exist when criteria are exceeded at any point in time, for example:

- Extreme heat if temperature is > 40°C
- Extreme cold if temperature is < -10 °C
- Temperatures exceed a seasonal distribution value (e.g. 5th or 95th percentile)
- A temperature threshold is associated with increased adverse health outcomes

There are two broad categories of approaches to identifying thermal extremes using observed/forecast meteorological conditions: Fixed threshold criteria and relative threshold criteria.

Fixed threshold criteria use non-varying values for temperature, or combined measures such as humidex or apparent temperature, to define when conditions would be defined as extreme heat or extreme cold. The humidex, heat index, apparent temperature, and other combined variable measures combine temperature, humidity, and other variables to provide a measure of how the temperature feels and/or to quantify the associated physical discomfort and health risk for hot weather. Estimates of the temperature adjusted for wind chill provide a similar example of an index used for extremely cold temperatures.

17

Meteorological options to identify extreme thermal conditions

Relative threshold criteria

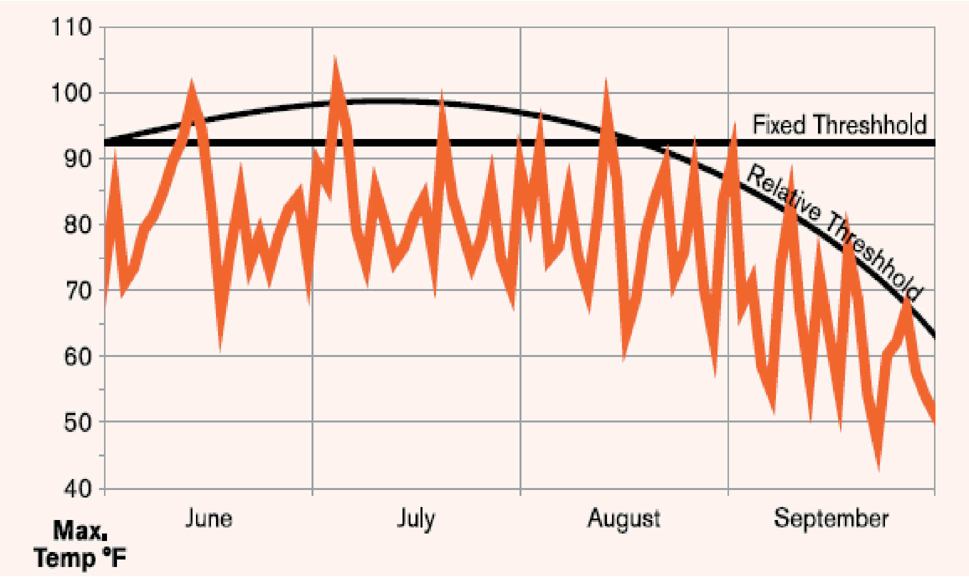
Criteria for extreme thermal conditions vary by location and/or time of season

- Recognize that perceptions of what is exceptionally "hot" & "cold" vary across locations

Relative criteria use threshold measures that vary by location and time of season to identify extreme thermal conditions. In areas with minimal thermal variation, where there is also generally low health risk and minimal health impacts from extreme thermal events, there might be no effective difference in a fixed or relative threshold. In areas where "normal" conditions vary over the course of a season, the use of relative thresholds can result in criteria that also vary considerably within a season.

18

Identifying thermal extremes using fixed & relative thresholds



Source: US EPA (2006)

This hypothetical example shows how the use of fixed and relative thresholds would result in different periods within a summer meeting the criteria for "extremely hot". Extreme thermal event conditions and impacts are measured against local baselines. In this example, the relative threshold is based on the daily maximum temperature. The threshold value initially increases in the early part of the summer season and then declines from roughly mid-July through the end of September. As a result, a number of days in September would fail to satisfy the established fixed threshold criteria, yet would satisfy the relative threshold criteria for being considered extremely hot.

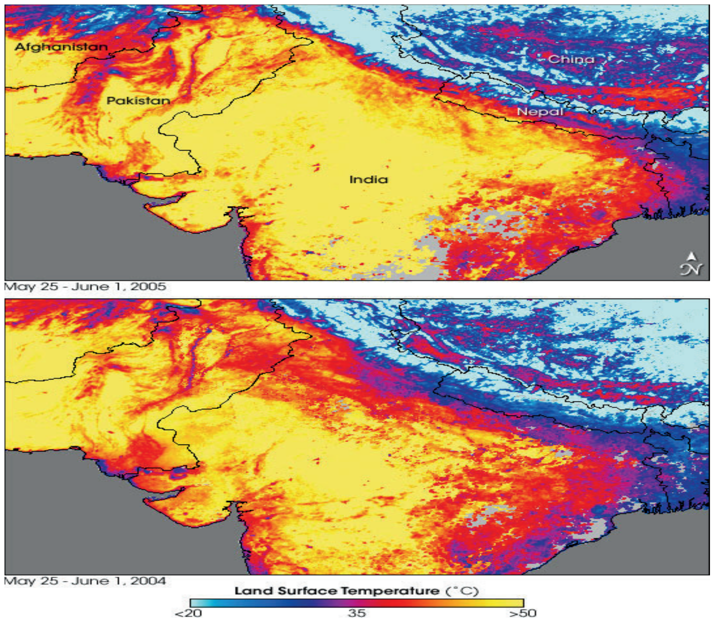
Source: *US EPA 2006. Excessive Heat Events Guidebook, http://www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf*

19

Extreme heat & relative thresholds: India, May 2005

Upper image shows the start of an Indian heat wave in May 2005 when compared with the same area at the same time in 2004.

Note the expanded yellow areas in 2005.



Source: NASA (2008)

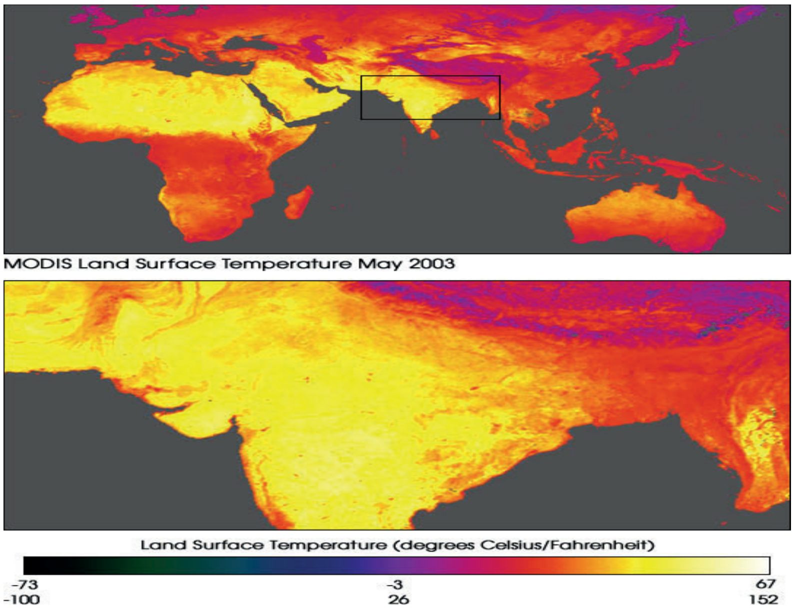
This provides an example of how relative thresholds could be used to identify extreme thermal conditions. This figures compare satellite-based thermal images for part of South-Eeast Asia from the end of May in 2004 (bottom image) and 2005 (top image). The contrast shows the increased area of yellow throughout Northern and Western India. These regions would be considered "hot" by many, with the heatwave further pushing up temperatures to over 50C in many regions. This heatwave was responsible for over 200 deaths across the region (EM-DAT, 2008).

Source: *NASA 2008. Southern Asia Heat, http://earthobservatory.nasa.gov/IOTD/view.php?id=5603*

20

Extreme heat & fixed thresholds: India in 2003

India in 2003 had the same temperature signal as the Sahara desert: ≥50°C



Source: NASA (2008)

Unlike other extreme weather events, it is difficult to visually convey the conditions during an extreme thermal event on the ground (e.g. heat ripples coming off surfaces, potential warping of train rails). These images attempt to visually convey what an extreme heat event in India during May 2003 looked like using satellite data for land temperatures. The focus is on the comparison of thermal images for part of India, in the box in the top image and the whole bottom image, with the temperatures recorded in the Sahara desert in Africa. During this event in India, temperatures in both areas were similar and were above 50°C.

This is an example of using a fixed threshold criteria to identify extreme thermal conditions.

Source: *NASA 2008 Heat wave in southern India, 2003, http://earthobservatory.nasa.gov/IOTD/view.php?id=3522&eocn=image&eoci=related_image*

21

Identifying thermal extremes based on health impacts

- Significant increases in health outcomes can be used to identify thresholds for extreme thermal conditions
- Increases should be evaluated vs. localized norms that account for the time of year
- Evaluate the historical relationship between weather & health outcomes (e.g. daily mortality) to establish criteria for extreme conditions

A more direct approach to identifying extreme thermal conditions is to consider health outcome data along with meteorological data to identify when excess health outcomes are observed. This approach looks for anomalies in health outcome data and then decides if the conditions are extreme. This can be used to identify thresholds for use in early warning systems.

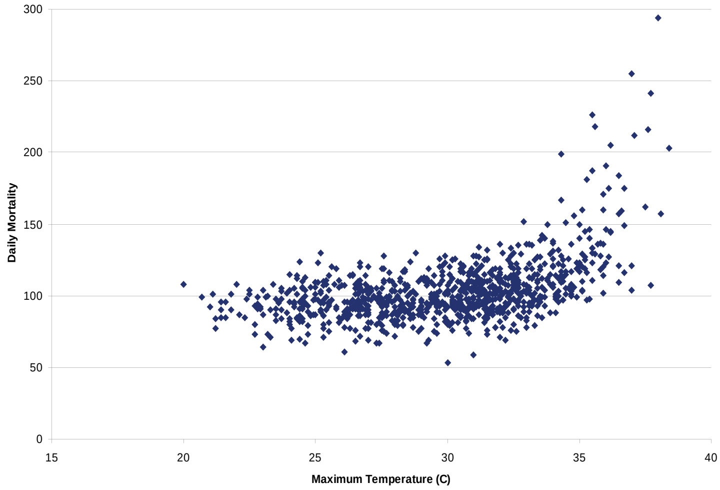
This approach is similar to the relative threshold idea but by considering health outcomes, it provides a focus on identifying conditions that are exceptional in a meteorological sense and that carry increased risk of adverse health risks/impacts.

22

Identifying thermal extremes using weather & health data

Scatter plot of daily maximum temperature & total mortality (to help identify possible summertime threshold temperatures for extreme heat) in Shanghai, China

Maximum temperature & daily summer mortality 1980–1989



Source: Kalkstein (2002)

This example shows how a scatter plot of total daily deaths versus daily maximum temperature could be used to identify a city-specific threshold of summertime temperature that was used to define extreme heat conditions when developing an early warning system.

As you can see, daily mortality starts increasing rapidly at about 35°C. This is an initial value to consider in setting an extreme heat threshold for Shanghai.

Source: *L.Kalkstein, personal communication, 2002*

23

Options for identifying extreme thermal conditions: Using observed health outcomes

Strengths:

- Certain: if you observe 'significant' impacts you know extreme thermal conditions exist

Weaknesses:

- Reactive: need to rely on real-time data to identify dangerous conditions
- Requires accurate, comprehensive & timely health outcome reporting systems
- Lagged notification & response: outcomes a result of exposure so dangerous conditions already experienced before warning is provided
- Short-term resource commitment to monitoring vs response might be better balanced

What are the strengths and weaknesses of using observed health outcomes to identify extreme thermal conditions?

Strengths (**CLICK** to appear)

Relying solely on observed health outcome data to identify extreme thermal conditions has the advantage of certainty. However, this comes at a price in terms of the sensitivity of results to the accuracy of the data provided and foregoing opportunities to identify extreme thermal conditions in advance.

Weaknesses (**CLICK** to appear)

Considering the relative ease of access to accurate long-range meteorological forecasts (i.e., conditions two to three days out) this is an extremely high price to pay for certainty. At the same time, programmes designed to address these events should work to ensure the availability of health outcome data during an event because they can be used to help adjust the level and location of resources being committed to managing the event.

24

Options for identifying extreme thermal conditions: Using combined meteorological & health impact data

Strengths:

- Accurate: any criteria will be based on periods of interest where weather significantly increased health impacts
- Flexible: various assessment methods can be used depending on available data (visual evaluation, regression)
- Proactive: with criteria established, it is possible to evaluate weather forecasts for dangerous conditions

Weaknesses:

- Approach can be difficult to explain
- Outreach & education messaging can be complicated

The recommended approach to identifying extreme thermal events is to consider health outcome data along with meteorological data whenever possible. This approach has the advantage of combining all available and relevant information to identify conditions of interest while having a range of options for actually completing the evaluation.

Strengths (**CLICK** to appear) – read

Weaknesses (**CLICK** to appear) – read

Results from these assessments can still be combined with weather forecasts to provide advance warning of conditions that are expected to be dangerous. Depending on the nature of the evaluation, the study results also could be combined with forecasts to predict the severity of the conditions based on past outcomes, to help guide resource allocation decisions for notification and response programmes.

25

3

Who is vulnerable to thermal extremes?

As health professionals it's important that we have an understanding of who is vulnerable to thermal extremes, so let's look at that now.

26

Factors associated with increased vulnerability

- Extreme age: older & younger individuals
- Poverty
- Lack of technology/adaptability
- Low level of fitness
- Physical or mental impairment
- Social isolation
- Chronic conditions
- Use of specific medications
- Extended direct exposure to ambient heat/cold

This slide provides a summary of characteristics that epidemiological studies, physiological studies, and studies of particular extreme heat events have identified as placing individuals at risk of experiencing adverse health outcomes during extreme thermal conditions, particularly extreme heat. Generally, any combination of factors that either increases exposures to high ambient temperatures or limits either the physical ability to respond to the conditions or the types of responses undertaken, will increase the risk of an adverse health outcome.

27

Managing the risks of thermal extremes

Risk factor	Risk management / adaptation
Lack of access to cooling	• Cooling in public facilities • Changes in urban infrastructure
Age	• Heatwave early warning systems
Pre-existing health conditions	• Social care networks
Poverty & isolation	• Urban green spaces

There are a wide range of options for managing the risk of thermal extremes; some are shown on this slide.

This slide can be used to ask participants what their city or country is doing to increase resilience to extreme temperatures, heat and cold.

28

Factors increasing risk of thermal extremes in a changing climate

- Larger populations
- Larger elevated risk groups (old, young, poor)
- Expect more & more severe extreme heat events
- May reach exposure thresholds without adaptation

In considering future health impacts of extreme thermal conditions, it is important to recognize that anticipated trends will increase many of the factors that affect the risk of experiencing adverse health outcomes, as listed on this slide. Larger and older populations, with more individuals at increased vulnerability because of chronic diseases, obesity, and other factors means more morbidity and mortality from extreme thermal events without climate change.

29

Factors reducing the risk of thermal extremes in a changing climate

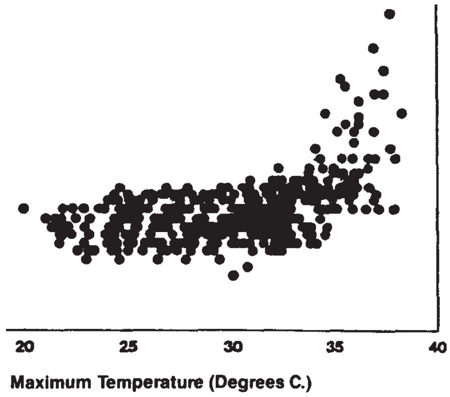
- Anticipated increase in standard of living
- Early warning & response systems
- Urban green spaces
- Infrastructure better designed for higher temperatures
- Cooling in public facilities
- Social care networks

A number of factors will work to reduce the risks of thermal extremes. A major issue with projecting future health outcomes from extreme thermal conditions is that the nature and effectiveness of future adaptation to these events is uncertain. Increases in standards of living, greater implementation of early warning and response systems, and adaptive responses can minimize future risks.

A critical element of the success of these programmes is how well any messages and programme activities reach the most vulnerable, and how well these are taken up by vulnerable individuals and communities.

30

Assessing the health risks & impacts of thermal extremes



How do we assess the health risks and impacts of thermal extremes? We'll focus on different assessment methods in section 4.

31

Quantifying the health impacts of thermal extremes

- Develop & use estimates of ‘excess’ outcomes instead of counts based on listed medical condition codes for thermal exposure
- Generate odds ratios or relative risk estimates for changes in thermal measures or combinations of meteorological conditions
- Conditional results can be generated (e.g. risk by age of persons affected, by thermal threshold)

As discussed earlier, excess health outcomes are the appropriate measure for quantifying the impacts of extreme thermal conditions. A significant drawback in basing estimates of health impacts attributable to the thermal exposure on only those health outcomes coded as being attributable to thermal conditions in ICD-10 codes is that they are generally believed to undercount the relevant health outcomes. Outcomes will be missed when, for example, high ambient temperature exacerbated a heart condition, causing a heart attack. Health care professionals would record the heart attack but are highly unlikely to include the heat as a contributing factor. Using all recorded outcomes and looking for the variation from baseline levels will provide a more comprehensive assessment of the total number of outcomes attributable to the heat.

32

Quantifying health impacts in air mass-based studies

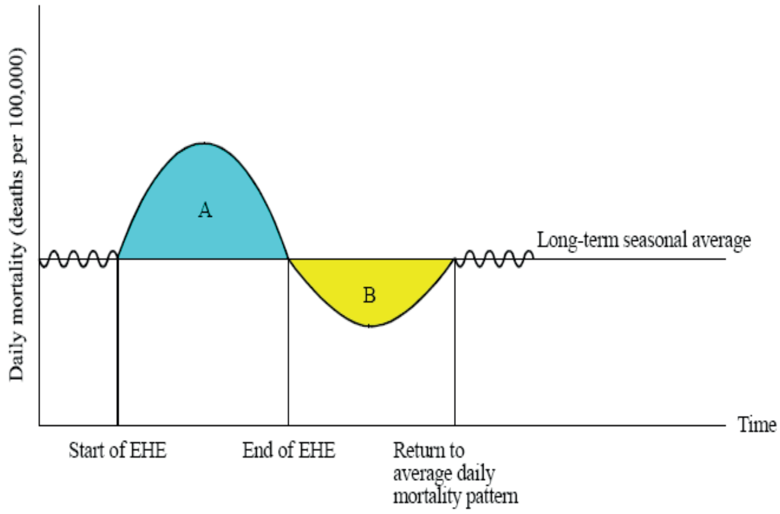
- Air masses capture distinctions in weather considering multiple meteorological variables (e.g. temperature, humidity, wind speed)
- Map the air masses over the time period of interest
- Compare health outcomes, by air mass, with longer-term averages
- Air masses with elevated outcome rates may identify extreme thermal conditions
- Regression analysis can be used to predict health outcomes given conditions in an air mass

Air mass-based studies approach the task of identifying thermal extremes and quantifying their impacts by first categorizing weather into combinations of characteristics distinguished mostly by heat and humidity levels. Different air mass groups are then evaluated for their relationship with health outcomes, with those having such a relationship being used to identify thermal extremes.

Results of the analyses can then be used in early warning systems based on forecast weather data.

Mortality displacement distributed lag model

Example reflects extreme thermal conditions that result in **excess mortality (A)** followed by **reduced mortality (B),** indicating 'mortality displacement'



This figure provides a hypothetical representation of what might be seen during and after an extreme thermal event. Note that EHE stands for extreme heat event. Key elements to note are the increase in daily mortality at approximately the start of the event with a peak at some point during the event (area marked in Blue as "A"). The height of the peak and the width of the base will generally be functions of the severity and duration of the event.

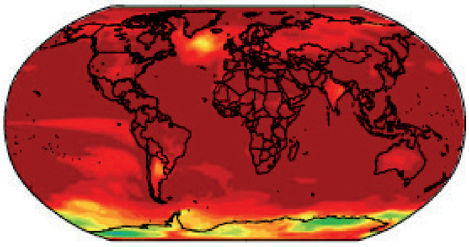
Following the return to expected mortality at the end of an event, there is a smaller decrease in mortality below baseline conditions (area in yellow marked as "B"). This decline in mortality is because some of the individuals who died in the event would have died anyway within a few days; the event brought their deaths forward. This effect is described in the epidemiology literature as "mortality displacement" or "harvesting". The greater the relative size of area "A" to area B, the greater the overall impact of the event.

Note that while thermal extremes are expected to affect morbidity and mortality in a population, research has tended to focus on mortality. In large part this reflects the relative quality and accessibility of mortality data compared with acute health outcome data (e.g., emergency room or hospital visits).

Source: *David Mills, et al, Online Resource 6. Mortality Displacement Impacts in Health Impacts Assessment of Projected Extreme Temperatures*

34

5

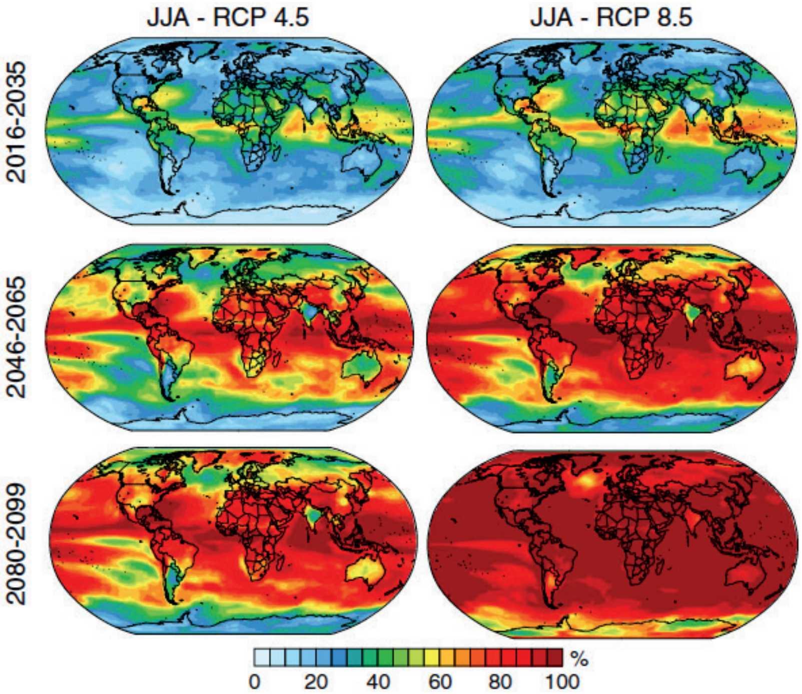


Potential impacts of thermal extremes

Lastly, let's look at the potential impacts of thermal extremes on health

35

Projected occurrence of max. temperatures
(% of years in each period)



Source: Diffenbaugh & Giorgi (2012)

These figures show how maximum temperatures could change in summer months (June, July, and August – JJA) over the course of the century under two emission scenarios. The analysis first determined the maximum temperature that occurred once every 20 years during the period 1985–2005. Then for the months June, July, and August for the time periods shown (next few decades, mid-century, and end of century), under a moderate and high emission scenario, the experiments determined how often that temperature could occur. The color bar at the bottom shows the absolute occurrences as the percent of years in each 20-year period. The frequency of occurrence of the 1986–2005 maximum JJA seasonal temperature value is, by definition, 5% at each grid point during the 20-year 1986–2005 period.

Within the next few decades, many regions in the low and mid-latitudes could experience the 1 in 20 year temperature up to every other year. By mid-century, even under the moderate emissions scenario, the temperature could occur every year. By the end of the century for both scenarios and under a high emissions scenario by mid-century, that temperature could occur every year.

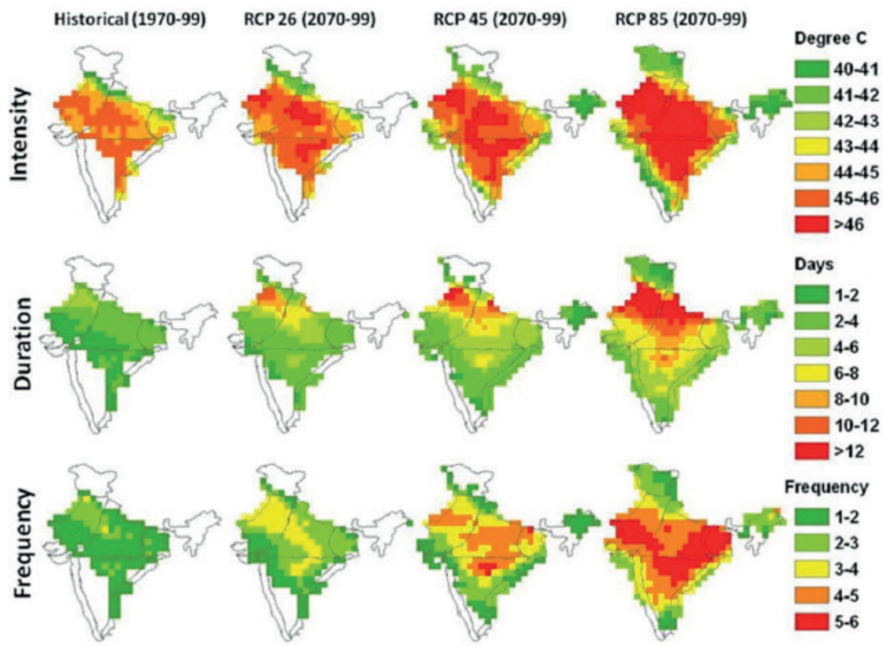
The panels show the absolute occurrences as the percent of years in each 20-year period. The frequency of occurrence of the 1986–2005 maximum JJA seasonal temperature value is, by definition, 5 % at each grid point during the 20-year 1986–2005 period.

Climate change will fundamentally change the nature of summer months.

Source: *Diffenbaugh NS, Giorgi F. Climate change hotspots in the CMIP5 global climate model ensemble. Climatic Change 2012. DOI 10.1007/s10584-012-0570-x*

36

Projected changes in heatwaves in India

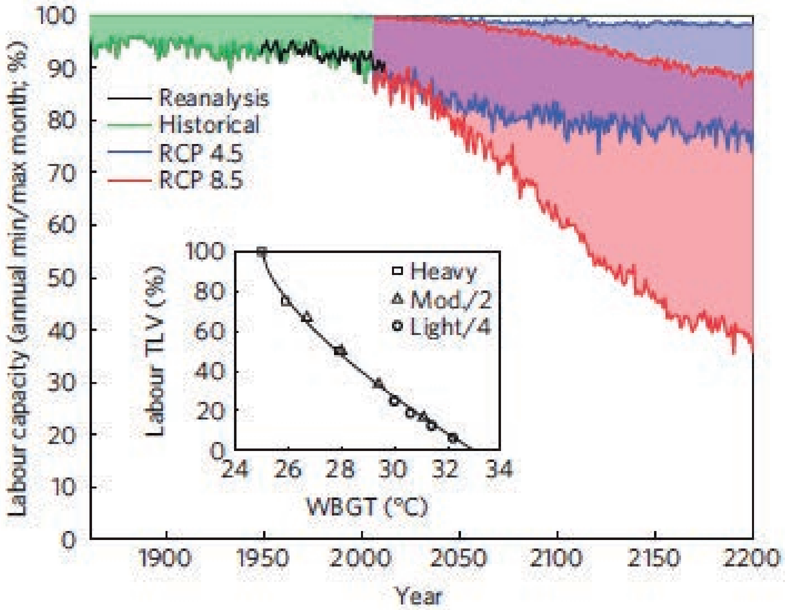


Source: Murari et al. (2014)

These figures show historical and projected changes in heatwaves in India using three emission scenarios; projections are for changes in the frequency, duration, and intensity. Heatwaves are projected to be more intense, have longer durations and occur at a higher frequency and earlier in the year. Projections indicate that a sizable part of India will experience heat stress conditions in the future. Southern India, currently not influenced by heatwaves, is expected to be severely affected by the end of the twenty-first century. In northern India, the average number of days with extreme heat stress condition during pre-monsoon hot season could reach 30. The intensification of heat waves might lead to severe heat stress and increased mortality.

Source: *Murari et al. Intensification of future severe heat waves in India and their effect on heat stress and mortality. Reg Environ Change 2014. DOI 10.1007/s10113-014-0660-6*

Population-weighted individual labor capacity (%) during annual minimum (upper lines) & maximum (lower lines) heat stress months



Source: Dunne et al. (2013)

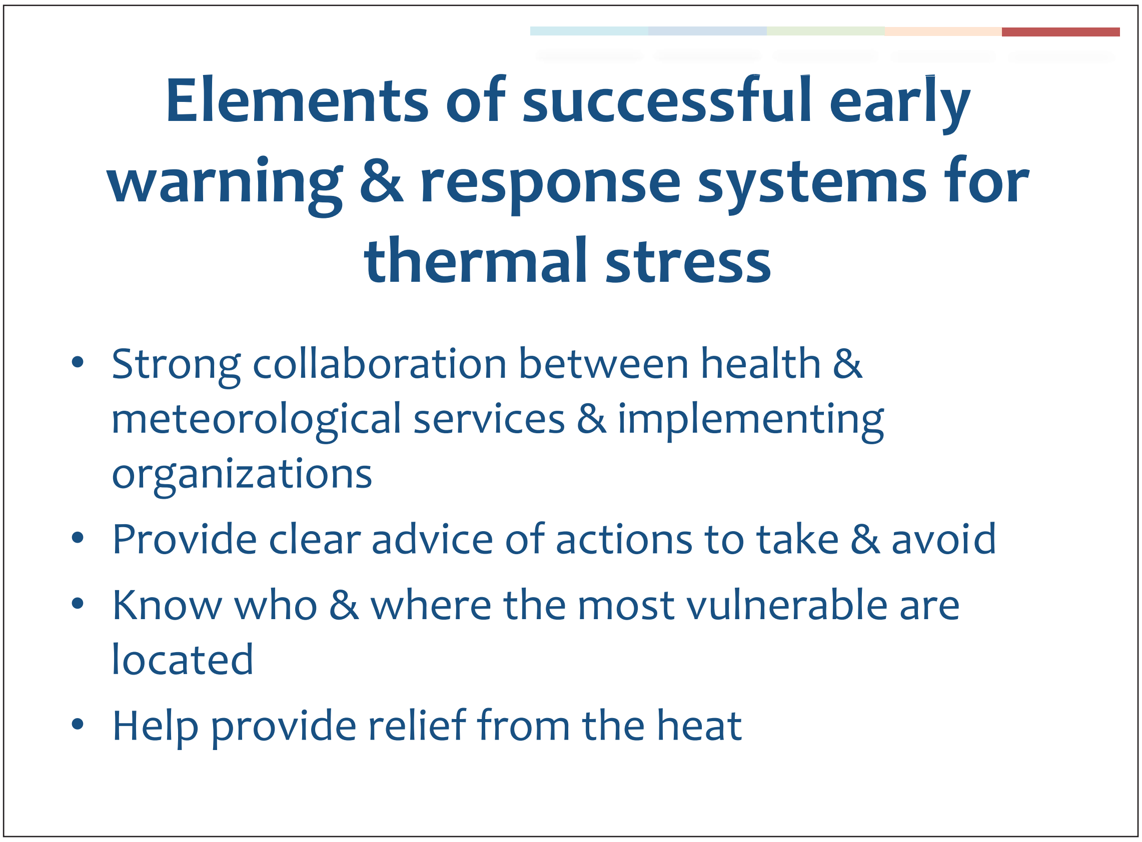
In addition to increasing temperature, climate change also is increasing absolute humidity. As shown previously, the combination of heat and humidity is one approach for determining the impact of extreme temperatures on health. With continued warming, the increase in humidity has been shown to pose increasingly severe limitations on human activity in tropical and mid-latitudes during peak months of heat stress.

This study combined wet bulb globe temperatures from climate historical reanalysis and projections with industrial and military guidelines for an acclimated individual's capacity to safely perform sustained labor under environmental heat stress (labor capacity); this was defined as a global population-weighted metric fixed at the 2010 distribution. The figure shows population-weighted individual labor capacity (%) during annual minimum (upper lines) and maximum (lower lines) heat stress months. The authors estimate that environmental heat stress has reduced labor capacity to 90% in peak months over the past few decades. Projections indicate reductions in labor capacity to 80% in peak months in 2050. Under the highest emission scenario considered, projections indicate reductions in labor capacity to less than 40% by 2200, with most tropical and mid-latitudes experiencing extreme climatological heat stress.

The inset graph shows labor capacity by wet bulb globe temperature.

Source: *Dunne et al. Reductions in labor capacity from heat stress under climate warming. Nature Climate Change 2013;3:563-566. DOI: 10.1038/NCLIMATE1827*

38



Recognizing the potential for effective programmes to minimize the public health impact of extreme thermal conditions, elements of successful programmes are summarized in this slide. A growing number of guidance documents are available from WHO European Regional Office (2008), US EPA (2006), US Centers for Disease Control and Prevention, Health Canada, UK Health Protection Agency, and others.

This slide can be used to ask participants if any of these have been used in their city or country and, if so, what the experience has been.

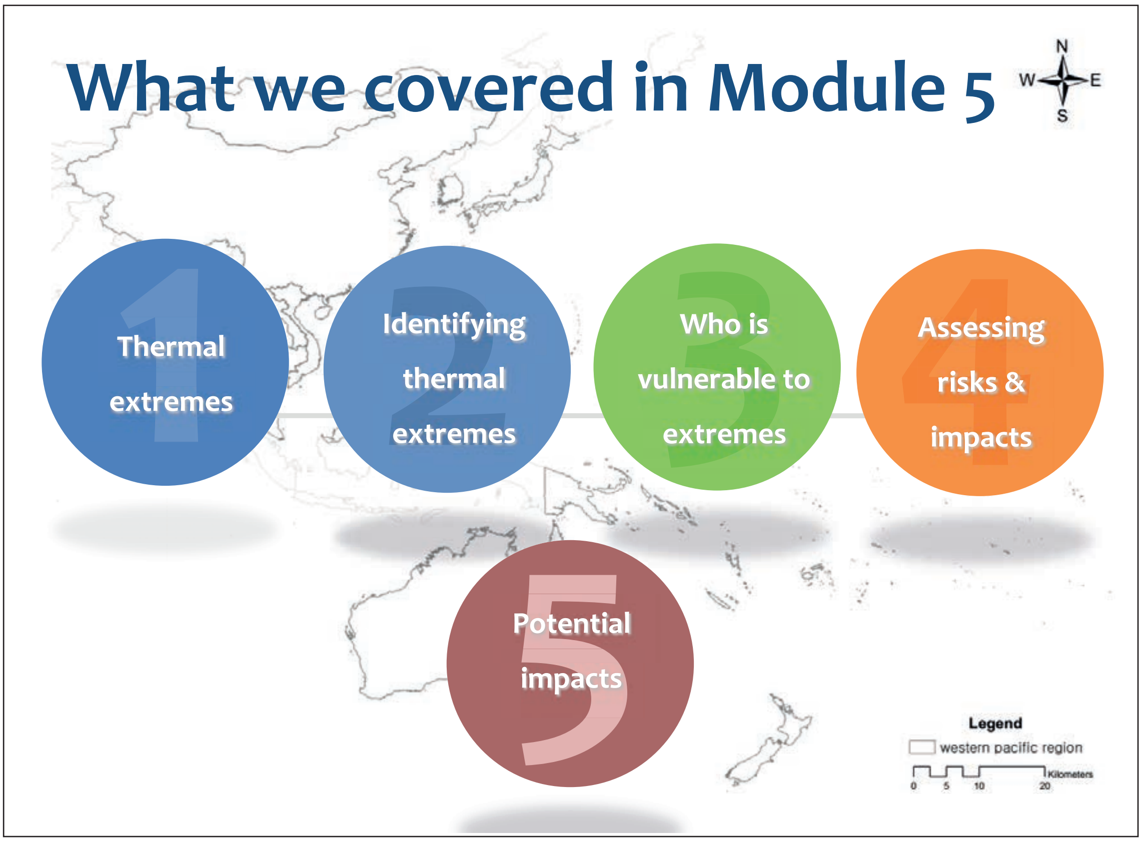
39

Elements of successful early warning & response systems for thermal stress

- Provide opportunities to request assistance or evaluation
- Be creative in use of available resources
    - Short-term assignment changes for some public sector staff
- Review response to events to identify successes & areas for improvement
- Revise programme as needs/opportunities change

Recognizing the potential for effective programmes to minimize the future public health impact of extreme thermal conditions, elements of successful programmes are summarized in this slide. A growing number of guidance documents are available from WHO European Regional Office (2008), US EPA (2006), US Centers for Disease Control and Prevention, Health Canada, UK Health Protection Agency, and others.

This slide can be used to ask participants if any of these have been used in their city or country and, if so, what the experience has been.



This module's goal was to help you start to think about:

- What defines an extreme thermal event;
- Who is at greatest risk during these events;
- How should the health impact of these events be measured;
- How climate change could affect the future risk of these events.

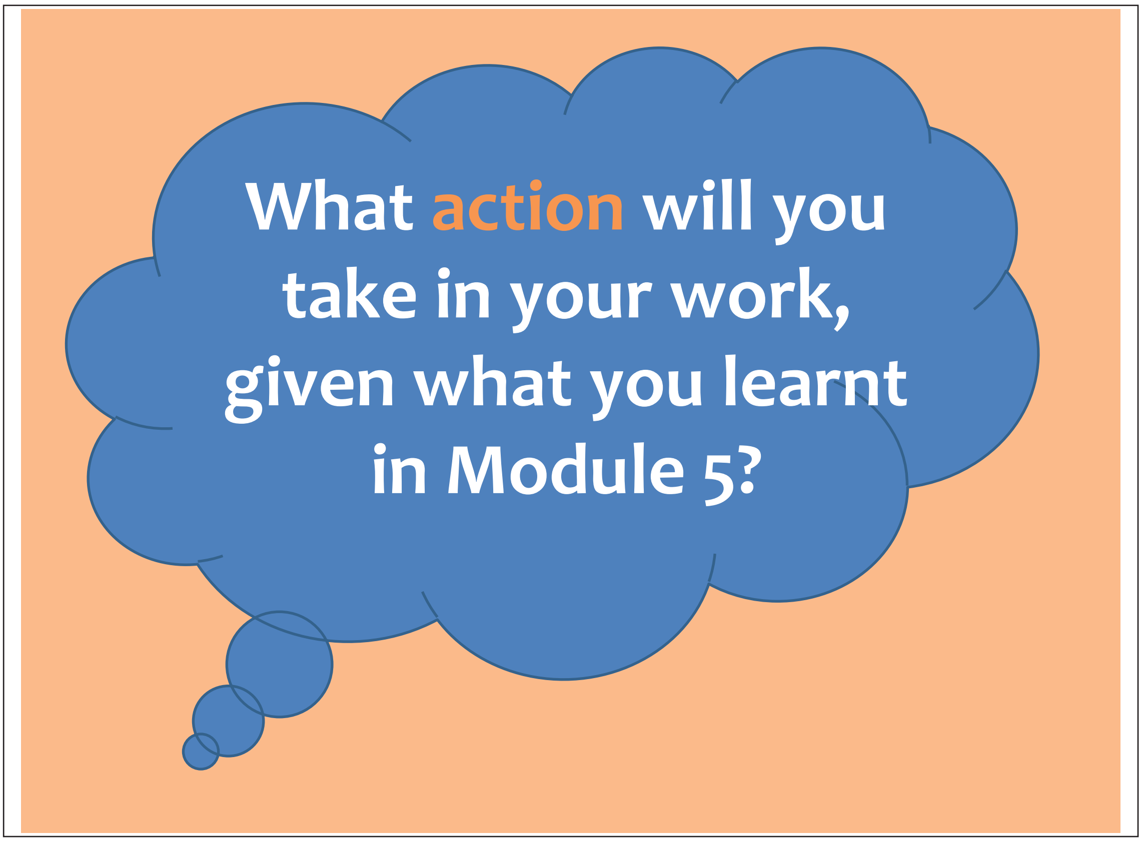
41

Learning from Module 5

- Extreme thermal events cause excess morbidity & mortality
  - All adverse health outcomes are preventable
  - Worker productivity likely to be adversely affected
- Climate change is projected to increase health risks with more, more severe, & longer heatwaves
  - Larger & older populations could increase the risk for additional adverse health impacts
- Adaptation can reduce current & future risks in morbidity & mortality due to temp extremes

This slide notes some of the key concepts and highlights some of the lessons that should have been learned through the presentation.

42



To finish off Module 5, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around food security and malnutrition under climate change.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes:** "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 6

Extreme weather

Key learning messages in Module 6

- Climate change is leading to changes in the frequency and intensity of many extreme weather & climate events
- Asia and the Pacific are particularly vulnerable to extreme events
- There are a wide range of health risks of extreme events in the region
- Public health and disaster risk management policies and measures can increase resilience to current and future health risks.

Estimated length: 60 minutes

Structure of Module 6

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. How to understand the health risks from extreme weather and climate events	4–6	
2. Worldwide trends in hazards	7–17	
3. Extreme weather and climate events in Asia and the Pacific	18–31	EXERCISE on slide 19 What examples have you seen of these extreme weather events in your country or region recently? Verbal responses from participants EXERCISE on slide 23: What is the experience in your country with early warning systems? Are they proving effective in preventing death? Verbal responses from participants
4. Sources of vulnerability to extreme weather events	32 –34	EXERCISE on slide 33: Why do you think these factors increase vulnerability to climate change impacts? 3 minute chat with person next to you
5. Public health risks from extreme events	35–38	
6. Disaster risk management	39–42	
Module outline	43	

Section	Slides	Activity (if any)
Learning from Module 6	44–45	
Learning reflection, action generation	46	

Required resources

- Data projector and slide changer
- Module 6 slides.

Instructions for delivery of Module 6

Numerous terms for extreme events are raised in Module 6 for the first time, but each is not defined in detail. Refer participants to the glossary if needed.

With 47 slides and six sections, Module 6 has quite a bit of content to get through within the estimated 60 minutes. Three verbal exercises have been designed to break up the one way delivery, but if energy levels appear low, feel free to insert a stand and stretch or break break between two sections.

Key terms introduced in Module 6

- Loss events
- Natural disasters
- Typhoons
- Precipitation extremes
- Wildfires
- Windstorms
- Blizzards
- Cyclone
- Glacial lake outburst flood
- Forest and agricultural fires
- Direct public health impacts
- Morbidity
- Mortality
- Post Traumatic Stress Disorder (PTSD)
- Depression
- Indirect public health impacts
- Disaster risk management
- Extreme weather event notification
- Extreme weather event response plans.

References (in order of presentation)

- Munchener Ruckversicherungs-Gesellschaft. 2014. 2013 Natural Catastrophe Year in Review
- Centre for Research on the Epidemiology of Disasters. 2012. EM-DAT database.
- IPCC. 2012. *Special Report on Extreme Events*.
- Centre for Research on the Epidemiology of Disasters. 2012. EM-DAT database.
- UNICEF, 2007, Innocenti Research Center, Innocenti Working Papers, Child Mortality and Injury in Asia
- Cash et al. 2013, Reducing the health effect of natural hazards in Bangladesh
- Doocy et al. 2013. The Human Impact of Tropical Cyclones: a Historical Review of Events 1980-2009 and Systematic Literature Review
- World Health Organization (WHO),*Climate Change and Human Health,* A.J. McMichael et al., eds. (WHO, Geneva, 1996), Figure 7.3, p. 155.

Module 6:
Extreme weather

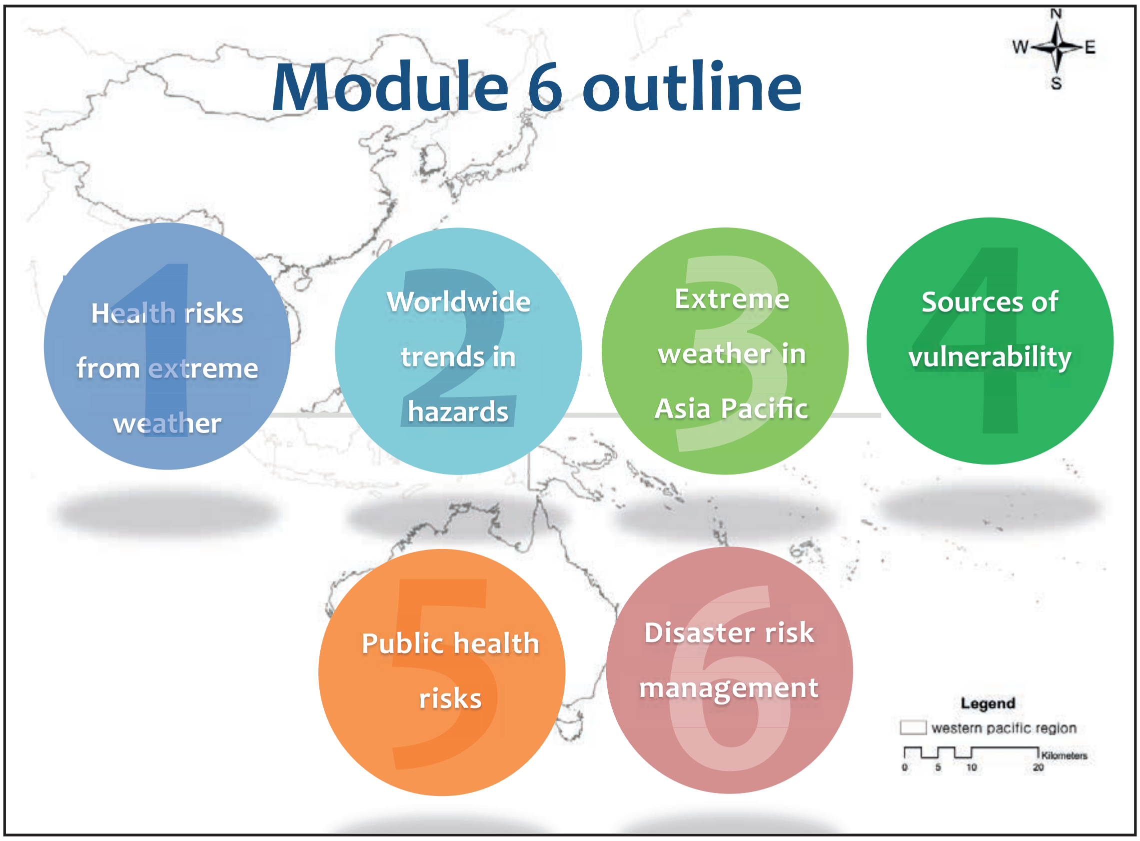
In Module 6 we'll look at extreme weather events, their connection to climate change, and the health risks they are likely to pose in Asia and the Pacific.

2

Key messages in Module 6

- Climate change is leading to changes in the frequency & intensity of many extreme weather & climate events
- Asia & the Pacific are particularly vulnerable to extreme events
- There are a wide range of health risks of extreme events in the region
- Public health & disaster risk management policies & measures can increase resilience to current & future health risks

3



This module presents a framework for considering the health risks associated with changes in the frequency and intensity of extreme weather and climate events. The module summarizes the worldwide trends in hazards, the types of extreme weather and climate events of importance in Asia and the Pacific, how these events threaten public health, the sources of vulnerability, and the health impacts associated with these events. Disaster risk management and adaptation options are briefly discussed.

(Section headings in full, for reference):

1. How to understand the health risks from extreme weather and climate events
2. Worldwide trends in hazards
3. Extreme weather and climate events in Asia and the Pacific
4. Sources of vulnerability to extreme weather events
5. Public health risks from extreme events
6. Disaster risk management.

4

Introduction:
Understanding the health risks from extreme weather & climate events

Let's start by looking at how to understand the health risks from extreme weather and climate events

5

A changing climate leads to changes in extreme weather & climate events

Source: IPCC (2012)

The Intergovernmental Panel on Climate Change (IPCC) Special Report on Managing the Risks of Extreme Weather and Climate Events to Advance Climate Change Adaptation (SREX) concluded that a changing climate is leading to changes in the frequency and intensity of many extreme weather and climate events http://www.ipcc-wg2.gov/SREX/.

6

Impacts from weather & climate events depend on:

Nature & severity of event

Vulnerability: the predisposition of a person or group to be adversely affected

Exposure

Source: IPCC (2012)

The risks of extreme weather and climate events depend on three factors:

- the nature and severity of the event;
- the extent to which a community is exposed to the event; and
- the vulnerability of the exposed community and region.

Because the extent of exposure and the underlying vulnerability vary from place to place, the same strength event will have different consequences in different locations.

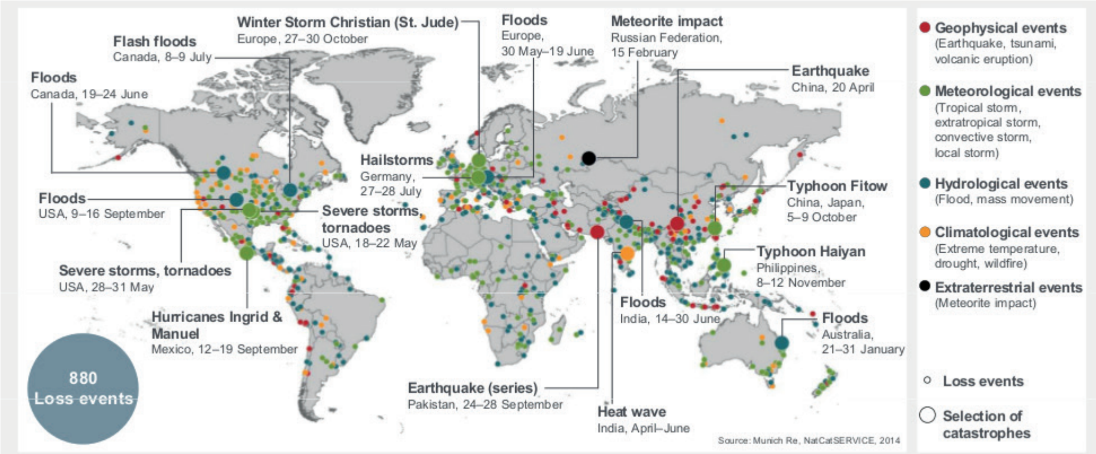
This slide can be used to ask the participants about recent extreme weather and climate events in their countries. Ask for descriptions not only of the event, but how local factors increased or decreased vulnerability.

7

Let’s now look at some of the trends globally for how and where hazards are occurring.

8

Loss events worldwide in 2013



Source: Munchener Ruckversicherungs-Gesellschaft (2014)

Munich Re collects data worldwide data on catastrophes. Depending on their financial and human impact, events are assigned to one of six loss categories, from a small-scale loss event to a great natural catastrophe. The categories depend on the numbers of fatalities, how many were affected (such as being homeless), the extent of economic loss, and whether interregional and/or international assistance was necessary.

Events are categorized as geophysical, meteorological (storms), hydrological (floods), climatological (extreme temperature), and extraterrestrial (meteorites). This shows the 880 loss events in 2013.

Source: *Munchener Ruckversicherungs-Gesellschaft. 2014. 2013 Natural Catastrophe Year in Review*

9

Top 10 natural disasters by number of victims

Event	Country	Victims (in millions)
Flood, June	China P Rep	17.4
Flood, April	China P Rep	13.1
Flood, July-October	Nigeria	7.00
Tropical cyclone (Bopha), December	Philippines	6.2
Tropical cyclone (Haikui), August	China P Rep	6.0
Flood, June	Bangladesh	5.1
Flood, August-October	Pakistan	5.0
Flood, August	Philippines	4.5
Tropical cyclone (Damrey), August	China P Rep	3.8
Drought	Kenya	3.8
	Total	72.00

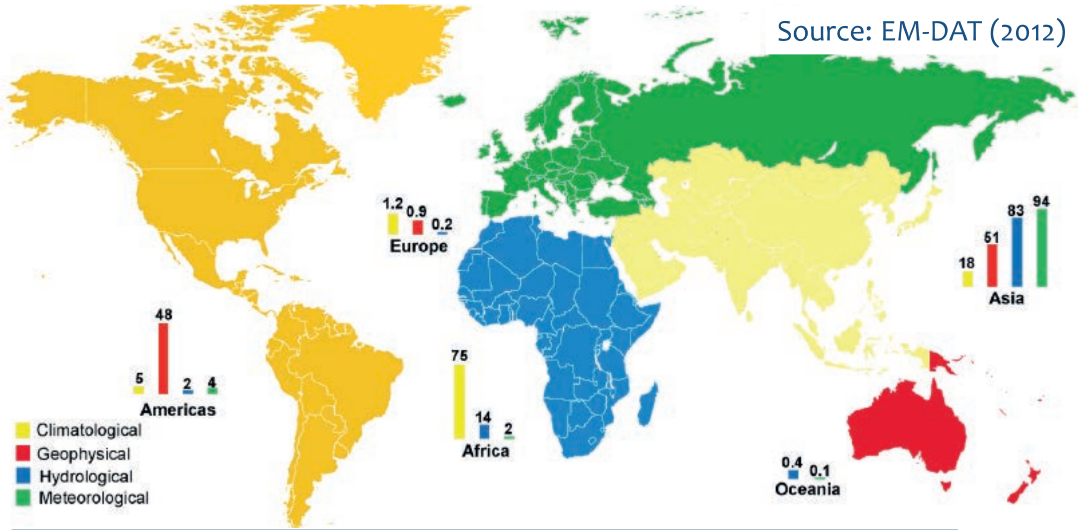
Source: EM-DAT (2012)

This table show the top 10 natural disasters in 2013 by number of victims, four of which occurred in China and four more in Asia.

Source: *Source: Centre for Research on the Epidemiology of Disasters. 2012. EM-DAT database.*

10

Percent share of reported victims by disaster sub-group & continent in 2012



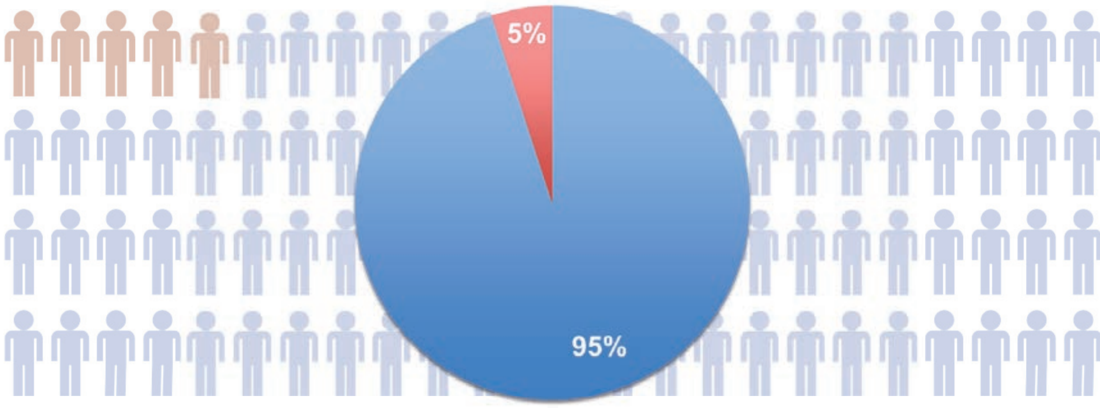
Meteorological = storm
Climatological = extreme temperature, drought, wildfire
Hydrological = flood

EM-DAT is the international disaster database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) in Belgium. The main objective of the database is to serve the purposes of humanitarian action at national and international levels. EM-DAT contains data on the occurrence and effects of over 18 000 mass disasters from 1900 to the present. The database is complied from various sources, including UN agencies, NGOs, insurance companies, research institutes, and press agencies. For a disaster to be entered into the database at least one of the following must be fulfilled: 10 or more people reported killed; 100 or more people reported affected; declaration of a state of emergency; or a call or international assistance.

This shows the percent share of reported victims by disaster sub-group. Asia is particularly vulnerable to hydrological and meteorological disasters.

11

Fatalities are higher in developing countries

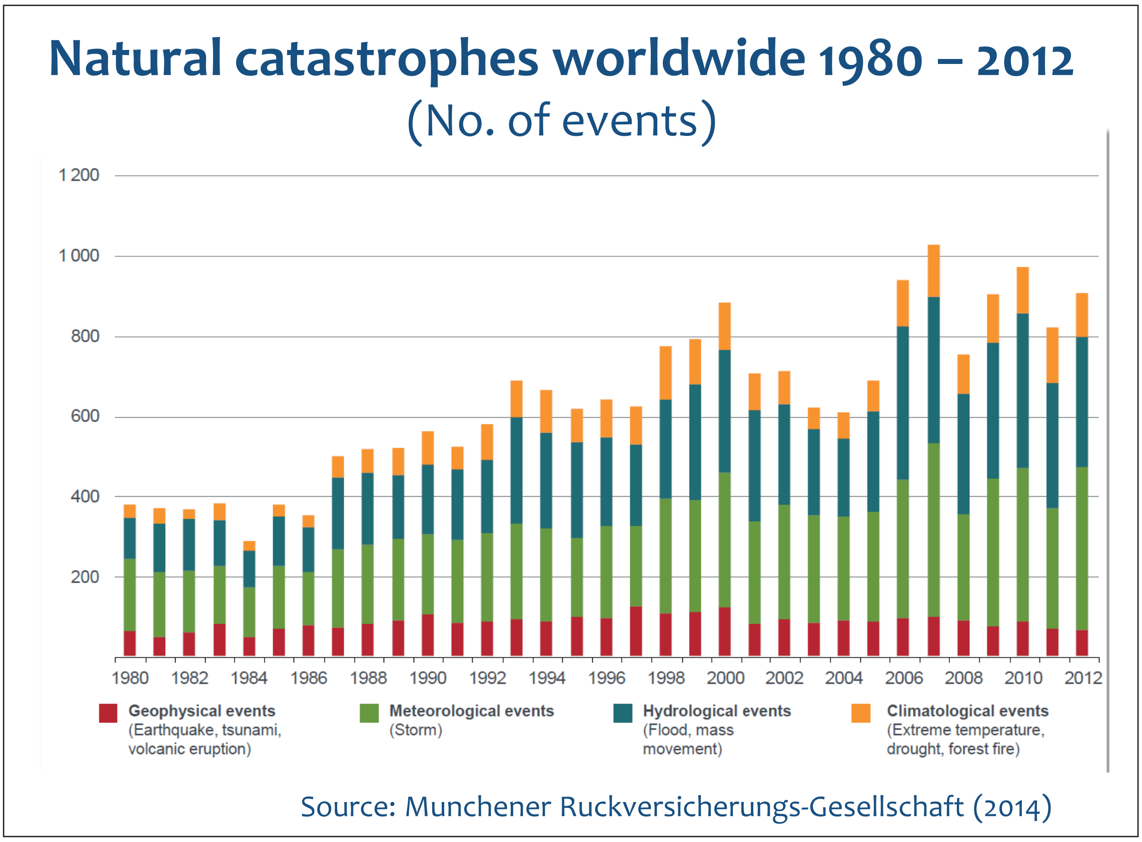


From 1970-2008, over 95% of natural-disaster-related deaths occurred in developing countries

Source: IPCC (2012)

These data are from the IPCC Special Report on Extreme Events. Over the period 1970-2008, over 95% of all natural disaster-related deaths occurred in developing countries, highlighting their higher vulnerability because of, among other factors, poorer quality infrastructure, urban planning, and early warning systems.

Source: IPCC. 2012. Special Report on Extreme Events



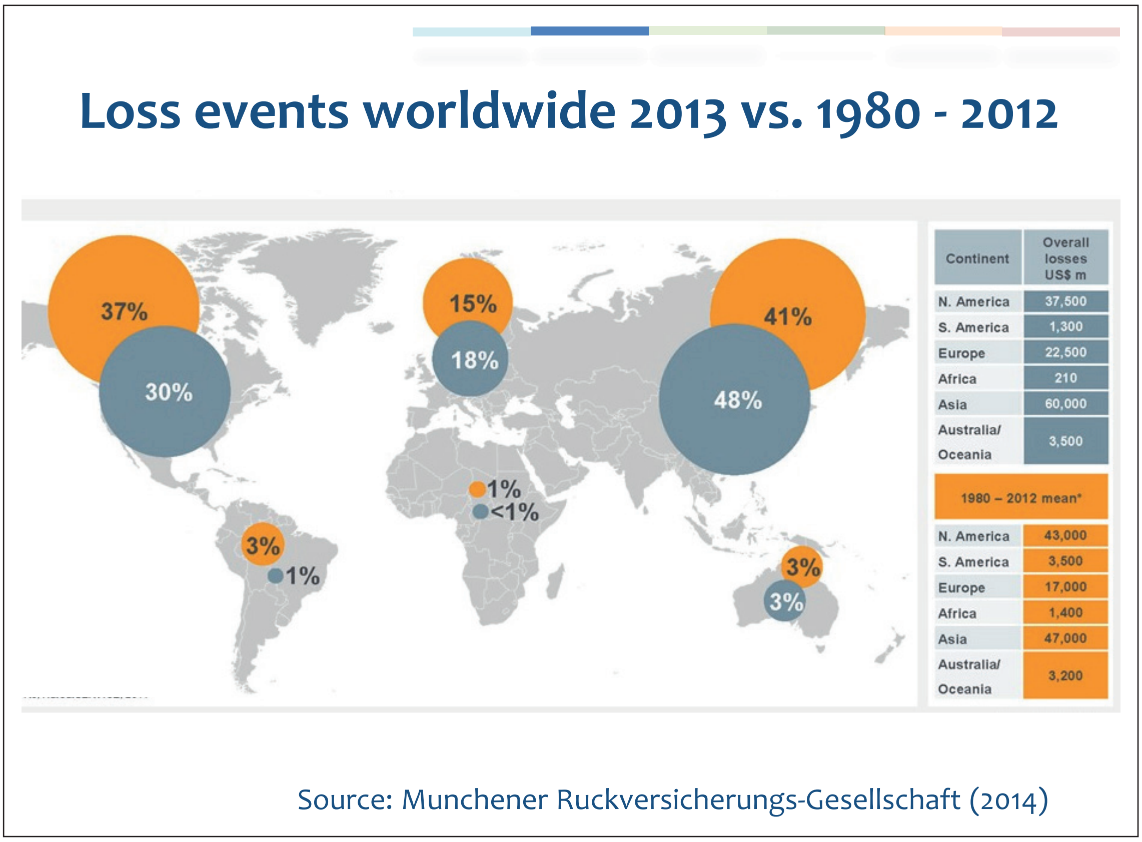
This shows the trends in natural catastrophes worldwide from 1980 to 2012. The number of events increased over time, at least in part because of more people living in harm's way. Geophysical events (in red) have varied over time, with no discernable trend.

This is not the case for the other categories, all of which are associated with weather and climate.

Obviously not all catastrophes are related to climate change. But meteorological, hydrological, and climatological events – the green, blue and yellow bars - increased over the 30+ year period. The increases were largest for meteorological and hydrological events.

Source: *Munchener Ruckversicherungs-Gesellschaft. 2014. 2013 Natural Catastrophe Year in Review*

13



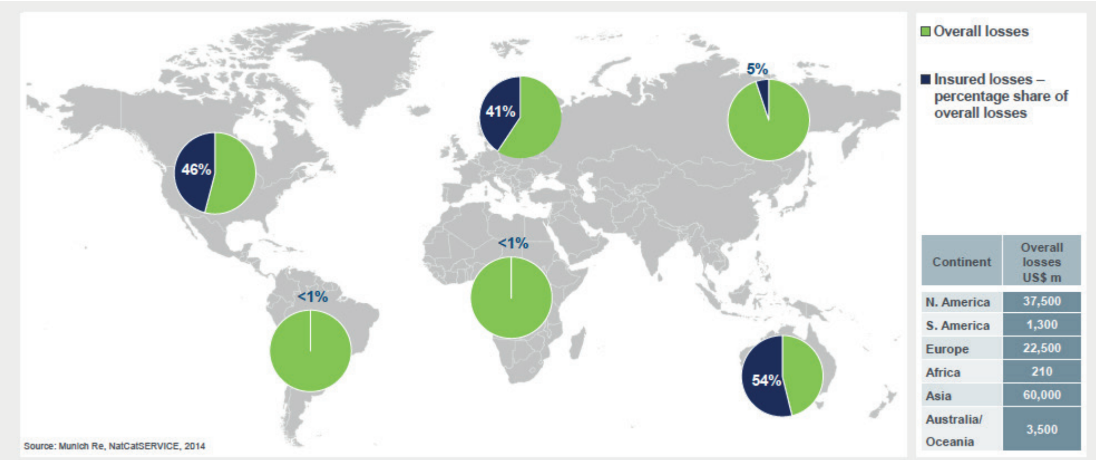
This figure shows the increases in loss events in 2013 vs. 1980-2012. Overall losses in 2013 were US$125 billion, vs an average of US$115 billion over the period 1980-2012. The largest proportion of losses (41%) was in Asia. North America was the geographic region with the second largest losses.

Overall losses in Asia in 2013 were US$ 60 000 million ($60 billion), compared with US$47 billion over the previous 30+ years.

Source: *Munchener Ruckversicherungs-Gesellschaft. 2014. 2013 Natural Catastrophe Year in Review*

14

Loss events worldwide 2013: Overall & insured loss per continent



Source: Munchener Ruckversicherungs-Gesellschaft (2014)

This figure shows the proportion of losses that were insured, showing that only 5% of losses in low- and middle-income countries in Asia were insured.

Source: *Munchener Ruckversicherungs-Gesellschaft. 2014. 2013 Natural Catastrophe Year in Review*

15

Increasing exposure of people & assets has been the major cause of changes in disaster losses

Pakistan floods, 2010
6 million left homeless

Source: IPCC (2012)

One of the conclusions from the IPCC Special Report on Extreme Events is that the major cause of increasing damages from disasters is the increasing exposure of people and assets. More people are moving into harm's way. The example shown is the 2010 flooding in Pakistan that left more than 6 million people homeless.

16

Flooding: China 2013

Many low- and middle-income countries have infrastructure that is vulnerable to extreme events, thus increasing economic losses when an event occurs. The IPCC Special Report on Extreme Events found that economic losses as a proportion of GDP from extreme events were highest in middle-income countries. As countries develop, their infrastructure becomes more valuable but may not have been designed and built to withstand extremes.

17

Summary: Trends in hazards

- More hazardous weather and climate events are occurring
- Low- and middle-income countries are particularly vulnerable
- Asia is at risk
- Hazardous events are becoming more expensive

So what we've been seen across these graphs is this general situation relating to hazards – that… READ

18

3

Extreme weather & climate events in Asia & the Pacific

We've looked at the global picture. Now let's focus on Asia & the Pacific, our key area of interest as health professionals working in these regions.

19

All extreme weather events experienced in countries of South East Asia & Western Pacific *could* be affected by climate change

This could alter the frequency & intensity of:

- Typhoons
- Floods
- Precipitation extremes
- Wildfires
- Temperature extremes
- Others (windstorms, blizzards, etc.)

Countries in the Asia Pacific regions with low-lying islands, extended coastal areas, mountains, and large river basins have a history of experiencing a wide range of extreme weather and climate events, all of which could be affected by climate change.

To expand on some of these impacts, ask the participants:

Q: What examples have you seen of these events in your country or region recently? Gather input from a handful of participants.

"Thanks. Let's look at some of the data from the region now, likely covering some of the events you mentioned".

20

Deaths from extreme weather events in South-East Asia, 1970 - 2008

SEARO country	Drought	Extreme temperature	Flood	Storm	Wildfire	Total
Bangladesh	18	2 171	41 759	474 098	-	***518 046***
Bhutan (no pre-1990 data)	-	-	222	17	-	***239***
India	320	11 710	46 185	49 029	6	***107 250***
Indonesia	1 329	-	5 227	1 692	300	***8 548***
Korea Dem P Rep	-	-	1 820	55	-	***1 875***
Korea Rep	-	40	2 274	2 186	2	***4 502***
Maldives	-	-	-	-	-	***-***
Myanmar	-	-	364	138 864	8	***139 236***
Nepal	-	108	5 481	97	88	***5 774***
Sri Lanka	-	-	941	754	-	***1 695***
Thailand	-	-	2 648	927	-	***3 575***
Timor-Leste (no pre-1990 data)	-	-	1	-	-	***1***
Total	**1 667**	**14 029**	**106 922**	**667 719**	**404**	**790 741**

Source: EM-DAT (2008)

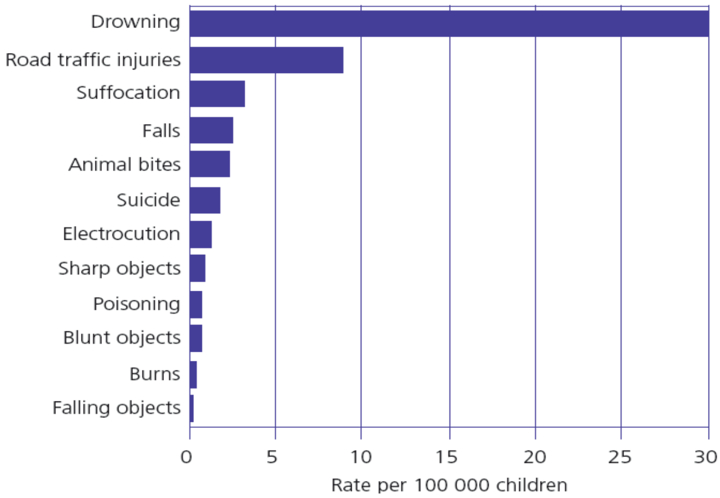
These results, from the EM-DAT database, show the reported deaths in South-East Asia over the period 1970-2008 from extreme weather events by country.

This shows nearly 800 000 reported deaths from extreme weather events. Storm mortality was by far the largest cause of death from extreme weather events, at 84% of the total.

Looking at the data for different countries, you can see that impacts are not equally distributed by country or type of extreme event.

21

Death by cause among children in some Asian countries



- More than 175 000 children & teenagers die from drowning each year
- Children under the age of 5 years are most at risk
- Most child drowning events happen in & around the home

This figure shows the rate of fatal injury rates per 100 000 children (0-17 years) in Bangladesh, China, Philippines, Thailand, and Vietnam. As shown, children under the age of 5 years are most at risk. More than 175 000 children and teenagers die from drowning each year.

Source: *UNICEF Innocenti Research Center, Innocenti Working Papers, Child Mortality and Injury in Asia, 2007*

22

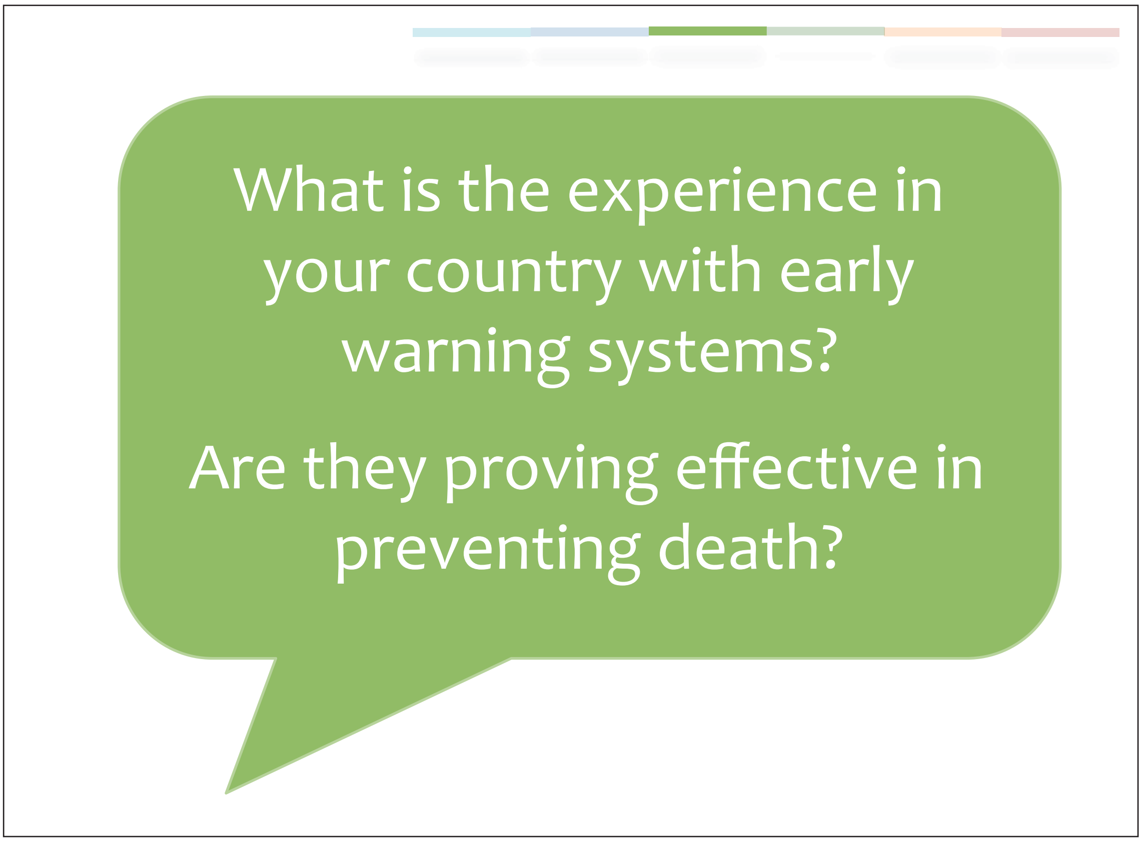
Conclusions from the data:

- The region has high vulnerability to extreme weather events
- Children are particularly vulnerable
- Mortality impacts are not evenly distributed across the types of events or across countries (even when differences in population size are accounted for)
- Storms & floods account for the vast majority of deaths from extreme weather events

The main conclusions are that:

- The region has high vulnerability to extreme weather events
- Children are particularly vulnerable
- Mortality impacts are not evenly distributed across the types of events or across countries, even when differences in population are accounted for, and
- Storms and floods account for the vast majority of deaths from extreme weather events.

23

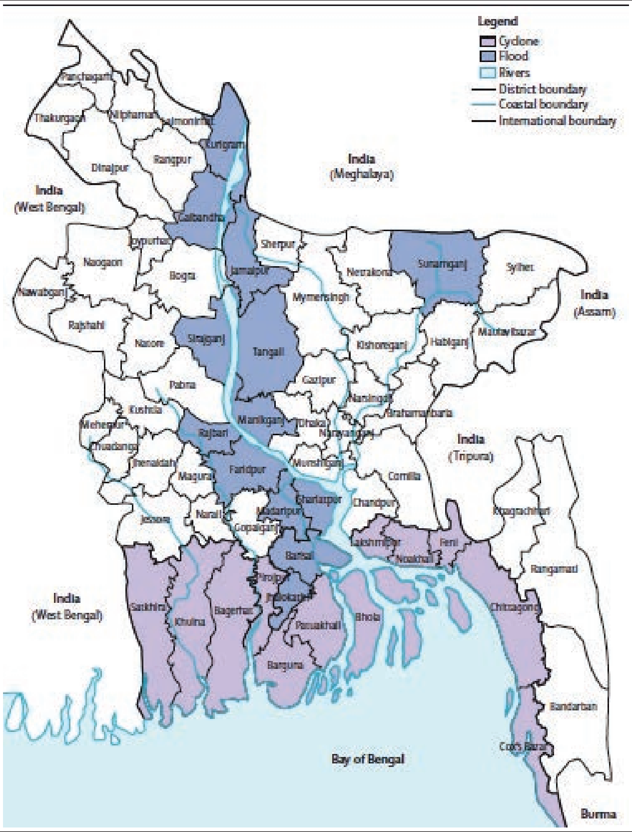


Ask participants:

Q: What is the experience in your country with early warning systems? Are they being effective in preventing death?

Would anybody like to share? Gather 2 – 3 responses from participants.

24



Case study: Disasters & hazard incidence in Bangladesh

Source: Cash et al. (2013)

This figure show disaster prone regions of Bangladesh by district, with cyclone-prone regions in mid purple colour, flood-prone regions in dark purple, and rivers in blue.

Source: *Cash et al. 2013. Reducing the health effect of natural hazards in Bangladesh*

25

Extreme events in Bangladesh's history

	Type of hazard	Proportion (%) of total region or population affected (n)	Height of storm surge (m)	Deaths (n)
1970	Bhola cyclone	..	6–10	225 000–500 000
1974	Flood	35·4%	NA	..
1985	Cyclone	167 500	3–4·6	11 000
1987	Flood	38·6%	NA	1657
1988	Flood	52·4%	NA	2379
1991	Cyclone Gorky	4·56 million	6–7·6	138 000
1998	Flood	67·4%	NA	918
2004	Flood	25%	NA	<800
2007	Cyclone Sidr	18·3 million	4·5–6·1	3300
2009	Cyclone Aila	3·9 million	2–3	190

Learning & innovation in Bangladesh's cyclone management

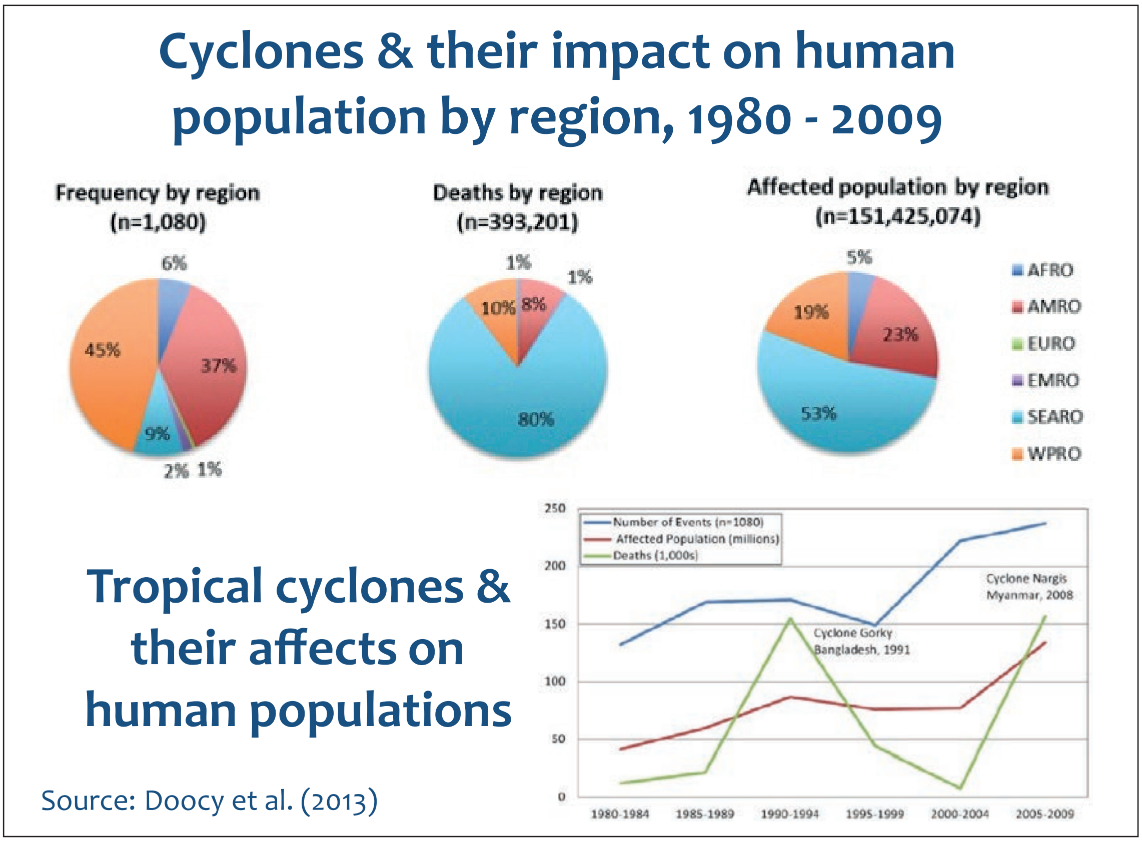
	Issues and experiences	New innovations applied	Action after event
Cyclone Bhola (1970)	Urgent need for more cyclone shelters	..	300 cyclone shelters built in highly vulnerable areas
Cylone Gorky (1991)	People did not heed warning messages, cyclone shelters were often ill maintained and positioned to be convenient to wealthy households, and many people were reluctant to leave home or livestock	The government divided NGO relief efforts geographically	Multipurpose cyclone shelters were better maintained—the total number of shelters available increased substantially; the Cyclone Preparedness Programme recruited 44 000 volunteers to communicate information about cyclones and mobilise communities to shelters
Cyclone Sidr (2007)	..	Satellite imaging was used to track the storm; the media were involved in relief strategies, such as helping to find missing people; NGOs began to provide cash to affected households, instead of just relief items	..

Source: Cash et al. (2013)

The box at the top shows major extreme events and their consequences, while the bottom box shows the issues and experiences in three major cyclones over the period 1970 and 2007, the innovations applied, and the actions after the event. The numbers in the upper right show how these actions significantly reduced mortality, thus highlighting that taking actions to prepare for and cope with extreme weather events can successfully reduce mortality.

Source: *Cash et al. 2013. Reducing the health effect of natural hazards in Bangladesh*

26



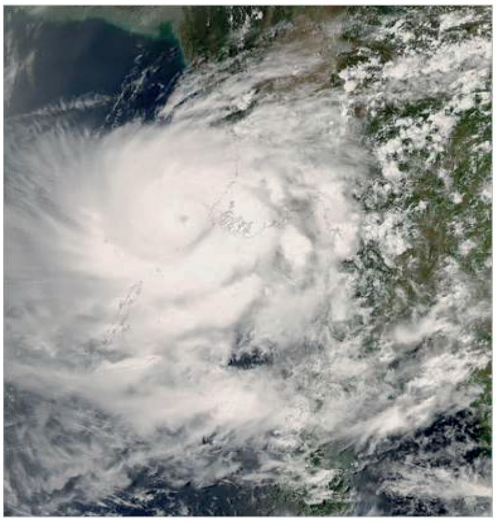
Cyclones cause considerable impacts in the South-East Asia Region. These pie graphs show deaths over the period 1980-2009 (SEARO). Just under half of all cyclones occur in the Western Pacific region (WPRO). However, more than half of the affected population and most of the deaths however occurred in SEARO countries – the light blue section of the pie graphs.

The line graph below shows the number of events, the affected population in millions, and deaths in 1000s from tropical cyclones. The very large number of deaths in cyclone Gorky are evident in the green spike on the bottom line.

Source: *Doocy et al. 2013. The Human Impact of Tropical Cyclones: a Historical Review of Events 1980-2009 and Systematic Literature Review*

27

Cyclone Nargis hits Myanmar, 2008



New York Times (2008)

The Guardian (2008)

These images shows the devastating effects that can result from cyclones. The first cyclone of the 2008 season in the northern Indian Ocean hit Myanmar. The category 4 cyclone killed more than 84 530 persons and over 53 000 were reported missing. The average reported number of deaths per household was 2.2 with 66% of the victims women. The most significant health need was support for psychological stress: 23% of people reported psychological problems after the cyclone.

In the areas affected, two thirds of health facilities suffered some damage. One out of five was totally destroyed. Most were small, rural primary care centers. The estimated cost for rebuilding health facilities was estimated at US$2 billion.

After the cyclone, 60% of people had no access to clean water as traditional sources of water in villages became contaminated with seawater. In addition, many water sources became polluted due to the breakdown of sanitation facilities in the flooded areas.

28

Danger of glacial lake outburst flood in the Himalayas

Photo: Dig Tsho, Nepal (1985)

Excessive melt water can lead to Glacial Lake Outburst Flood (GLOF) or 'mountain tsunami'

In 2007, 200 glacial lakes in the Himalayas were at risk of bursting.

A unique risk in the Himalayas is glacial lake outburst floods. As glaciers melt, the water collects in naturally occurring moraines. As they fill, the pressure of the water on the retaining walls can become too great, causing the walls to fail. Such glacial lake outburst floods have caused significant damage, with an increasingly large number of lakes at risk.

Smoke from forest & agricultural fires in 2006

Fire from smoke resulted in degraded air quality in Indonesia, Malaysia & Thailand

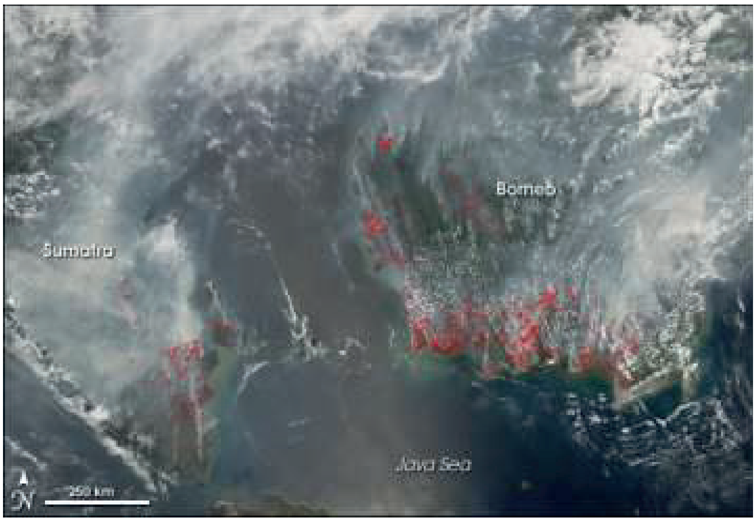
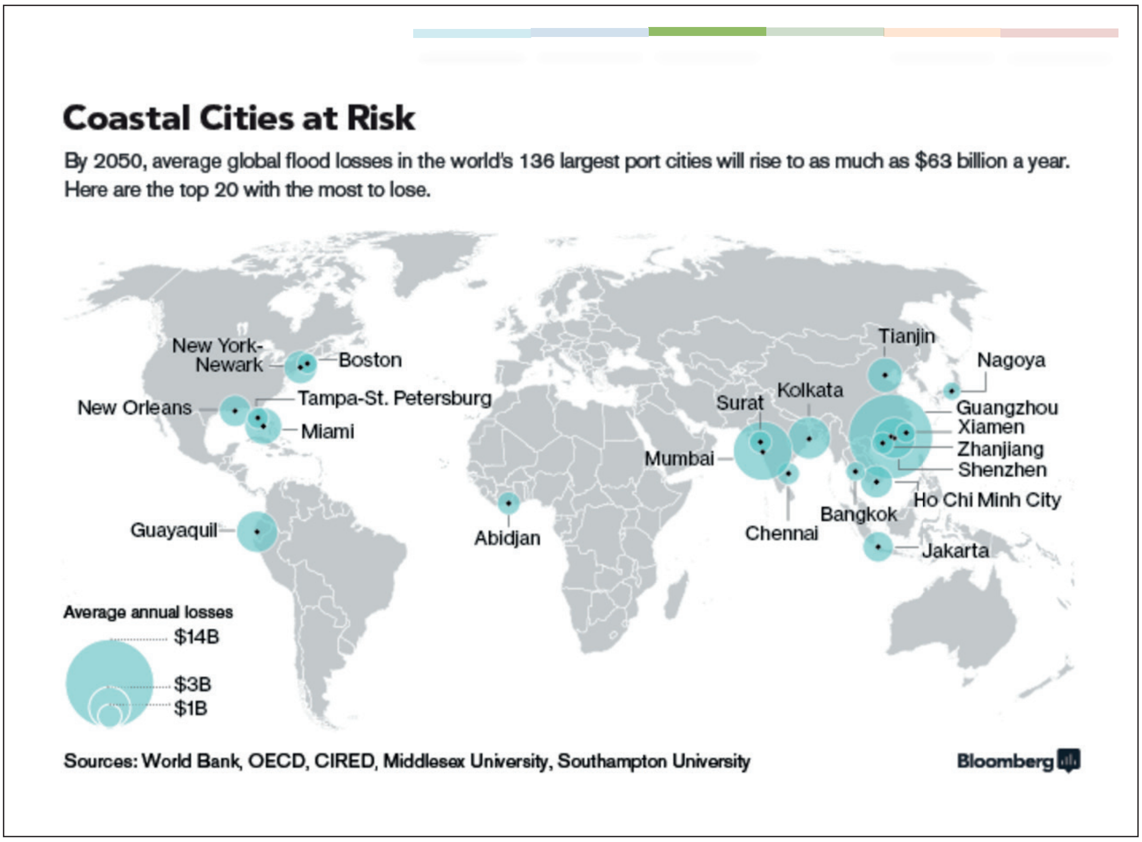


Photo: Mongabay.com (2006)

Smoke from agricultural and forest fires burning on Sumatra (left) and Borneo (right) in late September and early October 2006 blanketed a wide region with smoke that interrupted air and highway travel and pushed air quality to unhealthy levels.

This image from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite on October 1, 2006, shows places where MODIS detected actively burning fires marked in red. Smoke spreads in a gray-white pall to the north. As a result of these fires, air quality was degraded across the region including in Thailand and Malaysia. This degraded air quality also provides an example of how extreme weather events can have indirect health impacts far from and/or long after the events themselves end.

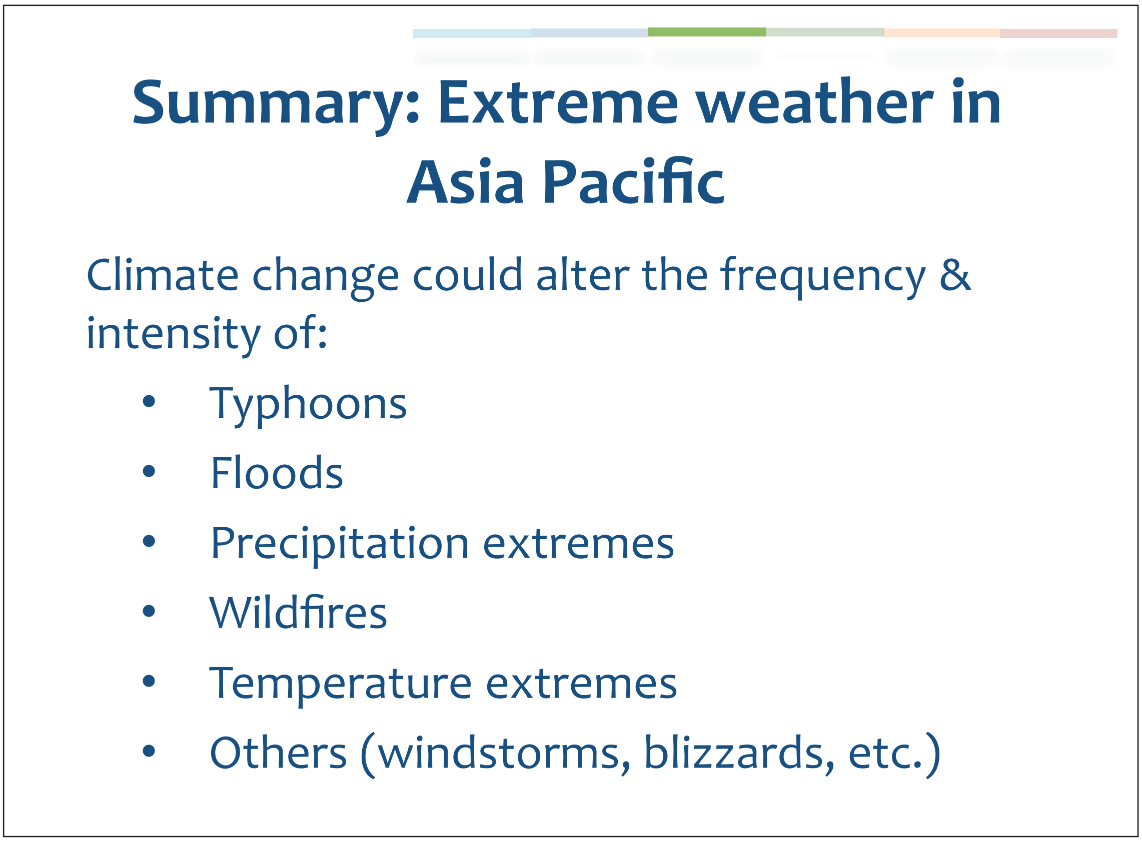
30



The Asia and Pacific regions have many cities in coastal areas vulnerable to sea level rise and to the associated increasing height of storm surges. As sea level rises, there is a non-linear increase in storm surge. As shown earlier in worldwide disaster trends, storm surge is a major cause of impacts from extreme events.

Source: *Bloomberg News, Nov 2014.*

31



As I'm sure many of you are experiencing, Asia and the Pacific are experiencing an increasing incidence of extreme weather events. The frequency, intensity, and duration of some of these events are being altered by climate change.

CLICK once to show all summary points. Read summary.

32

4

Sources of vulnerability

In order to manage the risks, we need to understand what makes individuals and communities vulnerable to climate change and how those vulnerabilities interact with extreme weather and climate events.

(This image shows low lying villages on the island of Kiribati, threatened by rising sea levels with climate change.)

33

Factors increasing vulnerability to extreme weather & climate events

- Age: older adults & younger children
- Presence of chronic medical conditions
- Low level of physical fitness or physical mobility
- Physical or mental impairment
- Social isolation
- Poverty

A wide range of factors affect individual vulnerability to an extreme event. Many of them are written here (let the group read them over the next 20 seconds).

Q: With the person next to you, have a chat for 3 minutes about why you think these factors increase vulnerability to climate change impacts.

Call people back together and acknowledge the points contributed and add in any of the explanatory points below if they're not covered:

- Older adults and young children are often less able to manage extremes
- Those with chronic medical conditions such as diabetes are more susceptible to extreme weather
- Those with low levels of physical fitness or mobility
- Those with physical or mental impairment
- Social isolation is associated with increased risk during heatwaves
- Poverty is associated with increased morbidity and mortality from all extreme events.

34

For exposed & vulnerable communities, even non-extreme weather & climate events can have extreme impacts

- Africa's largest recorded cholera outbreak
- Over 90 000 affected, over 4 000 killed
- Began following onset of seasonal rains
- Vulnerability & exposure increased risk

Source: IPCC (2012)

Case study: Zimbabwe 2008

This slide further emphasizes the importance of understanding vulnerability. One of the key conclusions of the IPCC Special Report on Extremes was that it doesn't take an extreme weather and climate event to create an extreme impact. The example is from Zimbabwe, which has very high vulnerability because of a weak health system, limited investment in public health infrastructure (particularly sanitation), and other factors. By the end of Nov 2008, three of Zimbabwe's four major hospitals had shut down, along with the Zimbabwe Medical School. The fourth major hospital has two wards and no working operating theatre. The urban water supply, sanitation, and garbage collection systems had collapsed. Due to the economic crisis, most households could not afford fuel to boil water.

In August 2008, cholera was introduced. Africa's largest cholera oubreak started following the onset of seasonal rains, with over 90 000 people affected and more than 4000 deaths. In Feb 2009, approximately 8000 cases were reported weekly. Cholera spread to Botswana, Mozambique, and Zambia. The outbreak was contained in mid-2009.

Source: *IPCC. 2012. Special Report on Extreme Events.*

5

Health risks of extreme weather & climate events

36

Direct public health impacts from extreme weather & climate events

- Morbidity
- Mortality
  - Both are observable & attributable to the physical impacts of the event
- Mental health impacts (Post Traumatic Stress Disorder-PTSD, depression)
  - Delayed onset & recognition can lead to impacts being missed in an event summary
  - Potential to adversely affect productivity
  - Potential for severe health & quality of life impacts

Direct health impacts of an extreme event are those that arise from the event itself (e.g., drowning from a cyclone). These impacts typically provide the information that is subsequently used to describe the event (e.g., so many dead and so many hospitalized).

CLICK *to display second section on mental health impacts*

Mental health impacts of extreme weather events are increasingly being recognized as a significant category of direct health impacts. There is often delayed onset of mental health impacts; these can have long-lasting effects on productivity and quality of life.

37

Indirect public health impacts from extreme weather & climate events

- Can be less observable
- Can take time to develop, such as infectious disease outbreaks
- May reflect a loss of access to critical resources: clean water, shelter
- Can result from disruption to routines
  - Restricted access to, or supply of, medicine, caregivers, medical facilities

Indirect health impacts arise the from the interaction of the extreme event with other factors, such as water supply systems, or from secondary effects, such as breeding of vectorborne diseases in pools of water created by floodwaters. Indirect impacts generally occur after the event. Understanding these indirect impacts is important for ensuring health systems are prepared to conduct surveillance and monitoring, and for ensuring that health care workers have the necessary training and that adequate supplies are available.

Climate change & health risks of future extreme weather events

Increases in health risk may or may not result from future extreme weather events in a changing climate.

- Single events could have a minimal or significant health impacts
- Socio-demographic changes in population location, size, health, & wealth can be as significant as climate change in altering future risks
- Adaptation, in the form of hazard planning, preparation & response, will play a critical role in determining the magnitude of future health risks from extreme weather events

This slide again highlights that climate change-based projections of the magnitude and pattern of future extreme events are only part of the information needed to estimate how health risks could change with changing weather patterns. Development pathways will be a strong determinant of future risks. Population growth and age distribution are easier to project than are other important factors, such as health status. Because the poor bear a disproportionate share of health impact, considering how economic growth and inequity might evolve are important considerations, as are the number and distribution of low-income populations. Improving the quality of life of the poor can provide health benefits. The role of adaptation must be considered when predicting future health risks.

39

6

Disaster risk management

40

Effective risk management & adaptation are tailored to local & regional needs & circumstances

- Changes in climate extremes vary across regions
- Each region has unique vulnerabilities & exposure to hazards

- Effective risk management & adaptation address the factors contributing to exposure & vulnerability

Source: IPCC (2012)

When planning for how to increase resilience to extreme weather and climate events, an important consideration is that effective risk management and adaptation options are designed and implemented taking into consideration the unique vulnerabilities and exposure to hazards of each region. In some situations, the most important policies and measures are those that reduce vulnerability (instead of focusing on extreme weather and climate events).

Source: *IPCC. 2012. Special Report on Extreme Events.*

41

Goals for extreme weather event notification & response plans

- Improve public understanding of the magnitude & severity of the risks involved
- Develop plans for reducing exposure to the events
- Prepare response plans with clearly defined goals & responsibilities
  - Include planning for indirect health impacts - they can be significant

(Overview) Developing effective adaptive responses for extreme weather events requires understanding the nature of the health risks, who is particularly vulnerable, and the options for increasing resilience to the risks. Planning should include local / national disaster risk management committees, NGOs such as the Red Cross, and other stakeholders working to increase resilience to extreme events. Creating hypothetical scenarios and holding drills can develop the networks and teamwork needed to manage an event.

CLICK *slide changer to animate each of these goals one by one, reading each*

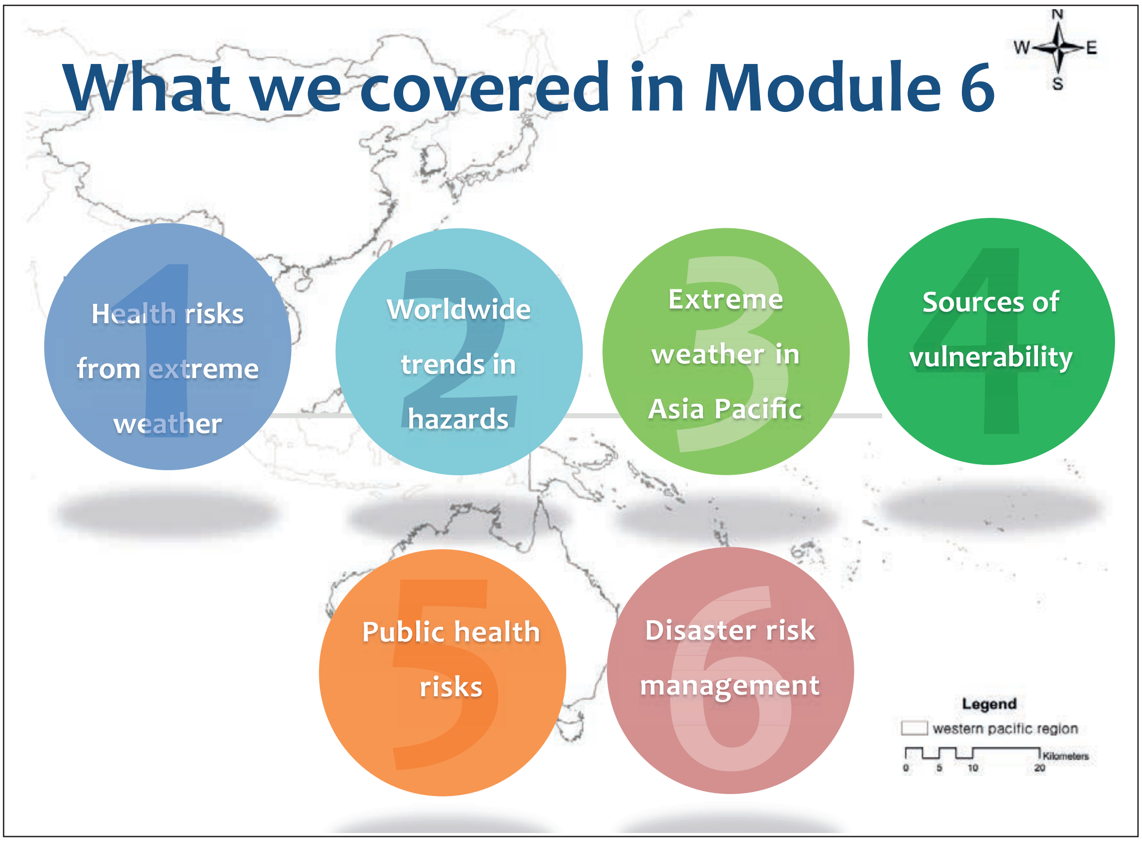
42

Goals for extreme weather event notification & response plans

- Coordinate health system responses with national disaster risk management committee
- Develop hypothetical scenarios & practice
- Draw on past experience
- Be open to outside assistance that has the potential to improve public health

CLICK *slide changer to animate each of these goals one by one, reading each*

43



Here's a reminder of what we covered in Module 6:

1. How to understand the health risks from extreme weather and climate events
2. Worldwide trends in hazards
3. Extreme weather and climate events in Asia and the Pacific
4. Sources of vulnerability to extreme weather events
5. Public health risks from extreme events
6. Disaster risk management

44

Learning from Module 6

- Extreme weather events already present a significant health risk to countries in South-East Asia & the Western Pacific
- Climate change is increasing the frequency and/or severity of many extreme weather & climate events, such as storms, flooding & wildfires

CLICK slide changer to animate each conclusion point, stating each.

45

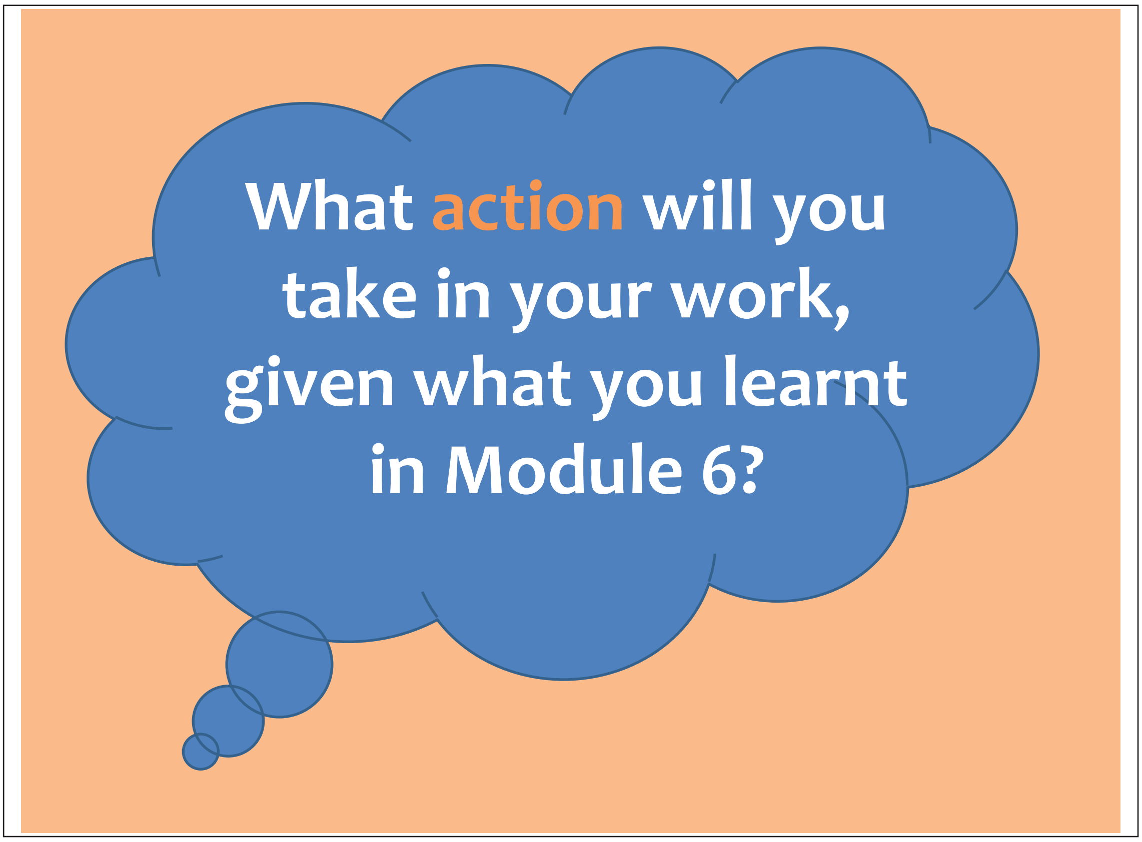
Learning from Module 6

- How the health risks of extreme events could change with climate change is uncertain
  - Changes in factors other than climate change will be critical in determining the nature & extent of future risks.
- However, uncertainty is not a reason to not take action
- Effective preparation can significantly reduce current & future risks under a changing climate.

CLICK slide changer to animate each conclusion point, stating each.

Q: Are there any questions on the learning from Module 6?

46



To finish off Module 6, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around extreme weather.

Encourage quiet reflection (verbally if needed). At the end of 2 minutes:

"Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 7

Vector-borne diseases and climate change

Key learning messages in Module 7

- Climate change could affect vector-borne disease (VBD) in humans
- Climate change affects vector-borne diseases through several mechanisms
- Impacts will vary from region to region
- Current evidence suggests impacts on some diseases may already be occurring
- Impacts may include unanticipated emergence of new pathogens.

Estimated length: 60 minutes

Structure of Module 7

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Vector-borne disease (VBD) introduction	4–10	
2. Effects of climate change on VBD	11–25	
3. Some case studies of climate change effects on VBD	26–36	
4. Potential for adaptation to minimize health risks and impacts	37–39	EXERCISE on slide 39: What VBD's are most relevant in your region? How can your region/country better prepare for the risks of VBD with climate change? 5 mins in pairs, somewhere else in the room.
Module outline	40	
Learning from Module 7	41	
Learning reflection, action generation	42	

Required resources

- Data projector and slide changer
- Module 7 slides
- Stopwatch
- Bell or noise maker

Instructions for delivery of Module 7

There is likely to be a mix of backgrounds in the group, with some having studied epidemiology and others not. So when introducing technical terms such as 'vector-borne disease', 'pathogen' and 'Zoonotic infections' for the first time in the module, ensure that a definition is provided and people are comfortable in their understanding of the term, before moving on.

Remind participants that they can refer to the glossary if they need to refer back to key terms and their meaning.

The case studies of the impacts of climate change on malaria and dengue will likely be compelling for participants, so if there is interest, make sure time is allowed for discussion. The action exercise and closing action reflection will also help end the module on a more empowered note, after seeing figures of widespread disease risk.

Key terms introduced in Module 7

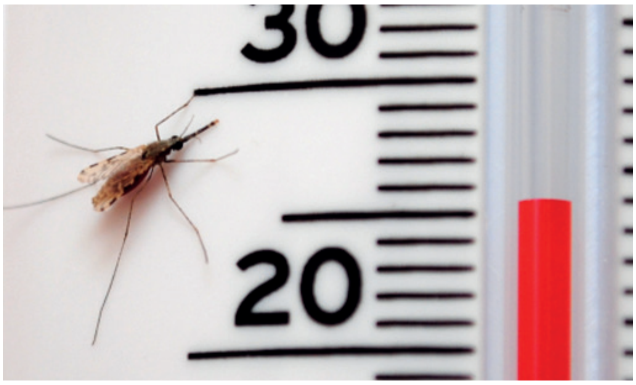
- Vector-borne disease
- Arthropod
- Transmission cycle
- Anthroponotic infections
- Zoonotic infections
- Vector
- Pathogen
- Protozoan
- Viral
- Filarial nematodes
- Seasonality
- Malaria
- Dengue
- El Niño.

References (in order of presentation)

- Hill, C.A., F.C. Kafatos, S.K. Stansfield, and F.H. Collins. 2005. *Arthropod-borne diseases: Vector control in the genomics era. Nature Reviews Microbiology 3:262−268.*
- Greer, A., V. Ng, and D. Fisman. 2008. *Climate change and infectious diseases in North America: The road ahead. CMAJ 178(6):715−722.*
- Gubler, D.J., P. Reiter, K.L. Ebi, W. Yap, R. Nasci, and J.A. Patz. 2001. *Climate variability and change in the United States: Potential impacts on vector- and rodent-borne diseases. Environmental Health Perspectives 109(Supplement 2):223-233.*
- Ogden N.H., M. Bigras-Poulin, C.J. O'Callaghan, I.K. Barker, L.R. Lindsay, A. Maarouf, K.E. Smoyer-Tomic, D. Walter-Toews, and D. Charron. 2005. *A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick Ixodes scapularis. International Journal for Parasitology 35:375-389.*

- Vail, S.G. and G. Smith. 1998. *Air temperature and relative humidity effects on behavioral activity of blacklegged tick (Acari: Ixodidae) nymphs in New Jersey. Journal of Medical Entomology 35(6):1025-1028.*
- Rogers, D.J. and S.E. Randolph. 2003. *Studying the global distribution of infectious diseases using GIS and RS. Nature Reviews Microbiology 1(3):231-237.*
- IPCC. 2014. *Assessment 5 Report.*
- Kenya Division of Malaria Control. 2009. *Malaria Background Info. Available: http://www.nmcp.or.ke/section.asp?ID=3*
- Yang G.J., P. Vounatsou, X.N. Zhou, M. Tanner, and J. Utzinger. 2005. *A potential impact of climate change and water resource development on the transmission of Schistosoma japonicum in China. Parassitologia 47:127-134*
- WHO, 2014. World Malaria Report 2014
- Macdonald, G. 1957. *The Epidemiology and Control of Malaria.* Oxford University Press, London, UK.
- Khasnis, A.A. and M.D. Nettleman. 2005. *Global warming and infectious disease. Archives of Medical Research 36:689−696.*
- Patz, J.A. and S.H. Olson. 2006. *Malaria risk and temperature: Influences from global climate change and local land use practices. PNAS 103(15):5635-5636.*
- Haines A. and J.A. Patz. 2004. *Health effects of climate change. JAMA 291(1):99−103.*
- Yang et al. Malaria Journal 2012 , *Malaria surveillance-response strategies in different transmission zones of the People's Republic of China: preparing for climate change*
- Hugo Ahlenius, UNEP/GRID-Arendal. 2005. *From collection of Environment and Poverty Times #4: MDG issue*
- Vezzani D., S.M. Velazquez, and N. Schweigmann. 2004. *Seasonal pattern of abundance of Aedes aegypti (Diptera: Culicidae) in Buenos Aires city, Argentina. Memoria do Instituto Oswaldo Cruz 99:351-356.*
- Watts, D.M., D.S. Burke, B.A. Harrison, R.E. Whitmire, and A. Nisalak. 1987. *Effect of temperature on the vector efficiency of Aedes aegypti for Dengue 2 virus. The American Journal of Tropical Medicine and Hygiene 36(1):143-152*
- Patz, J.A. and S.H. Olson. 2006. *Malaria risk and temperature: Influences from global climate change and local land use practices. PNAS 103(15):5635-5636.*
- Patz, J.A., W.J. Martens, D.A. Focks, and T.H. Jetten. 1998. *Dengue fever epidemic potential as projected by general circulation models of global climate change. Environmental Health Perspectives 106:147-153.*
- Hales S., P. Weinstein, Y. Souares, and A. Woodward. 1999. *El Nino and the dynamics of vectorborne disease transmission. Environmental Health Perspectives 107(2):99−102.*
- Mathuros Tipayamongkholgul, Chi-Tai Fang, Suratsawadee Klinchan, Chung-Ming Liu, and Chwan-Chuen King, 2009. *Effects of the El Niño-Southern Oscillation on dengue epidemics in Thailand, 1996-2005*
- Kuno G. 1995. *Review of the factors modulating Dengue transmission. Epidemiologic Reviews 17(2):321−335.*

Module 7:
Vector-borne diseases & climate change



In Module 7 we're going to look at vector-borne diseases and how these are likely to be affected by climate change – a really important issue for health management.

2

Key messages in Module 7

- Climate change could affect vector-borne disease (VBD) in humans
- Climate change affects vector-borne diseases through several mechanisms
- Impacts will vary from region to region
- Current evidence suggests impacts on some diseases may already be occurring
- Impacts may include unanticipated emergence of new pathogens

Key messages we'll cover in Module 7 are:

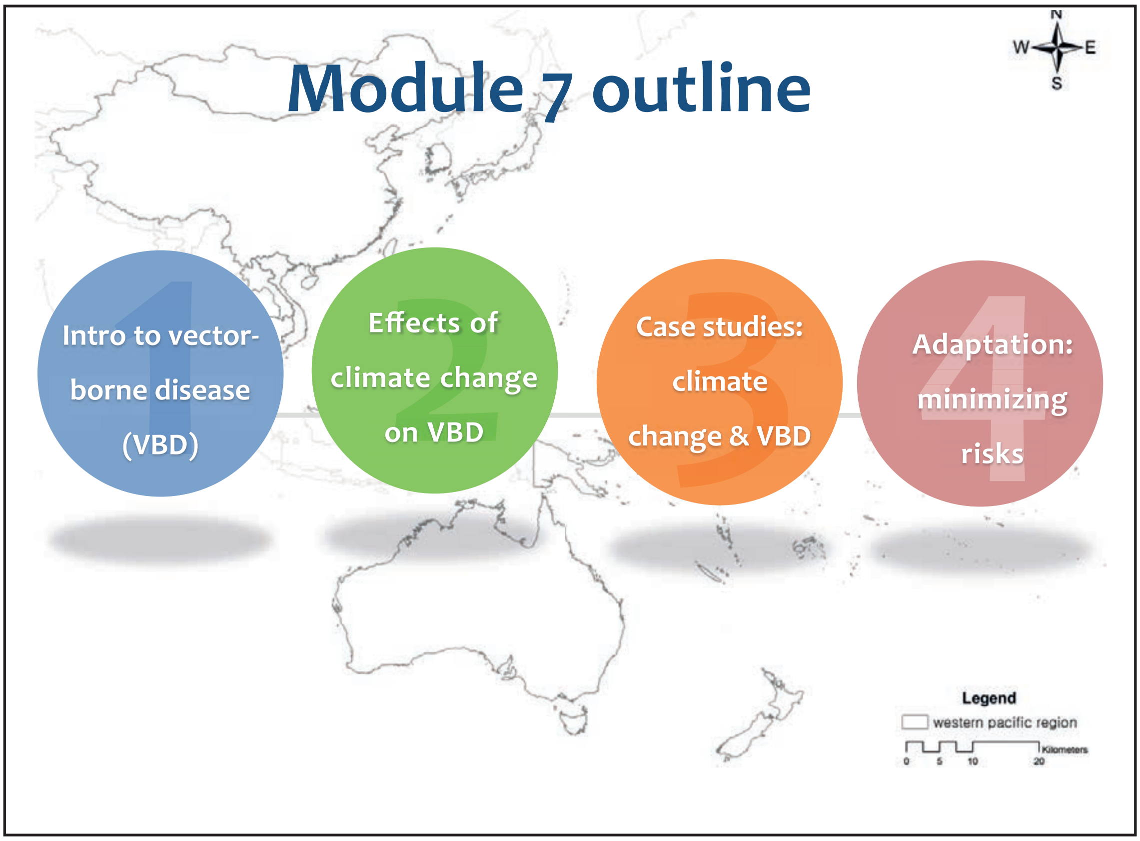
- It is likely that climate change will affect the distribution and incidence of VBD globally
- Impacts will vary from region to region
- Current evidence uncovered to date suggests that impacts on some diseases may already be occurring

In addition:

- Some of the potential impacts of climate change may include the unanticipated emergence of new pathogens.

Recommended further reading: 2007 IPCC report: The Physical Science Basis, FAQ 3.1 page 103 and FAQ 3.2 page 105

3

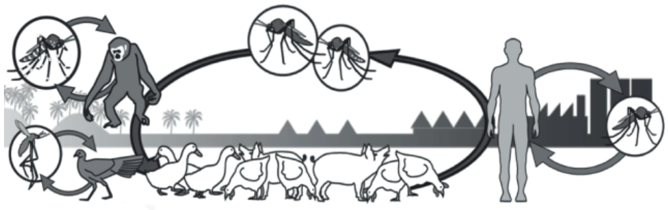


Here's what we'll cover in Module 8:

1. Vector-borne disease (VBD) introduction
2. Effects of climate change on VBD
3. Some case studies of climate change effects on VBD
4. Potential for adaptation to minimize health risks and impacts

4

1



Introduction to vector-borne disease (VBD)

Let's start by looking at a general introduction to vector-borne diseases.

5

What is vector-borne disease?

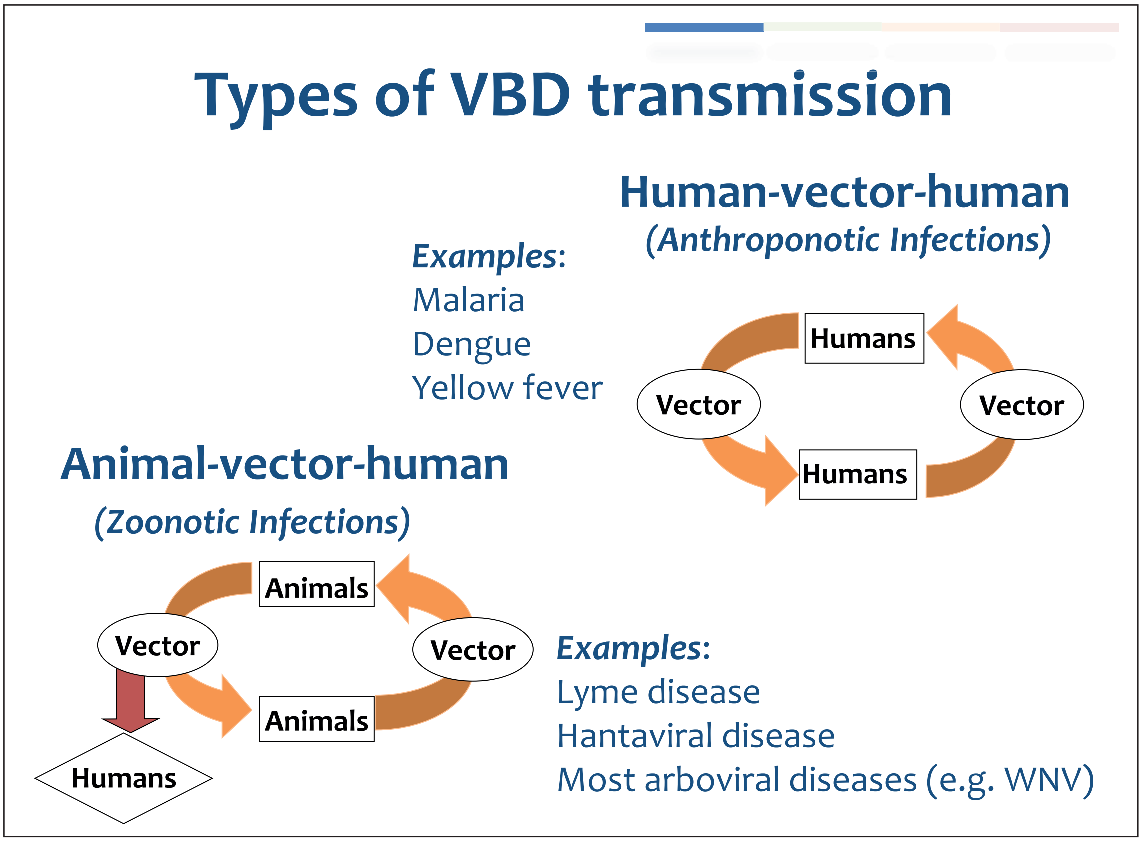
Diseases that are spread by arthropod or small animal vectors.


Vectors act as the main mode of transmission of infection from one host to another, & as such, form an essential stage in the transmission cycle.

VBDs are diseases that are spread by arthropod or small animal vectors.

Vectors act as the main mode of transmission of infection from one host to another and as such form an essential stage in the transmission cycle.

6

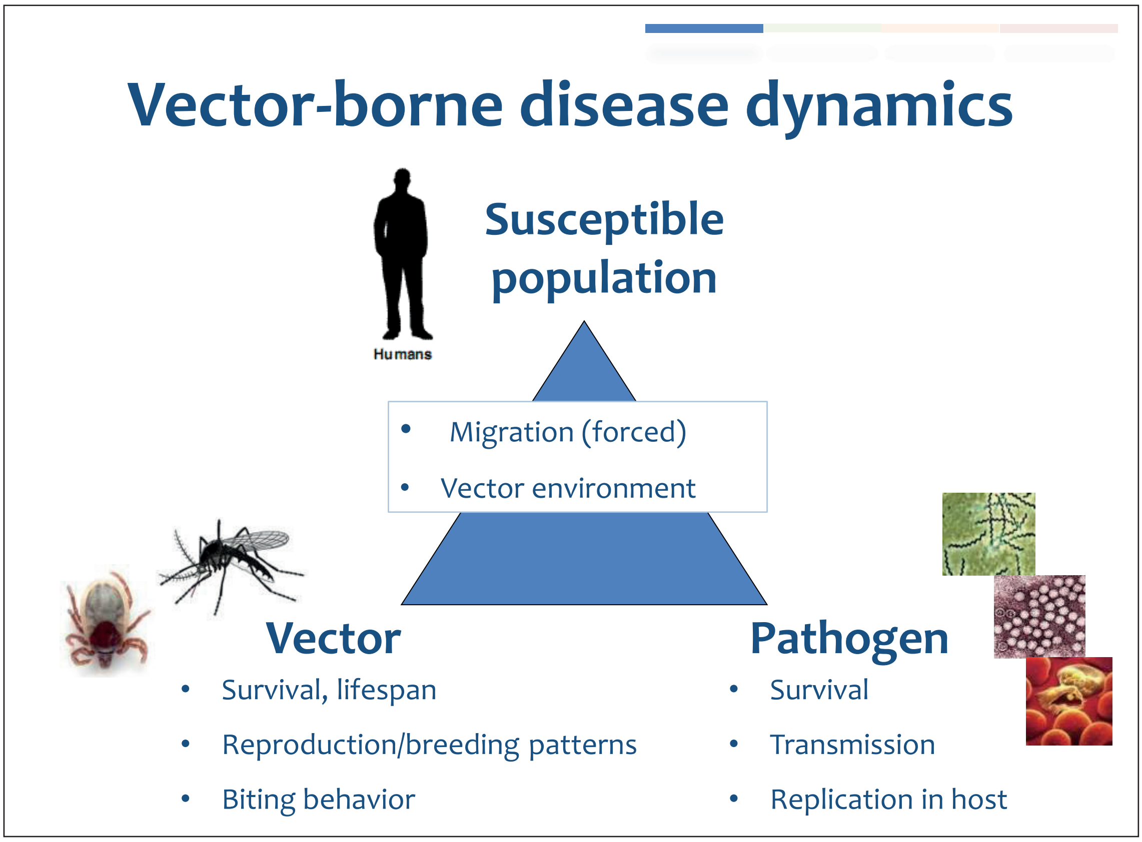


Two main types of VBD transmission exist:

1. Anthroponotic infections – or human-vector-human transmissions, where humans are the only reservoir of the disease
2. Zoonotic infections – or animal-vector-human transmission, where animals are the main reservoir of the disease and humans are considered secondary or spillover hosts and do not generally contribute to the disease transmission cycle as their levels of circulating pathogen are often too low to help maintain transmission.

The type of transmission of a VBD has implications for control strategies. Anthroponotic infections can theoretically be eradicated if all human cases of the disease can be treated, whereas zoonotic diseases are much more difficult to control since all animal reservoirs of the disease would need to be treated.

7



There are 3 crucial elements which must co-exist for the occurrence of VBD:

1. The susceptible population
2. The vector (most often arthropods), and
3. The disease pathogen (e.g., bacteria, virus, parasite).

In areas where VBD most frequently occurs, conditions must be suitable for vectors and pathogens, which implies physiologically suitable conditions for vector, host, and pathogen survival and reproduction/replication.

There are a number of areas in the world where conditions may be suitable for all three components; however, other factors have acted to prevent or eradicate disease transmission in these areas, perhaps as a result of improved health care services or vector control measures.

Global climate change is likely to affect all 3 of these components both directly and indirectly. As an example of direct effects: Arthropods are highly sensitive to changes in temperature and precipitation as they cannot regulate their own internal temperatures and are therefore critically dependent on climate for survival and development (Githeko et al., 2000). Changes in climate may accelerate the development time of some arthropod species, for example.

Similarly, many pathogens are climate sensitive as well, and changes in climate could result in increased reproduction rates of some pathogens.

Some example of indirect effects might include: Changes in livelihood conditions due to climate change, which could affect nutritional status of individuals, thereby potentially increasing susceptibility to disease.

The next section will cover indirect and direct effects of climate change on human health in more detail.

8

Vector-borne diseases of concern

Protozoan

Disease	Pathogen	Vector	Transmission
Malaria	*Plasmodium falciparum, vivax, ovale, malariae*	***Anopheles* spp. Mosquitoes**	**Anthroponotic**
Leishmaniasis*	*Leishmania* spp.	***Lutzomyia* & *Phlebotomus* spp. Sandflies**	**Zoonotic**
Trypanosomiasis *	*Trypanosoma brucei gambiense, rhodesiense*	***Glossina* spp. (tsetse fly)**	**Zoonotic**
Chagas disease*	*Trypanosoma cruzi*	***Triatomine* spp.**	**Zoonotic**

* WHO neglected tropical disease

Source: Hill et al. (2005)

Which vector-borne diseases are of most concern?

There are many VBDs of concern, especially in developing countries, a number of which are on the WHO list of neglected tropical diseases because they occur in areas where poverty is the most significant risk factor for their occurrence. These include Leishmaniasis, Trypanosomiasis, Chagas, Dengue, Lymphatic filariasis, and Onchocerciasis.

The agents causing these diseases are protozoa, bacteria, viruses and filarial nematodes, and are transmitted by a range of arthropod vectors.

Let's first look at Protozoan agents and their associated disease, pathogens, vectors and transmission type. **CLICK TWICE** to get 'Protozoan' title and table to appear.

Source: *Hill, C.A., F.C. Kafatos, S.K. Stansfield, and F.H. Collins. 2005 Arthropod-borne diseases: Vector control in the genomics era. Nature Reviews Microbiology 3:262–268.*

9

Vector-borne diseases of concern:
Viral

Disease	Pathogen	Vector	Transmission
Dengue*	*DEN-1,2,3,4 flaviviruses*	***Aedes aegypti* mosquito**	**Anthroponotic**
Yellow fever	*Yellow fever flavivirus*	***Aedes aegypti* mosquito**	**Anthroponotic**
Encephalitis (West Nile, Lyme, etc.)	*Flavi-, alpha- & bunyaviruses*	**Mosquitoes & ticks**	**Zoonotic**

* WHO neglected tropical disease

Source: Hill et al. (2005)

There are many VBDs of concern, especially in developing countries, a number of which are on the WHO list of neglected tropical diseases (including Leishmaniasis, Trypanosomiasis, Chagas, Dengue, Lymphatic filariasis, and Onchocerciasis) because they occur in areas where poverty is the most significant risk factor for their occurrence.

The agents causing these diseases are protozoa, bacteria, viruses and filarial nematodes and are transmitted by a range of arthropod vectors.

10

Vector-borne diseases of concern:
Filarial nematodes

Disease	Pathogen	Vector	Transmission
Lymphatic filariasis*	*Brugia malayi, timori, Wuchereria bancrofti*	**Anopheles, Culex, Aedes mosquitoes**	**Anthroponotic**
Onchocerciasis*	*Onchocerca volvulus*	***Simulium* spp. blackflies**	**Anthroponotic**

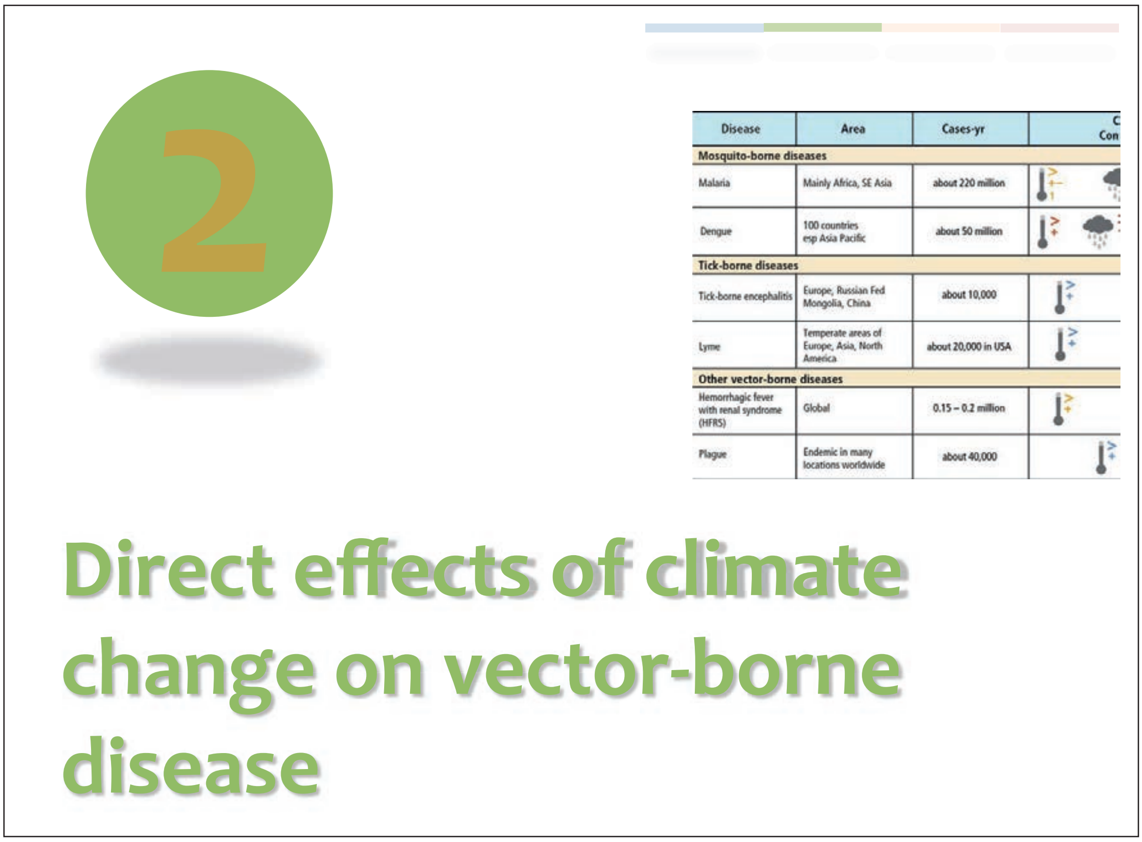
* WHO neglected tropical disease

Source: Hill et al. (2005)

There are many VBDs of concern, especially in developing countries, a number of which are on the WHO list of neglected tropical diseases (including Leishmaniasis, Trypanosomiasis, Chagas, Dengue, Lymphatic filariasis, and Onchocerciasis) because they occur in areas where poverty is the most significant risk factor for their occurrence.

The agents causing these diseases are protozoa, bacteria, viruses and filarial nematodes and are transmitted by a range of arthropod vectors.

11


2
Disease
Area
Cases-yr
Mosquito-borne diseases
Malaria
Mainly Africa, SE Asia
about 220 million
Dengue
100 countries esp Asia Pacific
about 50 million
Tick-borne diseases
Tick-borne encephalitis
Europe, Russian Fed Mongolia, China
about 10,000
Lyme
Temperate areas of Europe, Asia, North America
about 20,000 in USA
Other vector-borne diseases
Hemorrhagic fever with renal syndrome (HFRS)
Global
0.15 – 0.2 million
Plague
Endemic in many locations worldwide
about 40,000
Direct effects of climate change on vector-borne disease

12

Direct effects of climate change on vector-borne disease

Climate change has the potential to:

- Increase range or abundance of animal reservoirs &/or arthropod vectors
  - e.g. Malaria, Schistosomiasis, Lyme
- Prolong transmission cycle
  - e.g. Malaria, West Nile virus & other arboviruses
- Increase importation of vectors or pathogens
  - e.g. Dengue, Chikungunya, West Nile virus
- Increase animal disease risk & potential human risk
  - e.g. African Trypanosomiasis

Source: Greer et al. (2008)

In terms of direct effects, climate has the potential to:

1. Increase the range or abundance of both animal reservoirs and arthropod vectors.

   There is some emerging evidence of this occurring with Schistosomiasis in China and malaria in the Kenyan Highlands.

2. Climate change may also prolong the length of the transmission cycles of disease or the transmission season of diseases.

   West Nile virus (WNV), which has recently appeared in North America, has an amplification cycle involving mosquitoes and avian reservoir hosts. Human risk of infection is highest late in the summer when mosquito population densities are highest. Warmer spring and fall temperatures could increase the transmission season of the disease, thereby shifting the risk of human infection of the disease earlier in the summer.

3. Climate could also increase the likelihood of successful importation of disease vectors and animal host reservoirs.

   For example, the global spread of the Asian tiger mosquito, Aedes albopictus, which has been linked to the sale of used tires around the world, was linked to an outbreak of chikungunya virus, a dengue-like virus in Italy in 2007. Importation of a suitable animal reservoir is believed to be one of the possible methods of introduction of WNV to North America in the late 1990s.

4. As mentioned previously, climate change effects resulting in increased animal incidence of disease are likely to increase the risk of human disease as well.

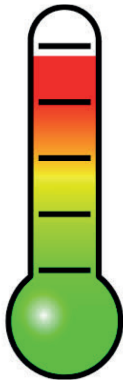
Source: *Greer, A., V. Ng, and D. Fisman. 2008. Climate change and infectious diseases in North America: The road ahead. CMAJ 178(6):715–722.*

13

Temperature effects on vectors & pathogens

Vector

- Survival decrease/increase depending on the species
- Changes in the susceptibility of vectors to some pathogens
- Changes in rate of vector population growth
- Changes in feeding rate & host contact



Source: Gubler et al. (2001)

Temperature can affect both the distribution of the vector and the effectiveness of pathogen transmission through the vector.

Gubler et al. (2001) list a range of possible mechanisms whereby changes in temperature impact on the risk of transmission of VBD:

Temperature may act to:

- Increase or decrease vector survival
- Change the rate of vector population growth
- Change the feeding behavior of vectors
- Change the susceptibility of vector to pathogens
- Change the incubation period of pathogens in vectors
- Change the seasonality of vector activity
- Change the seasonality of pathogen transmission
- Vector is infective.

Source: *Gubler, D.J., P. Reiter, K.L. Ebi, W. Yap, R. Nasci, and J.A. Patz. 2001. Climate variability and change in the United States: Potential impacts on vector- and rodent-borne diseases. Environmental Health Perspectives 109(Supplement 2):223-233.*

14

Temperature effects on vectors & pathogens

Pathogen

- Decreased extrinsic incubation period of pathogen in vector at higher temperatures
- Changes in the transmission season
- Changes in geographical distribution
- Decreased viral replication

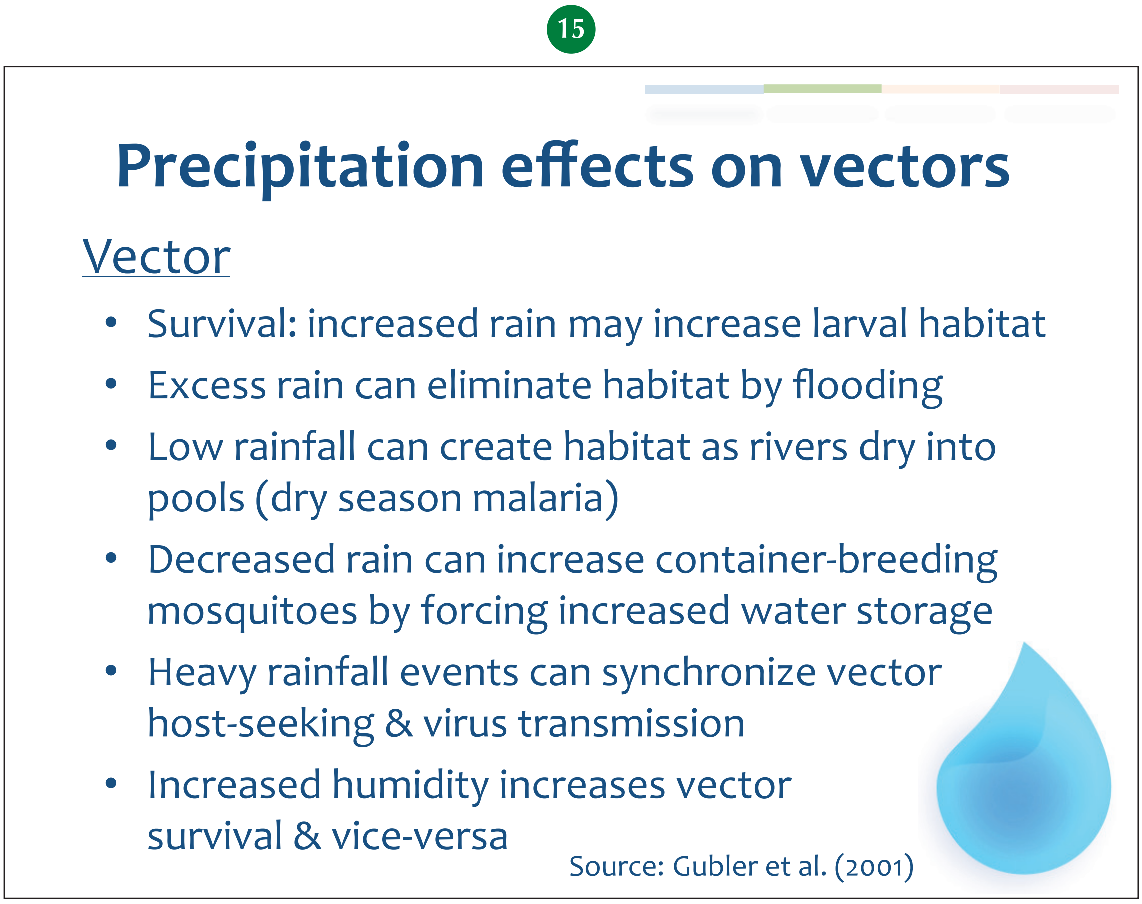
Source: Gubler et al. (2001)

Temperature can affect both the distribution of the vector and the effectiveness of pathogen transmission through the vector.

Gubler et al. (2001) list a range of possible mechanisms whereby changes in temperature impact on the risk of transmission of VBD:

Temperature may act to:

- Increase or decrease vector survival
- Change the rate of vector population growth
- Change the feeding behavior of vectors
- Change the susceptibility of vector to pathogens
- Change the incubation period of pathogens in vectors
- Change the seasonality of vector activity
- Change the seasonality of pathogen transmission
- Vector is infective.



Precipitation can also have a number of effects on vectors.

Gubler et al. 2001 highlight that:

Precipitation effects could include:

- Increased surface water thereby providing increased breeding sites for vectors
- Decreased rainfall could also increase breeding sites by slowing river flow
- Increased rain could increase vegetation and allow expansion in populations of vertebrate host
- Flooding could eliminate habitat for both vectors and vertebrate hosts
- Flooding could also force vertebrate hosts into closer contact with humans.

16

Precipitation effects on pathogens

Pathogen

- Few direct effects but some data on humidity effects on malarial parasite development

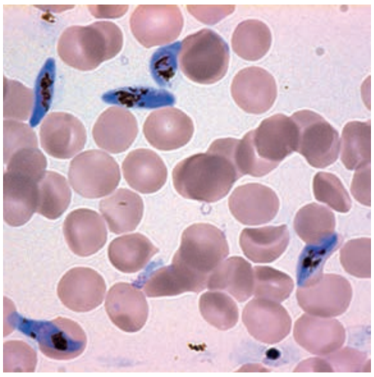


Photo: Science Daily

Source: Gubler et al. (2001)

Precipitation – and particularly humidity with precipitation - can also effects the development of malarial parasites.

(If asked: In this image shown in blue are Plasmodium falciparum malaria parasites in the sexual, gametocyte stage of development. In red are uninfected red blood cells.)

17

Vector activity

- Increased relative humidity increases activity, heavy rainfall decreases activity
- Increased activity increases transmission rates

Photo: National Geographic

Photo: Ranger DJ

Source: Ogden et al. (2005), Vail & Smith (1998)

Humidity and precipitation can also have a significant role in vector activity. A greater relative humidity can increase vector activity, but heavy rainfall can actually decrease activity.

Increased activity increases transmission rates.

Source: *Ogden N.H., M. Bigras-Poulin, C.J. O'Callaghan, I.K. Barker, L.R. Lindsay, A. Maarouf, K.E. Smoyer-Tomic, D. Walter-Toews, and D. Charron. 2005. A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick Ixodes scapularis. International Journal for Parasitology 35:375-389.*

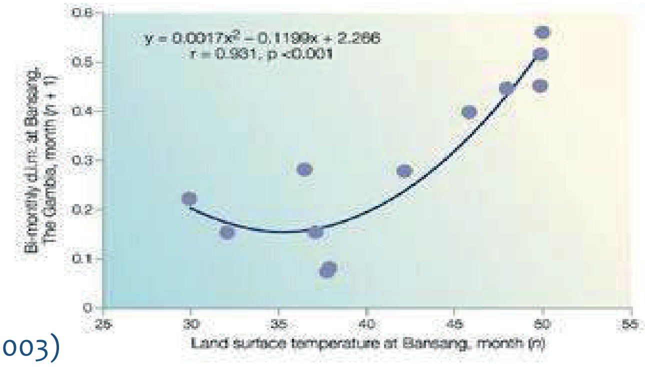
Vail, S.G. and G. Smith. 1998. Air temperature and relative humidity effects on behavioral activity of blacklegged tick (Acari: Ixodidae) nymphs in New Jersey. Journal of Medical Entomology 35(6):1025-1028.

18

Vector survival

- Direct effects of temperature on mortality rates*
- Temperature effects on development: at low temperatures, lifecycle lengthens & mortality outstrips fecundity*

Tsetse mortality



* Non-linear (quadratic) relationships with temperature

Source: Rogers & Randolph (2003)

Relationship between temperature and vector mortality is quadratic: mortality rates increase at high and low temperatures.

Temperature effects on development may affect mortality rates: particularly high rates of development of mosquitoes can result in small adults with poorer survival. This is one example where the terms in epidemiological models of VBDs interact with one another. Another important interaction is the dependence of transmission coefficients for tick-borne pathogens on the numbers of vectors feeding on the host. The understanding of such interactions is, however, largely rudimentary.

When relative humidity is low, ticks have to make more frequent, energy-expensive trips to the litter layer to rehydrate. High “monsoon” rainfall knocks ticks off the herbage and prevents them from finding a host.

Lower humidity ↑ the energy requirement for host seeking by ticks shortening their lives.*

Lower rainfall ↓ breeding areas for mosquitoes, compounded by density-dependent intraspecific competition amongst larvae.

More complex community-associated changes (habitat structure, predator abundance).

Source: *Rogers, D.J. and S.E. Randolph. 2003. Studying the global distribution of infectious diseases using GIS and RS. Nature Reviews Microbiology 1(3):231-237.*

19

Vector & host seasonality

- Vector-borne zoonoses mostly maintained by wildlife
- Vectors & their hosts are subject to seasonal variations that are climate related (e.g. temperature) & climate independent (e.g. day-length)
- Seasonal variations affect abundance & demographic processes of both vectors & hosts

Many VBDs are zoonotic and have life cycles that are fully maintained in wildlife.

In these diseases, seasons often play a very important role in the relationships between vectors and hosts.

20

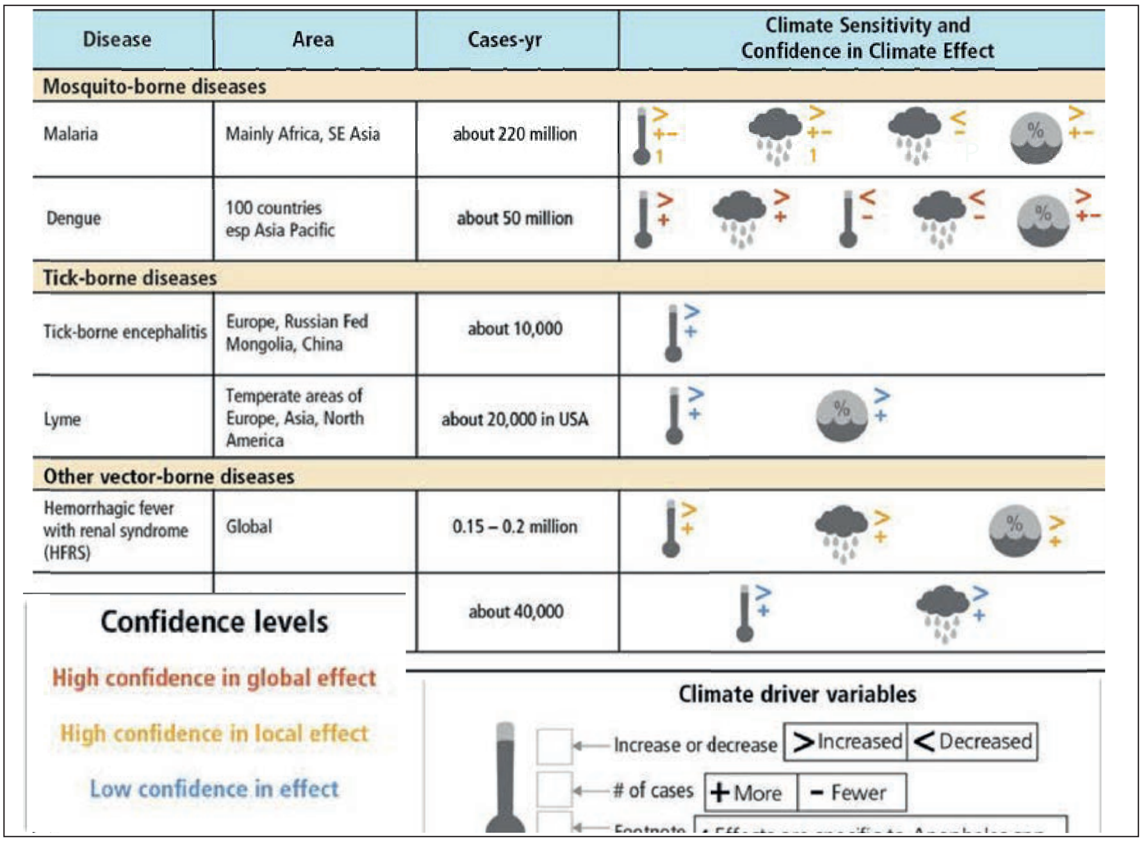
Vector & host seasonality

- Vector seasonality due to temperature affects development & activity ⟶ transmission
- Host demographic processes (reproduction, birth & mortality rates), affected directly by weather & indirectly by resource availability ⟶ VBD epidemiology

Both vectors and hosts have seasonal variations in their life cycles driven by seasonal changes in climate and climate independent effects such as day length.

- Vectors can be affected by the way in which temperature can change from season to season, with resultant impacts on their development, activity, and disease transmission role.
- The lifecycle and activity level of the host can be affected as well, affecting how fast infected or immune animals die and how fast uninfected animals are borne, with resultant impacts on the epidemiology of vector-borne zoonoses.

21



Disease	Area	Cases-yr	Climate Sensitivity and Confidence in Climate Effect
Mosquito-borne diseases			
Malaria	Mainly Africa, SE Asia	about 220 million	
Dengue	100 countries esp Asia Pacific	about 50 million	
Tick-borne diseases			
Tick-borne encephalitis	Europe, Russian Fed Mongolia, China	about 10,000	
Lyme	Temperate areas of Europe, Asia, North America	about 20,000 in USA	
Other vector-borne diseases			
Hemorrhagic fever with renal syndrome (HFRS)	Global	0.15 – 0.2 million	
		about 40,000	

The latest IPCC report shows the association between different climatic drivers and the global prevalence and geographic distribution of selected vector-borne diseases observed over the period 2008-2012.

CLICK *to animate the image to full screen.* ***CLICK*** *again to show the key for the confidence levels shown in the table.*

Among the vector borne diseases shown here, only dengue fever was associated with climate variables at both the global and local levels (high confidence), while malaria and hemorrhagic fever with renal syndrome showed a positive association at the local level (high confidence).

Source: *IPCC. 2014. AR5 Report.*

22

Evidence of climate change effects

Some specific disease examples:

- Malaria - East African highlands
- Schistosomiasis - China


Photo: CDC

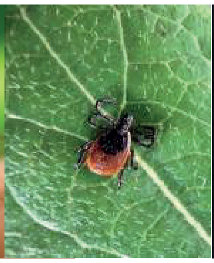


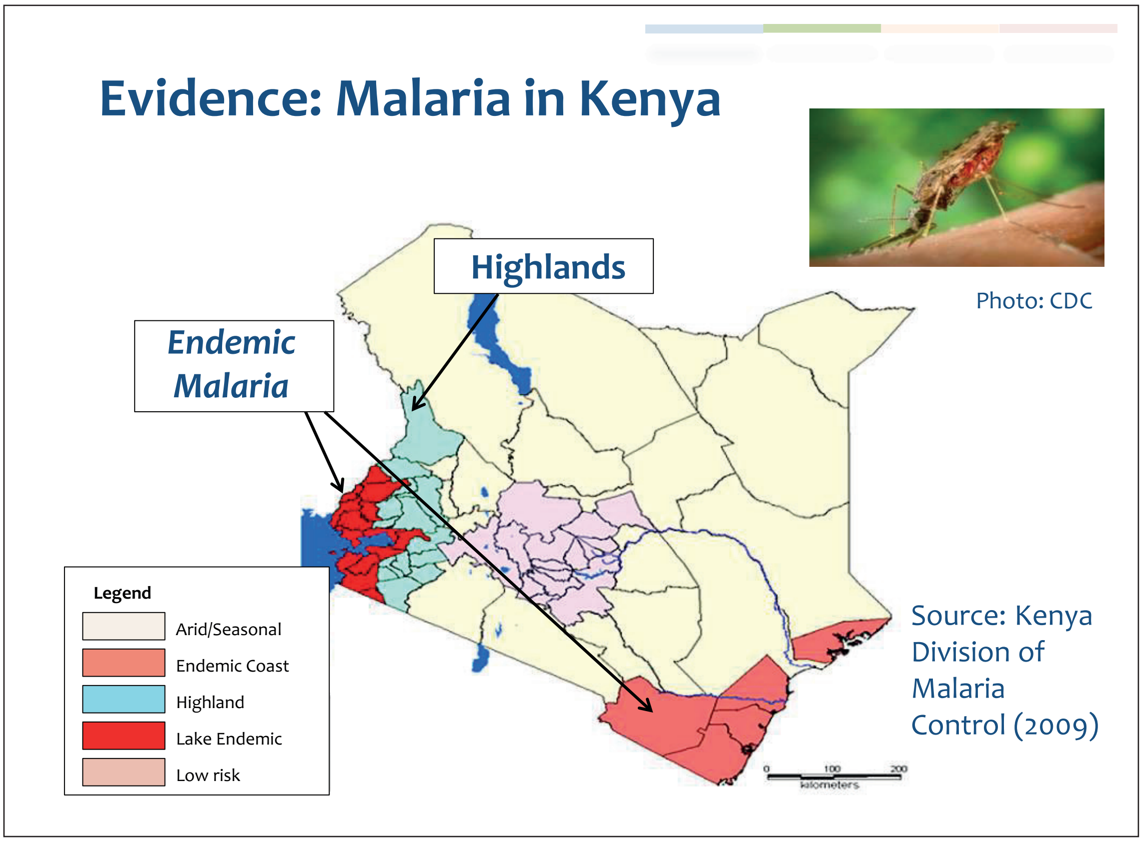
Photo: USDA


Photo: Davies Laboratory


Photo: CDC

In the next section, we will be looking at evidence of climate change effects. We will review some specific examples that provide some potential evidence of the effects of climate change on VBD. Our examples will include malaria, schistosomiasis, and bluetongue disease.

23

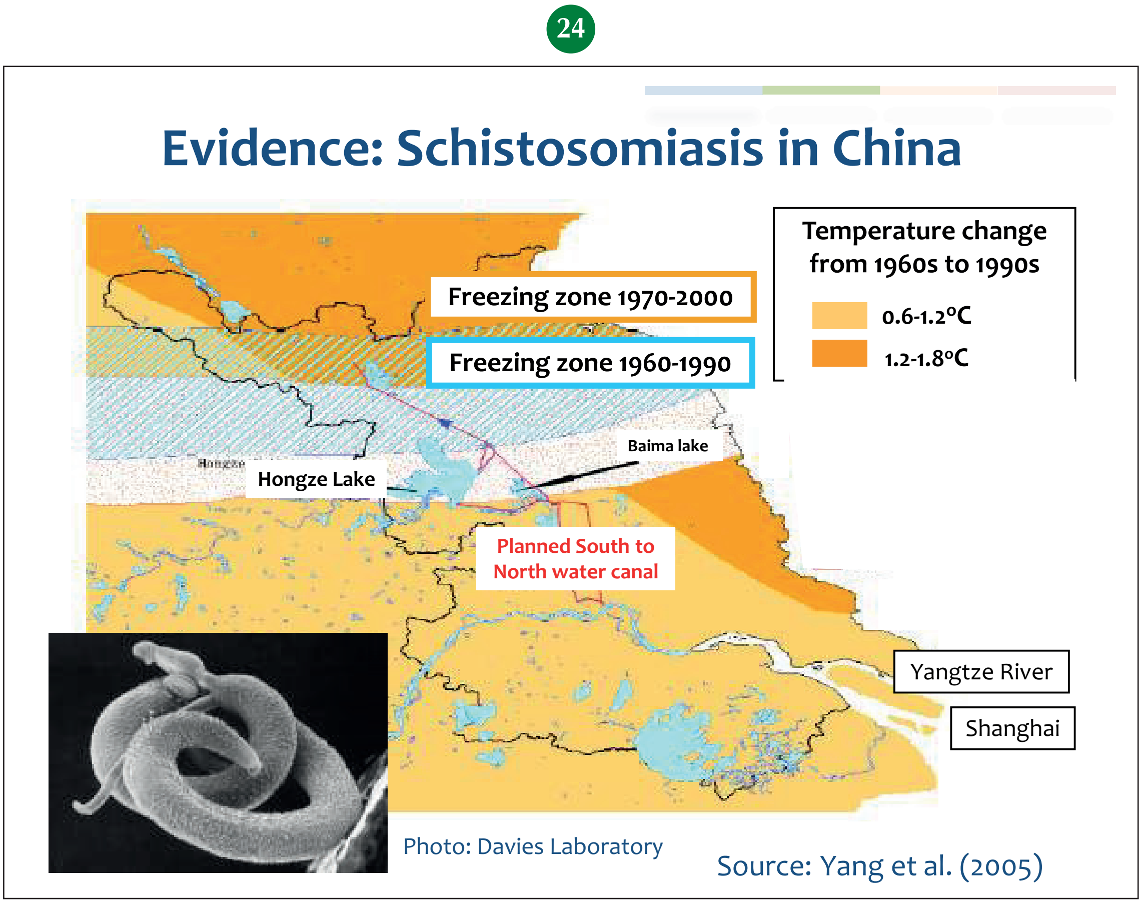


A study by Pascual et al. (2006) reviewed temperature data for the past 50 years in East Africa to examine the role of climate in exacerbating incidence of endemic malaria in the Eastern highlands of Kenya where increases in malaria have been observed since the 1970s.

Their analysis found evidence for significant warming at all sites and an applied dynamic model suggested that biological responses, such as those by the vector and pathogen, would also be magnified by at least 1 order of magnitude under climate warming.

The map you see in the slide shows the different areas of Kenya and the different incidence rates. The bright red portion of the map shows an area with endemic malaria. The pink area on the coast also shows an area with endemic malaria. The aqua section of the map that abuts the red endemic area is the “Highlands” area, where incidence has been increasing.

Source: *Kenya Division of Malaria Control. 2009. Malaria Background Info. Available: http://www.nmcp.or.ke/section.asp?ID=3*



The next example looks at Schistosomiasis in China.

There has been a northwards extension of potential transmission (limited by "freezing zone"), in Jiangsu Province, due to a rise in the average temperature in January since 1960.

The study by Yang et al. (2005) noted an increase in the reported incidence of Schistosomiasis over the past decade which may reflect the recent warming.

The northwards expansion of the "freeze line" (which limits survival of water snails) puts 21 million extra people at risk.

Source: *Yang G.J., P. Vounatsou, X.N. Zhou, M. Tanner, and J. Utzinger. 2005. A potential impact of climate change and water resource development on the transmission of Schistosoma japonicum in China. Parassitologia 47:127-134*

25

Summary of climate change effects on VBD:

Climate change has the potential to:

- Increase range or abundance of animal reservoirs &/or arthropod vectors
- Prolong transmission cycle
- Increase importation of vectors or animal reservoirs
- Increase animal disease risk & potential human risk

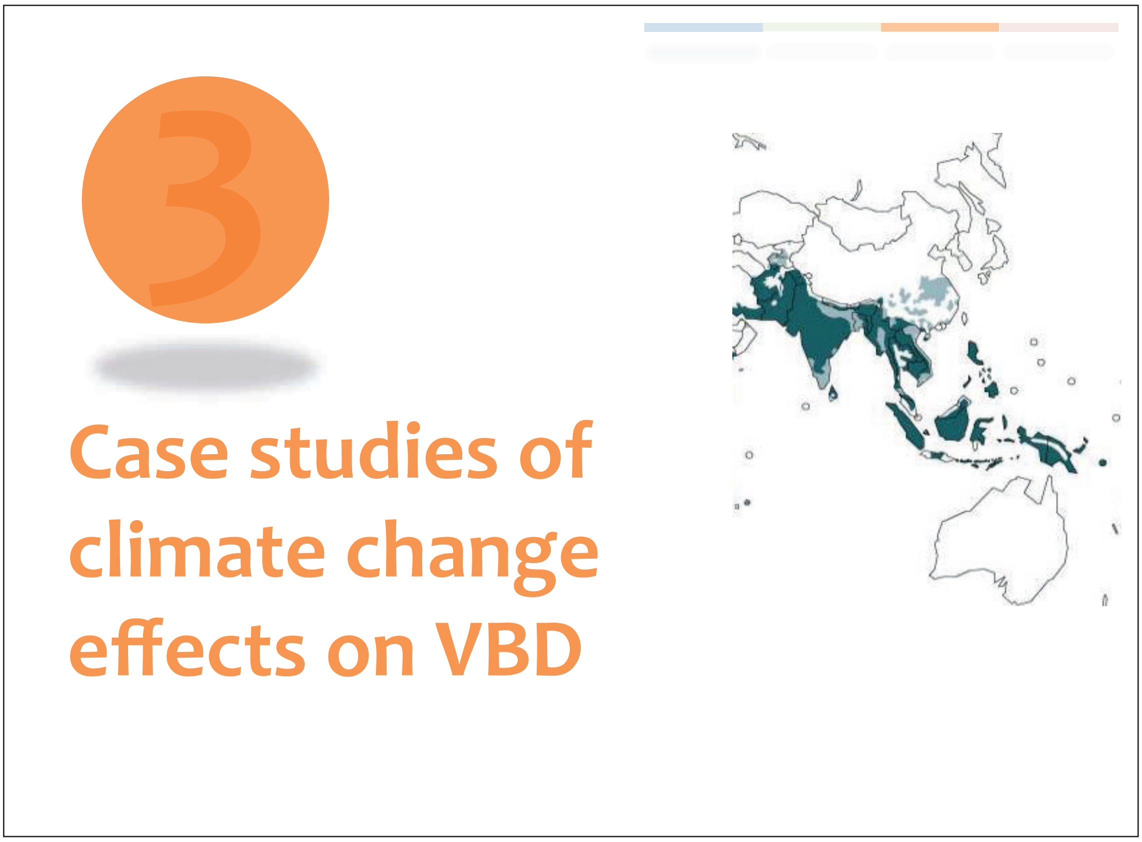
To finish off this section on the direct effects of climate change on VBD's, a quick recap:

The major ways in which climate change is likely to impact VBD include:

1. Increasing the range or abundance of animal reservoir and arthropod vectors
2. Prolonging the transmission cycle of disease
3. Increasing the likelihood of successful importation of disease vectors or animal reservoirs
4. Increasing the animal disease risk and potential human risks of disease.

We'll next look at some case studies of the influence of climate change on vector-borne disease.

26

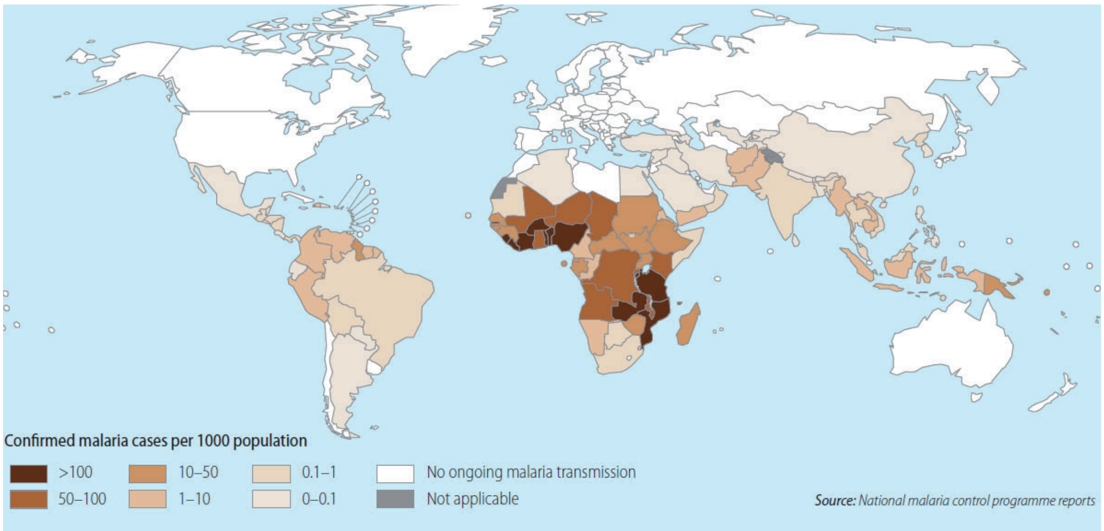


In the two case studies I'll present we'll focus particularly on malaria and dengue – two diseases with significant impacts across the Asia Pacific.

27

Case Study 1: Malaria

Countries with ongoing transmission of malaria, 2013



In 2014, 97 countries and territories had ongoing malaria transmission.

An estimated 3.3 billion people are at risk of malaria, of whom 1.2 billion are at high risk. In high-risk areas, more than one malaria case occurs per 1000 population.

There were an estimated 198 million cases of malaria worldwide (range 124–283 million) in 2013, and an estimated 584 000 deaths (range 367 000–755 000). 90% of all malaria deaths occur in Africa.

Between 2000 and 2013, an expansion of malaria interventions helped to reduce malaria incidence by 30% globally, and by 34% in Africa.

During the same period, malaria mortality rates decreased by an estimated 47% worldwide and by 54% in Africa. In the under-five age group, mortality rates have declined by 53% globally, and by 58% in Africa.

This is a map of the current distribution of malaria transmission.

Transmission zones are highly dependent on climate. Localized transmission is affected by regional factors (such as type of vegetation, health services, vector control), but the global ranges are predominantly affected by climate. The key areas of importance for climate change will be changes (loss or appearance) of incidence at the margins of these ranges, where climate suitability for the vector and/or pathogen are currently marginal, and where small shifts in climate may push the transmission potential of the disease above or below the required threshold.

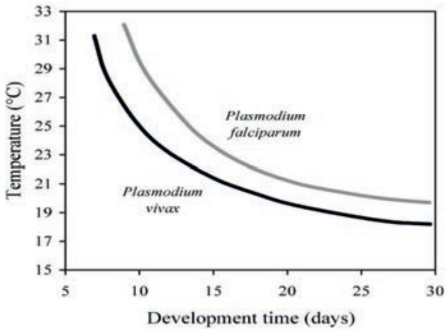
- There will likely be areas of decline and areas of emergence
- Impacts are likely to depend on localized factors and a combination of climate and socioeconomic conditions
- Risk will increase the most on the fringes of malarial transmission, but control is generally good in these areas
- Impacts will likely remain highest in currently endemic areas, where control is poor and vulnerability is high.

Source: *WHO, 2014. World Malaria Report 2014*

28

Malaria & climate

- Climate sensitive disease[1]
  - No transmission where mosquitoes cannot survive
  - *Anopheles*: optimal adult development 28-32°C
  - *P falciparum* transmission: 16-33°C
- Highland malaria[2]
  - Areas on the edges of endemic regions
- Global warming → El Niño[3]
  - Outbreaks



Source: McDonald et al. (1957)

[1] Khasnis & Nettleman (2005); [2] Patz & Olson (2006); [3] Haines & Patz (2004)

The effect of climate change on malaria remains in debate.

But malaria is an extremely climate sensitive disease. **Clearly transmission does not occur in climates where mosquitoes cannot survive**. Optimal larval development occurs at 28°C and optimal adult development between 28 and 32°C, as you can see in this temperature and development graph on the right. Transmission cannot occur below 16°C or above 33°C as sporogony (the production of sporozoites which comprises dissemination and development of the parasite in the vector) cannot take place.

The effect of global warming on malaria may be felt most in areas that are currently on the edges of the range of infected mosquitoes (Patz and Olson, 2006). These include many of the densely populated highland regions in Africa that are surrounded by lowland areas where malaria is endemic. Small changes may therefore lead to the exposure of many people to malaria.

Many global warming scenarios include an increase in the frequency and intensity of the El Niño phenomenon (Patz et al., 2002) such as storms, heavy rain, droughts, and warm temperature. El Niño seasons have been associated, although not always, with outbreaks of malaria in many areas (ref Atul). Therefore it seems reasonable to speculate that the intensification of El Niño effects due to global warming will facilitate local epidemics of malaria.

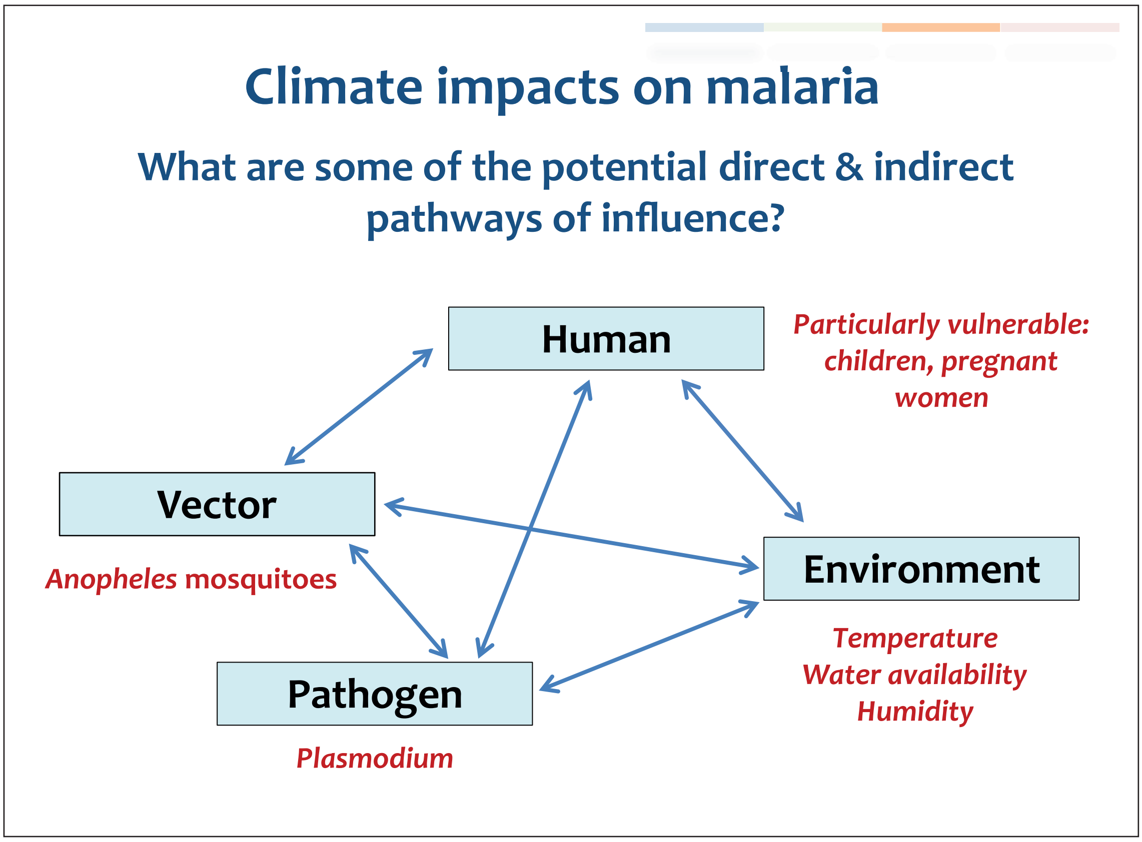
Source: *Macdonald, G. 1957. The Epidemiology and Control of Malaria. Oxford University Press, London, UK.*

Khasnis, A.A. and M.D. Nettleman. 2005. Global warming and infectious disease. Archives of Medical Research 36:689–696.

Patz, J.A. and S.H. Olson. 2006. Malaria risk and temperature: Influences from global climate change and local land use practices. PNAS 103(15):5635-5636.

Haines A. and J.A. Patz. 2004. Health effects of climate change. JAMA 291(1):99–103.

29



This slide will examine the role of climate impacts on the vector, the pathogen, and humans.

Vector:

The malaria vector is the Anopheles mosquito. Several key transmission variables can be affected by climate. Most important are the climatic requirements for survival. Different species require different temperature ranges.

Key vector factors:

- Climatic requirements for survival
- Temperature ranges for different species
- Standing water and humidity requirements
- Insecticide resistance (e.g., DDT).

Pathogen:

The malaria pathogen is the Plasmodium parasite. Common species include *P. falciparum, P. vivax,* and *P. malariae*. The pathogen requires a certain temperature for reproduction.

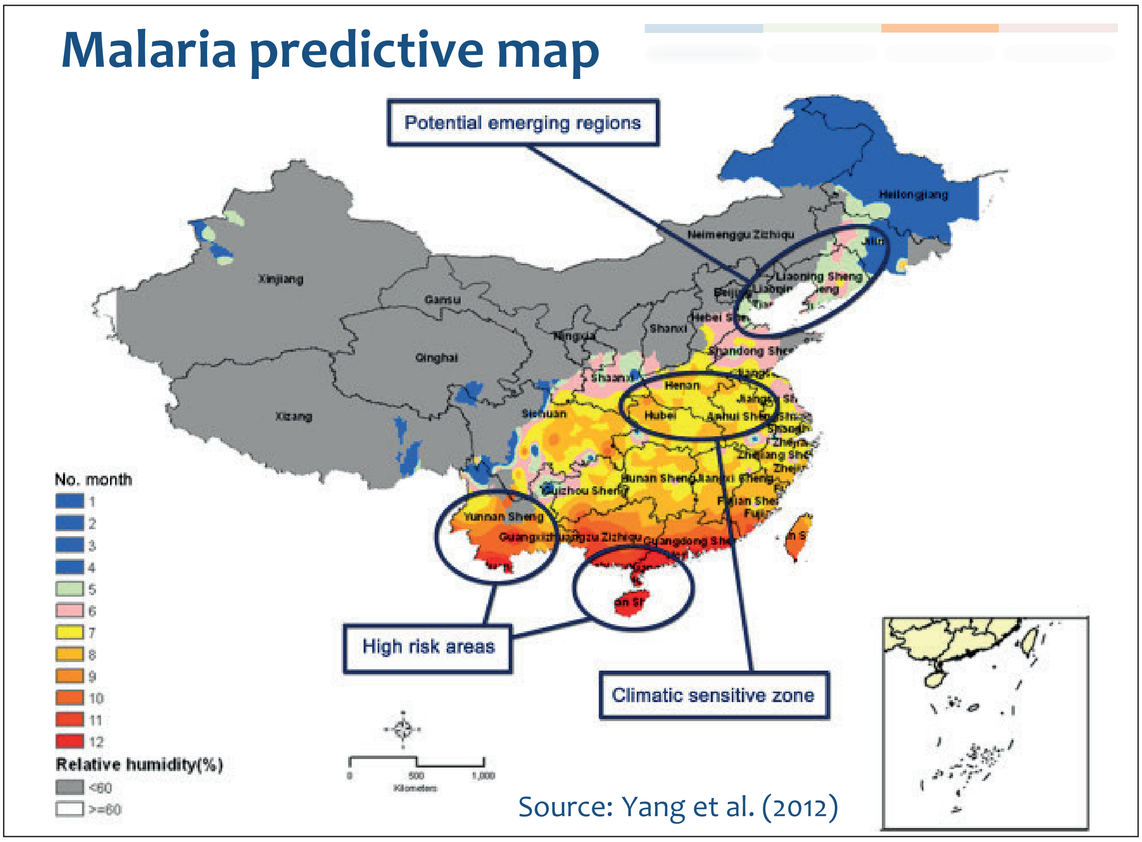
Human population:

The human population can be affected by climate and the environment as well. Climatic change can affect the ability of the human population to access medical treatment. Climate can also affect patterns of human movement, contributing to the spread of transmission to new areas.

Key human population factors:

- Poverty and other social determinants of health
- Acquired immunity
- Access to medical treatment
- Resilience capacity: knowledge of how environmental factors affect malaria (i.e water management).

30



The figure shows a predictive map for malaria according to multiple environmental factors. These maps predict that P. vivax malaria mainly occurs in the south-eastern part of P.R. China with the risk of malaria increasing steadily from north to south. Comparison between different decades shows that there is a high probability that variables suitable for malaria transmission will shift northwards, mainly driven by relative humidity (RH)

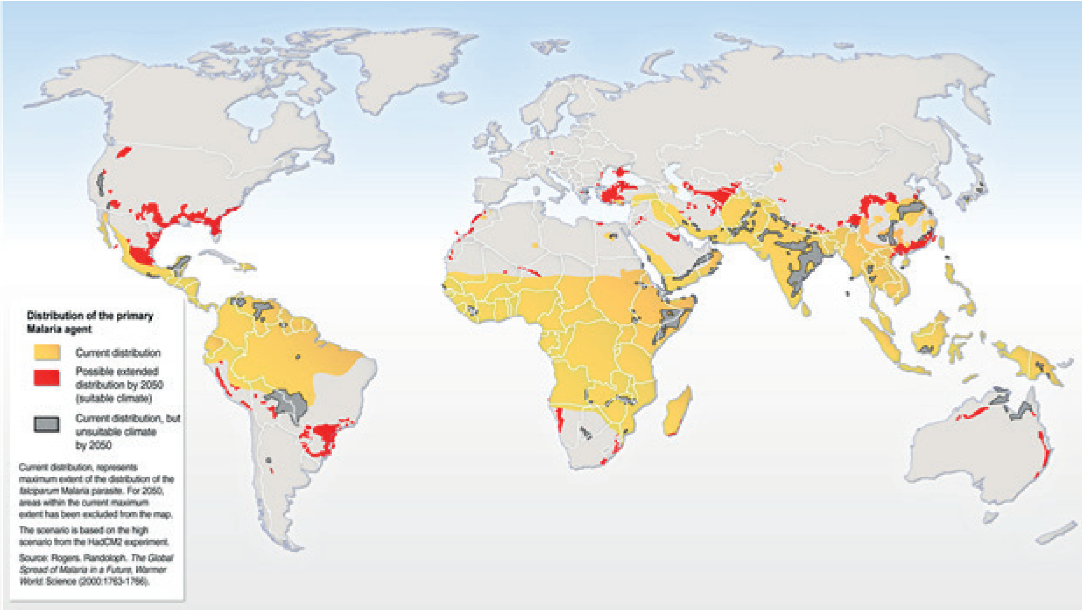
In the southern and south-eastern region of China where is the high risk areas for malaria transmission, the passive and active surveillance approaches identified. In the central region where is the climate sensitive zone to the malaria transmission, an appropriate surveillance-response approach is necessary to develop. In the north-eastern region where is potential malaria emerging regions due to climate change, the continuous surveillance and monitoring is warranted.

Source: *Yang et al. Malaria Journal 2012, Malaria surveillance-response strategies in different transmission zones of the People's Republic of China: preparing for climate change*

31

Climate change & malaria scenario for 2050

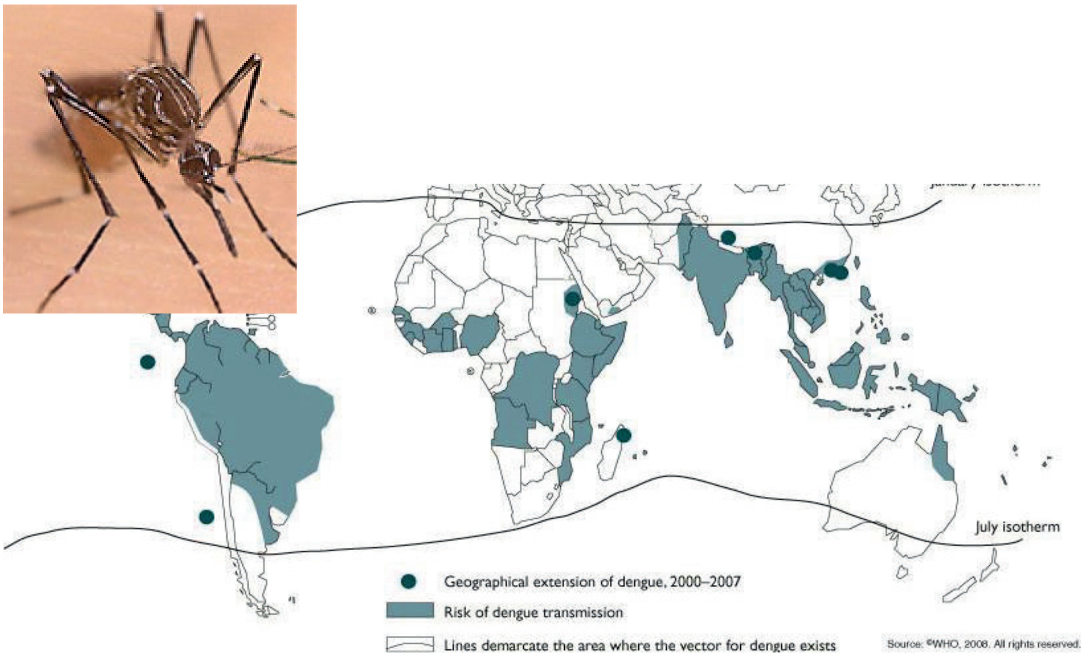
Source: Hugo Ahlenius, UNEP/GRID-Arendal (2005)



With climate conditions changing in the future, due to increased concentrations of carbon dioxide in the atmosphere, conditions for pests also change. The primary Malaria agent, the falciparum malaria parasite, will be able to spread into new areas, as displayed in this map, by 2050 using the Hadley CM2 high scenario.

Source: *Hugo Ahlenius, UNEP/GRID-Arendal. 2005. From collection of Environment and Poverty Times #4: MDG issue*

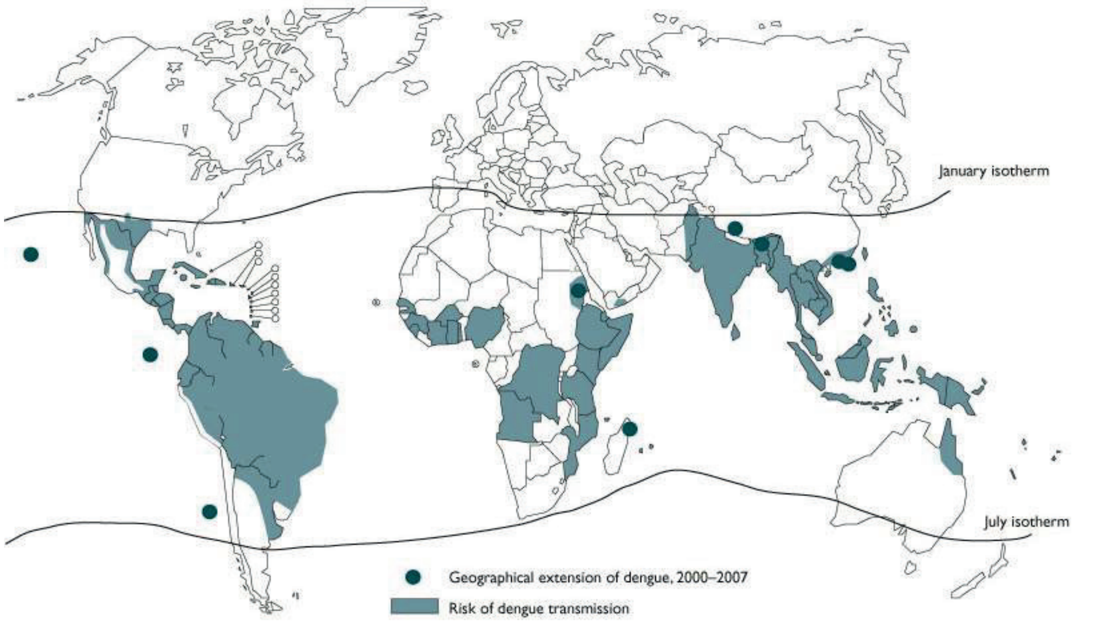
Case Study 2: Dengue



The next case study that we will discuss is dengue.

Dengue is the most rapidly spreading mosquito-borne viral disease, showing a 30-fold increase in global incidence over the past 50 years (WHO, 2013). Each year there occur about 390 million dengue infections worldwide, of which roughly 96 million manifest with symptoms (Bhatt et al., 2013). Three quarters of the people exposed to dengue are in the Asia-Pacific region.

Dengue transmission map



Source: WHO (2008)

This is the current area at risk of dengue transmission in more detail.

The lines represent January and July isotherms and demarcate the area where the vector for dengue exists.

Climate change is likely to shift these isotherms farther north above the equator and farther south below the equator, thereby potentially increasing the size of the area at risk of dengue transmission.

Source: *WHO. 2008. World Health Organization Map, Countries/areas at risk of dengue transmission.*

34

Climate variability & dengue incidence

***Aedes* mosquito breeding (Argentina)[1]:**

- Highest abundance mean temperature 20°C, ↑ accumulated rainfall (150 mm)
- Decline in egg laying at monthly mean temperatures <16,5°C
- No eggs at temperatures <14,8°C

Other studies:

- Virus replication increases ↑ temperature[2]
- Transmission of pathogen ≠ >12°C[3]
- Biological models: small ↑ temperature in temperate regions → increases potential epidemics[4]

Sources: [1]Vezzani et al. (2004); [2]Watts et al. (1987); [3]Patz et al. (2006); [4]Patz et al. (1998)

Dengue is an important mosquito-born disease, with about 2.5 billion people at risk worldwide.

The *Aedes* spp. mosquito vectors are well adapted to the urban environment and thrive well in a warm, humid environment. Viral replication in the vector increases with temperature, with expected temperature-related effects on transmission. Minimal transmission temperature for the dengue virus is 12°C.

Dengue hemorrhagic fever (DHF) outbreak in southern Sumatra was accompanied by more extreme weather due to El Niño effects (Corwin et al., 2001).

Linked to future climate change projections, a small rise in temperature in temperate regions will increase the potential for future epidemics, given a susceptible population and introduction of the virus.

Sources: *[1]Vezzani D., S.M. Velazquez, and N. Schweigmann. 2004. Seasonal pattern of abundance of Aedes aegypti (Diptera: Culicidae) in Buenos Aires city, Argentina. Memoria do Instituto Oswaldo Cruz 99:351-356.*

[2]Watts, D.M., D.S. Burke, B.A. Harrison, R.E. Whitmire, and A. Nisalak. 1987. Effect of temperature on the vector efficiency of Aedes aegypti for Dengue 2 virus. The American Journal of Tropical Medicine and Hygiene 36(1):143-152

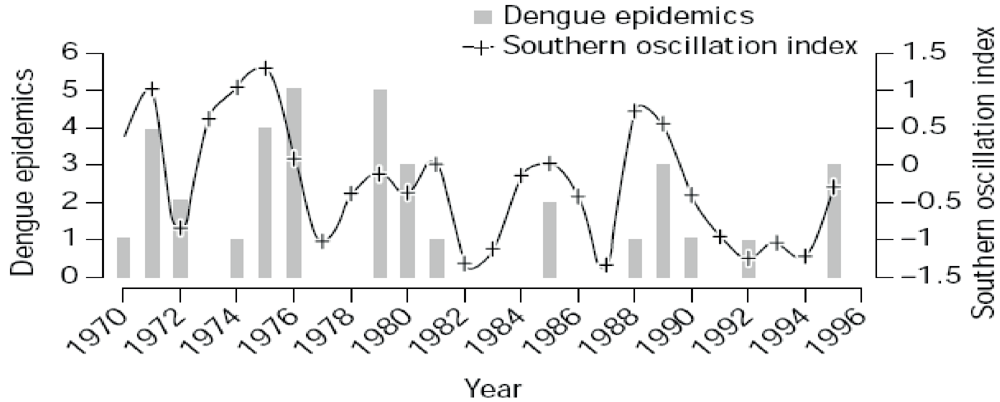
[3]Patz, J.A. and S.H. Olson. 2006. Malaria risk and temperature: Influences from global climate change and local land use practices. PNAS 103(15):5635-5636.

[4]Patz, J.A., W.J. Martens, D.A. Focks, and T.H. Jetten. 1998. Dengue fever epidemic potential as projected by general circulation models of global climate change. Environmental Health Perspectives 106:147-153.

35

Example of weather effects: El Niño

- Global warming intensifies El Niño
- Several studies found relationships between dengue epidemics & ENSO (El Niño Southern Oscillation)



Sources: Hales et al. (1999), Tipayamongkholgul et al. (2009)

Several studies have found relationships between dengue epidemics and ENSO (El Niño Southern Oscillation). ENSO is a global scale pattern of climate variation that accounts for up to 40% of temperature and rainfall variation in the Pacific. Both drought conditions and the rainfall accumulation following a drought contribute to augmentation of the vector population.

Sources: *Hales S., P. Weinstein, Y. Souares, and A. Woodward. 1999. El Nino and the dynamics of vectorborne disease transmission. Environmental Health Perspectives 107(2):99–102.*

Mathuros Tipayamongkholgul, Chi-Tai Fang, Suratsawadee Klinchan, Chung-Ming Liu, and Chwan-Chuen King, 2009. Effects of the El Niño-Southern Oscillation on dengue epidemics in Thailand, 1996-2005

36

Example of weather effects: El Niño

- Drought conditions: increase water storage around houses → elevated *Aedes aegypti* populations
- Enhanced breeding opportunities when rainfall accumulates following drought

Source: Kuno G (1995) Photo: University of California

Several studies have found relationships between dengue epidemics and ENSO (El Niño Southern Oscillation). ENSO is a global scale pattern of climate variation that accounts for up to 40% of temperature and rainfall variation in the Pacific. Both drought conditions and the rainfall accumulation following a drought contribute to augmentation of the vector population.

Source: *Kuno G. 1995. Review of the factors modulating Dengue transmission. Epidemiologic Reviews 17(2):321–335.*

37

4

Potential of adaptation to minimize VBD health risks & impacts

38

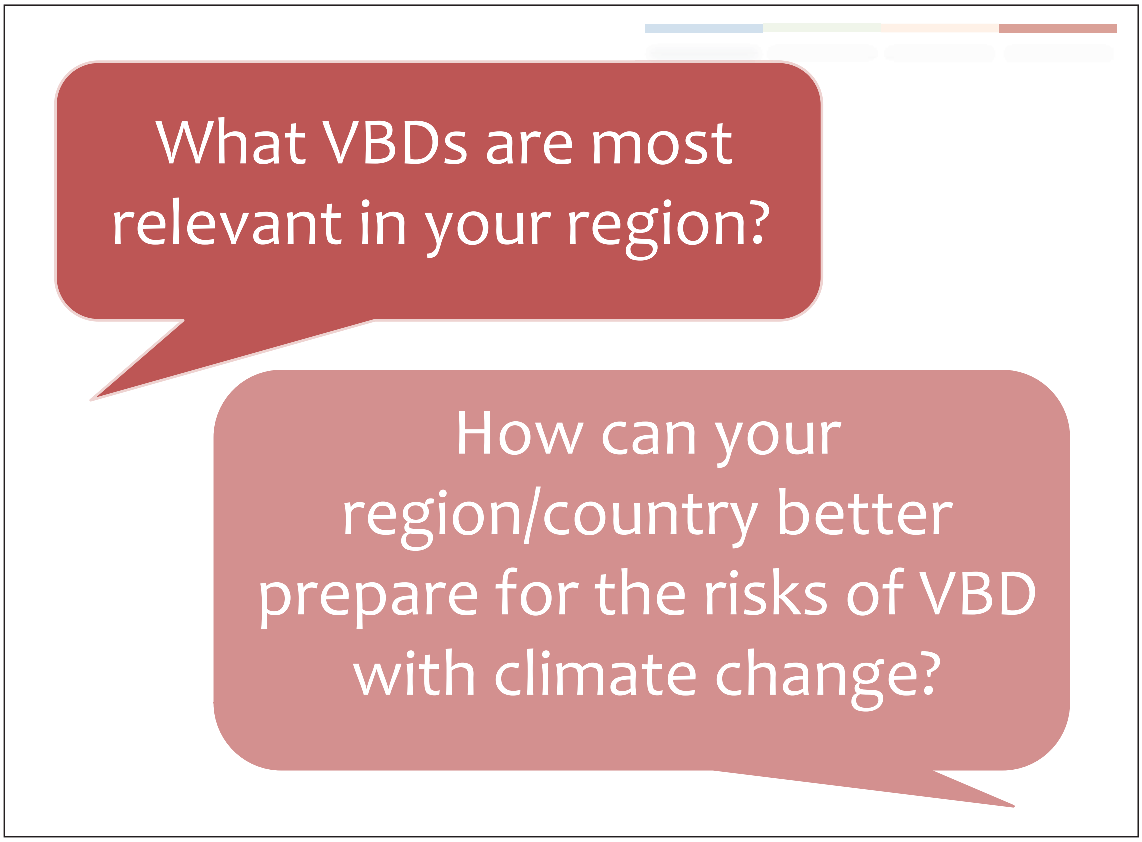
Opportunities for adaptation

- Strengthening surveillance
- Adopting a precautionary approach
- Mainstreaming response to disease threats
- Enhancing health system capacity
- Anticipating new & emergent pathogens & their potential to change current VBD burden

Adaptation measures which can be implemented to reduce current and future disease threats include:

- Strengthening surveillance and public health
- Adopting precautionary approaches in health planning and disease monitoring
- Mainstreaming response to disease threats
- Enhancing health system capacity to handle current and anticipated future disease risks
- Anticipating the potential for new and emergent VBD pathogens and their potential to change the current VBD burden.

39



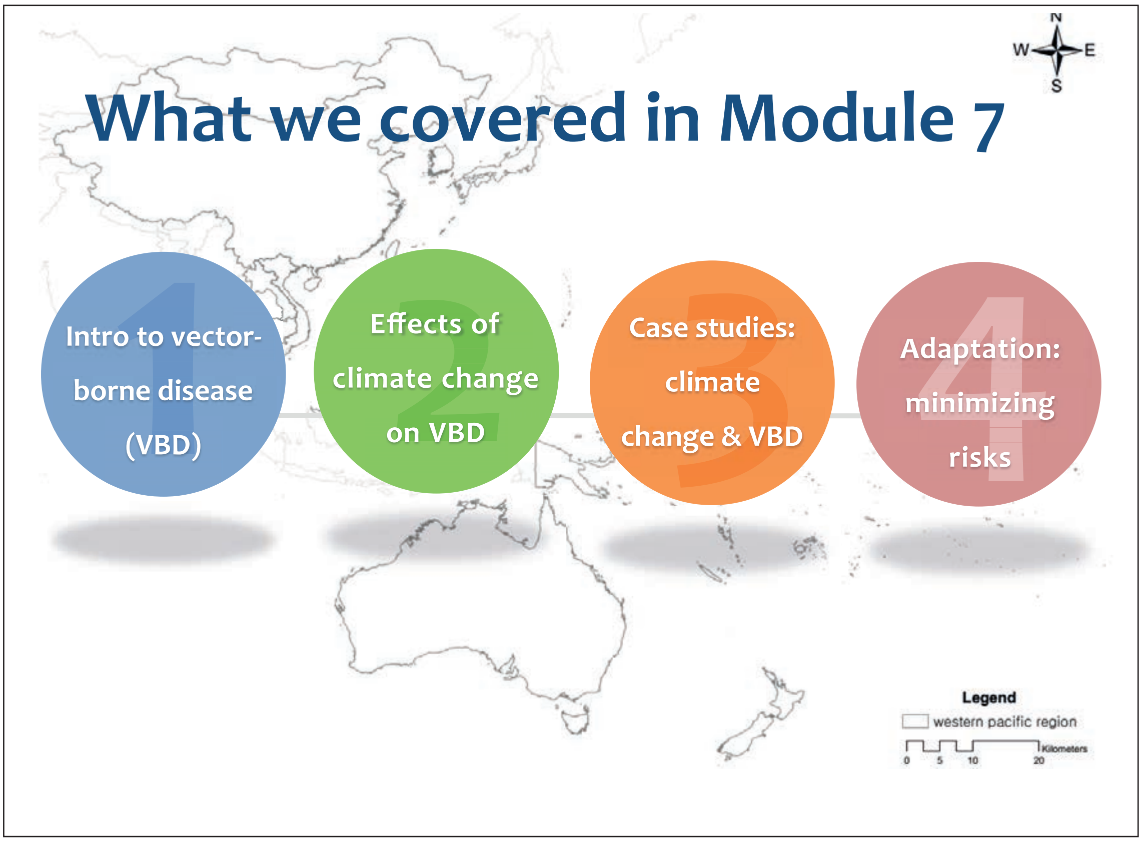
"To finish off, in a minute I'd like you to stand up, move to somewhere else in the room and find another person to chat with. Introduce yourself, and then discuss what VBDs are most relevant in your region.

Secondly, what ideas do you each have for how you can prepare for the risks of VBD under climate change?

You'll have 5 minutes."

Give time count down – **4 minutes**: "Ok, you have 1 more minute to wrap up your conversation. When you've finished, please return to your seat." **5 minutes**: "Thanks everybody. Thank your partner and return to your seats."

40



We just discussed the potential for adaptation to climate change to minimize health risks and impacts from vector-borne diseases.

Before that we looked at:

1. An introduction to vector-borne diseases
2. The effects of climate change on VBD; and
3. Some case studies of climate change effects on VBD.

41

Learning from Module 7

- Climate change could affect vector-borne disease (VBD) in humans
- Climate change affects vector-borne diseases through several mechanisms
- Impacts will vary from region to region
- Current evidence suggests impacts on some diseases may already be occurring
- Impacts may include unanticipated emergence of new pathogens

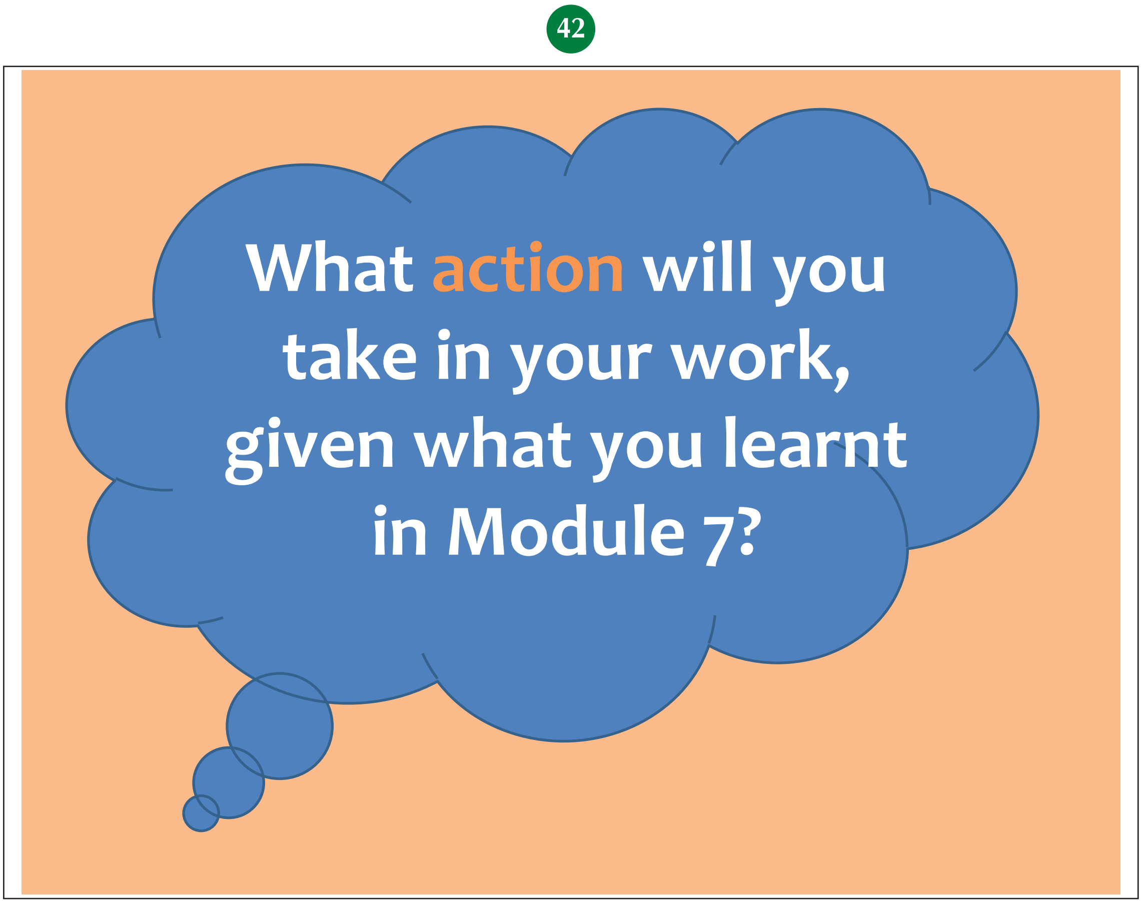
Across those four areas, the key learnings to take away from this module are:

- It is likely that climate change will affect the distribution and incidence of VBD globally
- impacts will vary from region to region
- Current evidence uncovered to date suggests that impacts on some diseases may already be occurring

In addition:

- Some of the potential impacts of climate change may include the unanticipated emergence of new pathogens.

Recommended further reading: 2007 IPCC report: The Physical Science Basis, FAQ 3.1 page 103 and FAQ 3.2 page 105



To finish off Module 7, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from the module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around vector-borne diseases and climate change.

Encourage quiet reflection (verbally if needed). At the end of 2 minutes: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 8

Water-borne diseases and climate change

Key learning messages in Module 8

- Water-borne diseases are mostly transmitted by faecal-orally transmitted diseases
- Climate can influence waterborne diseases in different ways depending on the local environment and population
- Mitigation and adaptation will be enhanced by understanding the ecology of pathogens.

Estimated length: 60 minutes

Structure of Module 8

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Water quantity and quality	4–9	EXERCISE on slide 6: Hand raise for list of water-borne diseases
2. Burden of diarrhoeal diseases	10–15	
3. How climate and weather affects diarrhoeal diseases and water-borne pathogens - Season - Temperature - Precipitation (flooding and drought) - Sea level rise	16–43 18–21 22–24 25–37 38–43	
4. Measures to address water-borne diseases	44–48	
Module outline	49	
Learning from Module 8	50	
Learning reflection, action generation	51	

Required resources

- Data projector and slide changer
- Module 8 slides

- Stopwatch
- Bell or noise maker

Instructions for delivery of Module 8

Section 3 of this module, on how climate change is likely to affect water-borne disease, is quite a long and detailed section, featuring the key learning outcome of the module. It includes lots of case studies of a range of water-borne diseases, divided into impacts from Seasons, Temperature, Precipitation and Sea-Level Rise. Try to break up delivery of this section with clear signposting, such as "Ok, let's move onto our third climate change impact and its impact on water-borne disease: Precipitation, or rainfall." If energy levels are flagging, feel free to also ask participants to take a quick stretch break.

Key terms introduced in Module 8

- Water-related diseases
- Fecal-oral transmission
- Diarrhoeal disease
- Water quantity & quality issues
- DALYs = Disability Adjusted Life Years.
- Rotavirus infections
- Salmonellosis
- Dysentery
- Typhoid fever
- Run-off
- Flooding
- Gastroenteritis
- Cryptosporidiosis
- Enteric viruses (e.g. enteroviruses, noroviruses, adenoviruses)
- Enteric bacteria (e.g. Salmonella, Campylobacter, E. coli, fecal indicator bacteria)
- Shigellosis
- Vibrio species
- Cholera

References (in order of presentation)

- Prüss-Üstün et al. 2008. *Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, p.7.*
- IPCC. 2007. *IPCC fourth assessment report, Working Group II: Impacts, Adaptation and Vulnerability*
- World Health Organization, 2009. *Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, 2008, p.11.*
- Mead et al. 1999. *Food-related illness and death in the United States. Emerg Infect Dis 5(5):607–625*

- IPCC AR5 (2014)
- Kovats and Lloyd, WHO. 2014. *Drawn from Table 4.7, Quantitative risk assessment of the effects of climate change on selected causes of deaths. 2030s and 2050s. World Health Organization, 2014, p. 48.*
- Patel et al. 2013. *Global seasonality of rotavirus disease. Pediatr Infect Dis J 2013;32(4):e134-e147.*
- Kovats et al. 2004. *The effect of temperature on food poisoning: a time-series analysis of salmonellosis in ten European countries. Epidemiol Infect. 2004 Jun; 132(3): 443–453.*
- Hall et al. 2002. *Foodborne disease in the new millennium: out of the frying pan and into the fire? Med J Aust 2002; 177 (11): 614-618.*
- Singh et al. 2001. *Singh RB et al. 2001. The influence of climate variation and change on diarrheal disease in the Pacific Islands. Environ Health Perspect. 109(2): 155–159.*
- Kim H et al. Climate change and health adaptation strategy in Lao PDR: final report. World Health Organization Western Pacific Regional Office, 2011
- Bennett et al. 2012 Drawn based on the table 4 of Bennett A et al. *Effects of the 1997–1998 El Niño Episode on Community Rates of Diarrhea. Am J Public Health. 2012 July; 102(7): e63–e69.*
- Curriero FC et al. 2001. *The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994. Am J Public Health. 2001 Aug;91(8):1194-9.*
- Auld H et al, 2004. *Heavy rainfall and waterborne disease outbreaks: the Walkerton example. J Toxicol Environ Health A. 67(20-22):1879-87.*
- Howard KWF, 2004. *Microbial pollution of groundwater in the town of Walkerton, Canada. In: Tellam JH et al. eds. Urban Groundwater management and sustainability. IV Earth and Environmental Sciences Vol 74. NATO Science Series. Dordrecht; Springer*
- Das P et al. 2006. *Molecular characterization of Cryptosporidium spp. from children in Kolkata, India. J Clin Microbiol. 44(11):4246-9*
- CRCWQT. 2005. *Drought and Water Quality: Background Paper for Workshop, 2nd August 2005 – Brisbane. Report No. DC05119. July. Cooperative Research Centre for Water Quality and Treatment*
- Hallegatte et al. 2013. *Future flood losses in major coastal cities. Nature Climate Change 2013;3:802-806.*
- Lobitz B et al. 2000. *Climate and infectious disease: Use of remote sensing for detection of Vibrio cholerae by indirect measurement. PNAS 2000;97(4):1438-1443.*
- ICIMOD. 2009. *Climate change and its impacts on glaciers and water resource management in the Himalayan Region*
- Gosain AK et al. 2006. Climate change impact assessment on hydrology of Indian river basins

Module 8:
Water-borne diseases

In this module, we will learn how climate variability and change is related to waterborne diseases, and how these impacts can be managed.

2

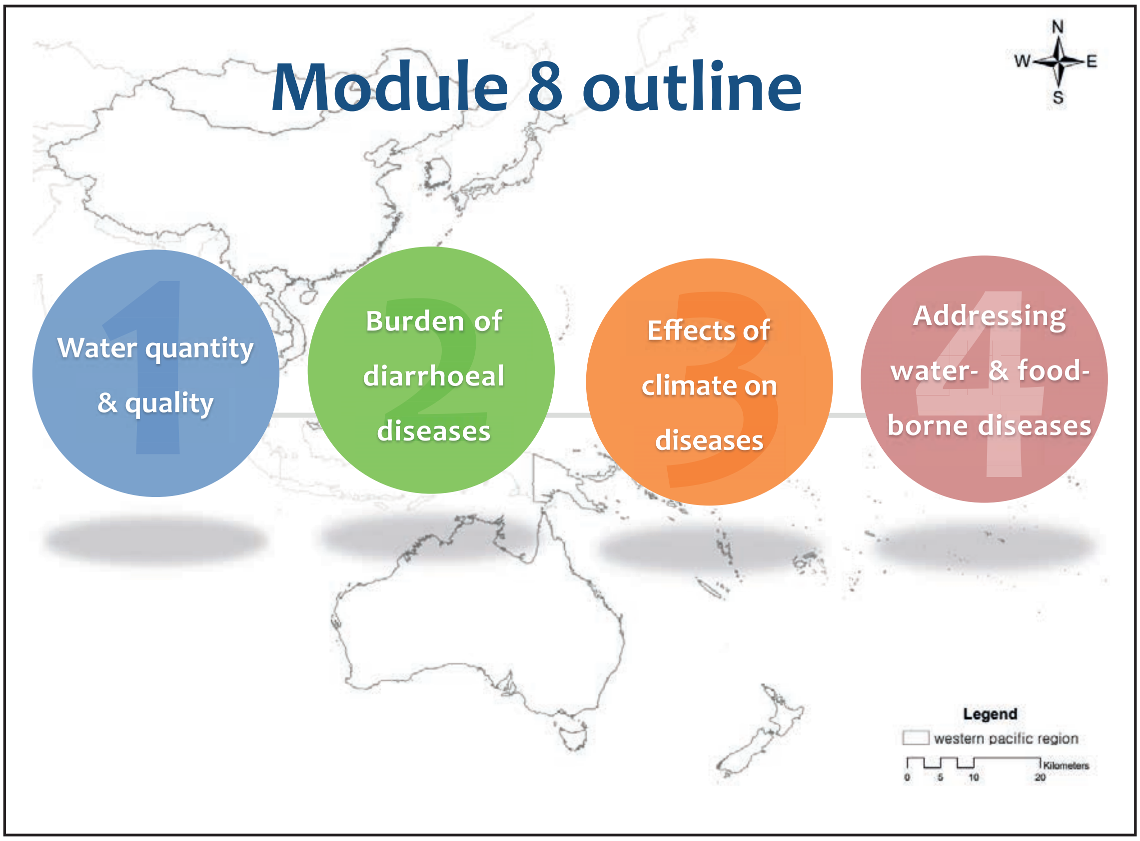
Key messages in Module 8

- Water-borne diseases are mostly transmitted by faecal-orally transmitted diseases
- Climate can influence waterborne diseases in different ways depending on the local environment & population
- Mitigation & adaptation will be enhanced by understanding the ecology of pathogens

Key messages we'll cover in this module include: (CLICK to show each)

- Water-borne diseases are mostly transmitted by faecal-orally transmitted diseases
- Climate can influence waterborne diseases in different ways depending on the local environment & population
- Mitigation & adaptation will be enhanced by understanding the ecology of pathogens

3



Here's what we'll cover in Module 8:

1. Water quantity and quality
2. Burden of diarrhoeal diseases
3. How climate and weather affects diarrhoeal diseases and food- and water-borne pathogens
    - Season
    - Temperature
    - Precipitation (flooding and drought)
    - Sea level rise
4. Measures to address water & food-borne diseases

4

1

Water quantity & quality

Water is an essential component of human body and life. Both quality and quantity are important, but without enough quantity, quality cannot be assured.

5

Water-related diseases

Category	Transmission	Disease examples
Water-borne	Ingestion of water contaminated by human or animal faeces or urine containing pathogenic bacteria, viruses or parasites	Gastroenteritis, enteric hepatitis, amoebic & bacillary dysentery, cholera, leptospirosis, poliomyelitis, typhoid/paratyphoid fever
Water-washed	Skin, ear or eye contact with contaminated water & poor personal hygiene	Conjunctivitis, trachoma, intestinal helminth infections, leprosy, scabies
Water-aerosol disease	Inhalation of water aerosol containing pathogen	Legionellosis, phiesteria
Water-based	Parasitical worm infections (parasites found in intermediate organisms living in water)	Dracunculiasis, schistosomiasis, (tricho)bilharziasis
Water-related arthropod vector	Insect vectors breeding in water or biting near water	Dengue, lymphatic filariasis, malaria, onchocerciacis, trypanosomiasis, yellow fever

Water is related with development of diseases in various ways.

The most common mode of transmission is waterborne diseases. It is transmission of fecal-orally transmitted infectious diseases through ingestion of water contaminated by human or animal faeces or urine containing pathogenic bacteria, viruses or parasites.

However, transmission of faecal-orally transmitted diseases can develop from shortage of water, in case of long-term shortage of water, lowered hygiene level may provide more opportunity for the pathogens by direct person-to-person route. Those waterborne diseases with winter or dry season peak may be related with this type of transmission.

In some infectious disease such as legionellosis, microbe proliferates in water and infects human who inhaled the aerosol.

In some parasitic infestations in which the intermediate vectors are water-living organism, water can be a media of transmission of disease.

In many mosquito-borne infectious diseases, presence of stationary water mass is an essential condition for the survival of the larva. In this group of diseases, rainfall is very important determinant of the disease transmission.

6

Which of these water-related diseases do you experience in your country?

Category	Disease examples
Water-borne	Gastroenteritis, enteric hepatitis, amoebic & bacillary dysentery, cholera, leptospirosis, poliomyelitis, typhoid/paratyphoid fever
Water-washed	Conjunctivitis, trachoma, intestinal helminth infections, leprosy, scabies
Water-aerosol disease	Legionellosis, phiesteria
Water-based	Dracunculiasis, schistosomiasis, (tricho)bilharziasis
Water-related arthropod vector	Dengue, lymphatic filariasis, malaria, onchocerciacis, trypanosomiasis, yellow fever

Q: "I'm curious which of these water-related diseases you deal with in health practice in your country. Have a look over the list, which I'll also read out, and then we'll do a poll of the room to see which types of disease are likely to be most common, based on your knowledge.

I'll read each out and if you know that this disease is present in your country, please raise your hand.

Read slowly, one by one, and raise your own hand for each (at least at the start) to model the behaviour you're looking for:

- Gastroenteritis
- Enteric hepatitis
- Amoebic & bacillary dysentery
- Cholera
- Leptospirosis
- Poliomyelitis
- Typhoid/paratyphoid fever
- Conjunctivitis
- Trachoma
- Intestinal helminth infections

6

Which of these water-related diseases do you experience in your country?

Category	Disease examples
Water-borne	Gastroenteritis, enteric hepatitis, amoebic & bacillary dysentery, cholera, leptospirosis, poliomyelitis, typhoid/paratyphoid fever
Water-washed	Conjunctivitis, trachoma, intestinal helminth infections, leprosy, scabies
Water-aerosol disease	Legionellosis, phiesteria
Water-based	Dracunculiasis, schistosomiasis, (tricho)bilharziasis
Water-related arthropod vector	Dengue, lymphatic filariasis, malaria, onchocerciacis, trypanosomiasis, yellow fever

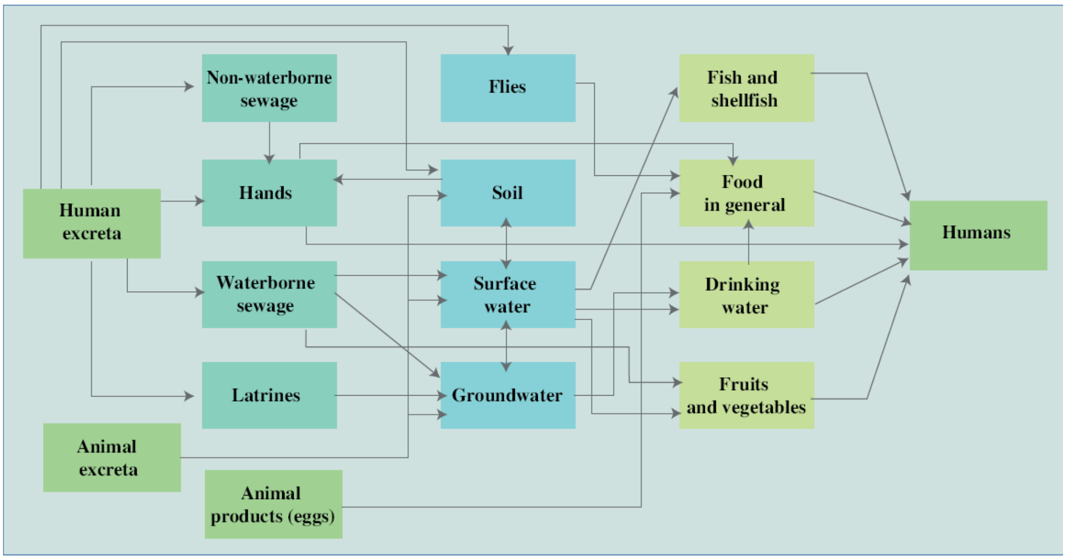
- Leprosy
- Scabies
- Legionellosis
- Phiesteria
- Dracunculiasis
- Schistosomiasis
- (tricho)bilharziasis
- Dengue
- Lymphatic filariasis
- Malaria
- Onchocerciacis
- Trypanosomiasis
- Yellow fever

Thanks. That gives us a sense of some of the most common water-related diseases in the Asia Pacific, and that water-borne diseases are definitely a key area of public health practice.

Let's now look at some of the ways that climate change is likely to affect water-borne disease."

7

Diarrhoeal disease pathways: Faecal-oral transmission



Source: Prüss-Üstün et al. (2008)

While the first goal, as stated in the previous slide, of determining human health end points (morbidity) in relation to climate change parameters can be measured in the absence of information about specific factors in transmission, an understanding of the specific mechanisms that link the climate parameter to the pathogen and transmission route, require an understanding of how a climate parameter acts on specific pathways.

This flow chart illustrates the points at which we might start to investigate the mechanisms that provide the link between a climate signal and a disease.

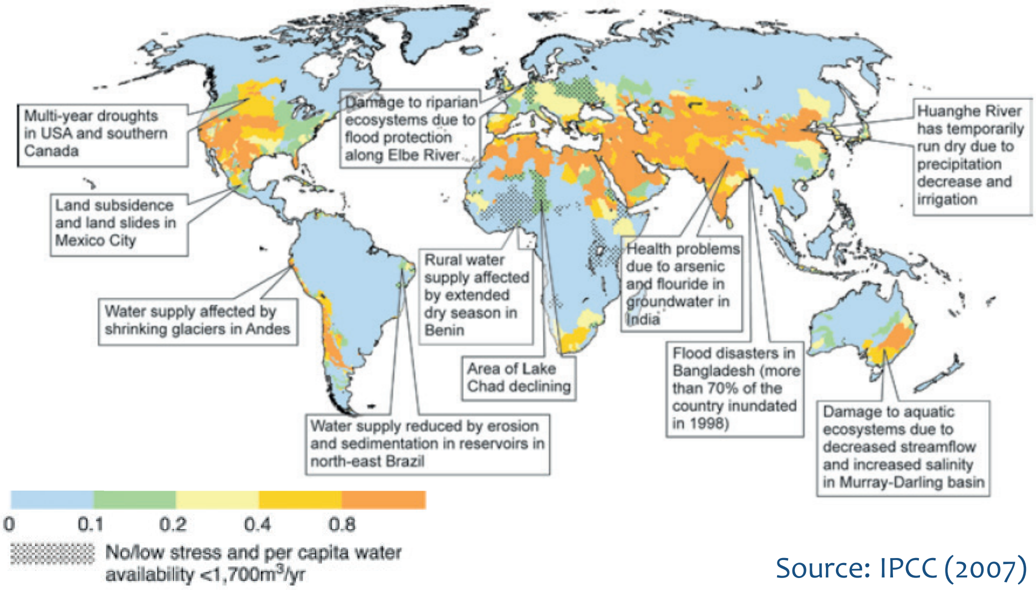
It is evident even in this relatively simple chart that the pathways from source to exposure can be complex. While we are interested in the human health end points (at the far right of the chart), many of these diarrheal diseases are zoonotic and, therefore, transmission pathways must include both human and animal contamination. The pathogens can be transmitted from person to person (in some cases), or indirectly through contamination of food products, groundwater, and surface water.

Source: *Prüss-Üstün et al. 2008. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, p.7.*

8

Water quantity & quality issues

E.g.s of current vulnerabilities of freshwater resources



Source: IPCC (2007)

As preface to any discussion of water and foodborne disease trends, it is important to point out current and predicted changes in the water cycle.

Both water quality and water quantity are significant issues.

Across large areas of the globe, many of which are in lesser developed nations, freshwater sources are already vulnerable due to a combination of contamination and inadequate supply.

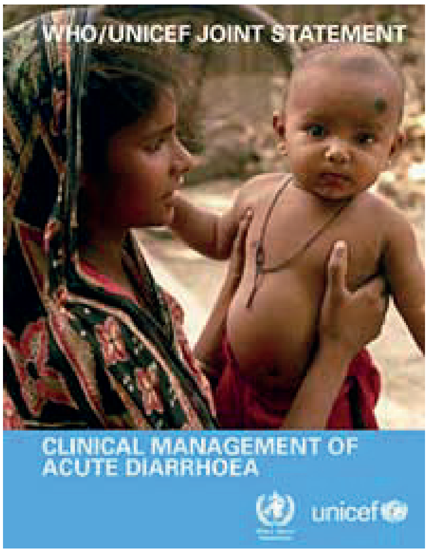
Many of the predicted trends are for increased areas of drought leading to desertification, decreased crop production and food scarcity, along with increasing water sanitation problems associated with increasing demand placed on a diminishing supply of water.

Source: *IPCC. 2007. IPCC fourth assessment report, Working Group II: Impacts, Adaptation and Vulnerability*

9

2

Burden of diarrhoeal diseases



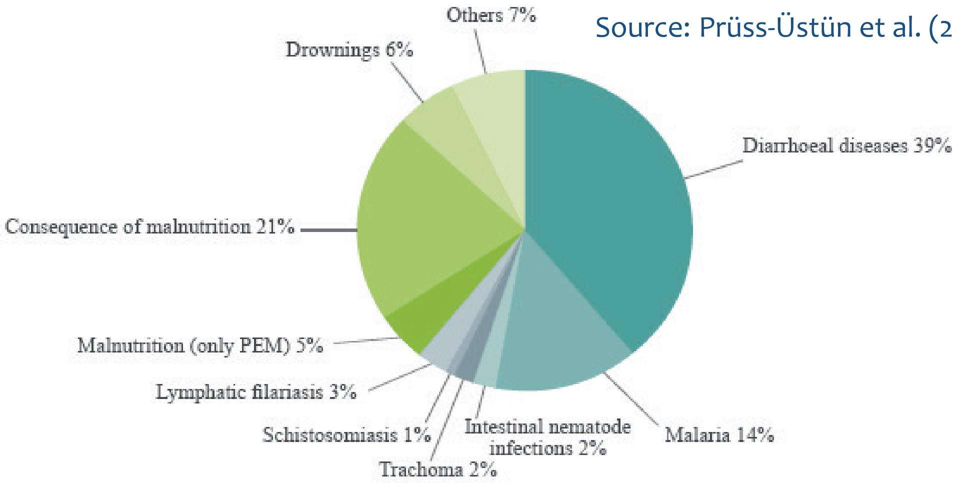
Burden of diarrhoeal diseases

10

Burden of water-borne disease

- 1.8 million deaths - 4 million cases- in 2004 due to gastroenteritis (WHO)
- 88% due to unsafe water & poor sanitation

Source: Prüss-Üstün et al. (2008)



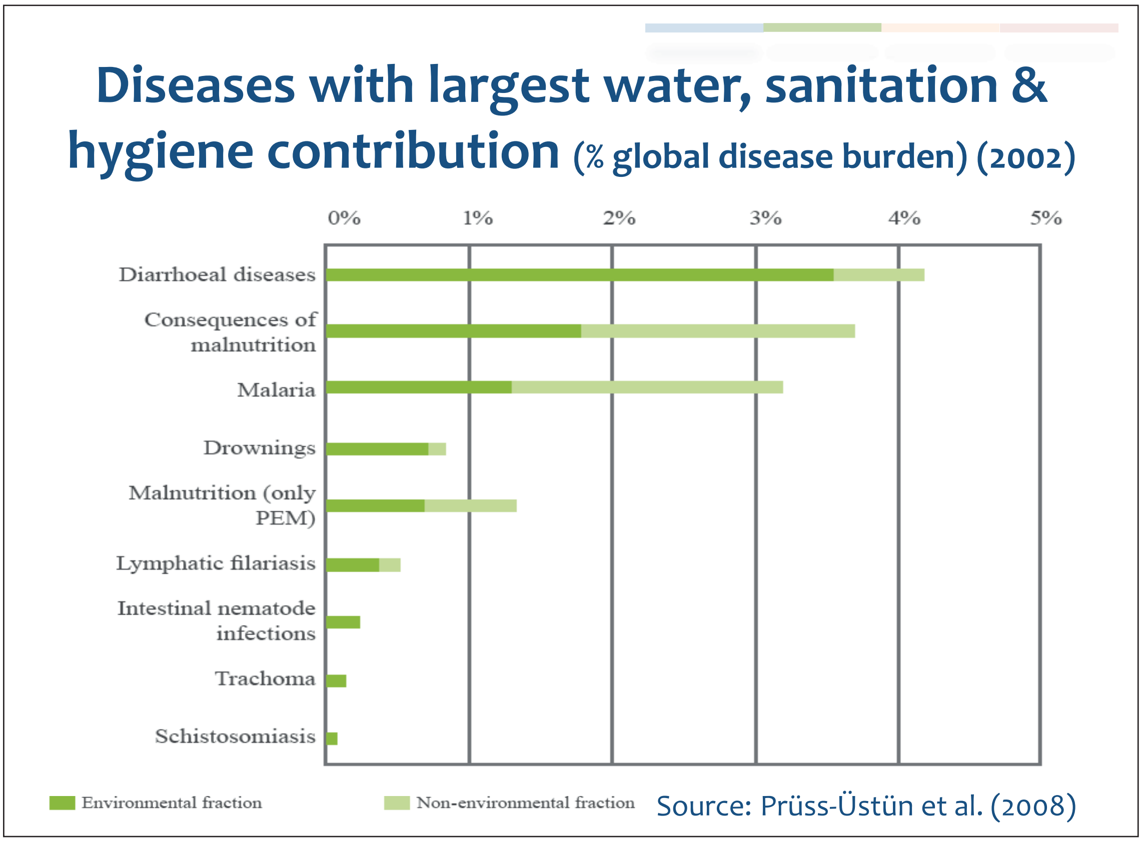
Overlaying the issues of water stress both from flooding and drought is the fact that water-borne and foodborne diseases continue to be significant causes of morbidity and mortality world-wide.

Among the wide spectrum of diseases that are associated with food and especially water, gastroenteritis is the most commonly identified illness. These diarrheal diseases contribute to as many as 4 million cases annually and 1.8 million deaths. Of these cases, 88% can be linked to poor water quality (World Health Organization, 2009. **Title?**).

DALYs = Disability Adjusted Life Years.

Source: *Prüss-Üstün et al. 2008. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, 2008, p.11.*

11



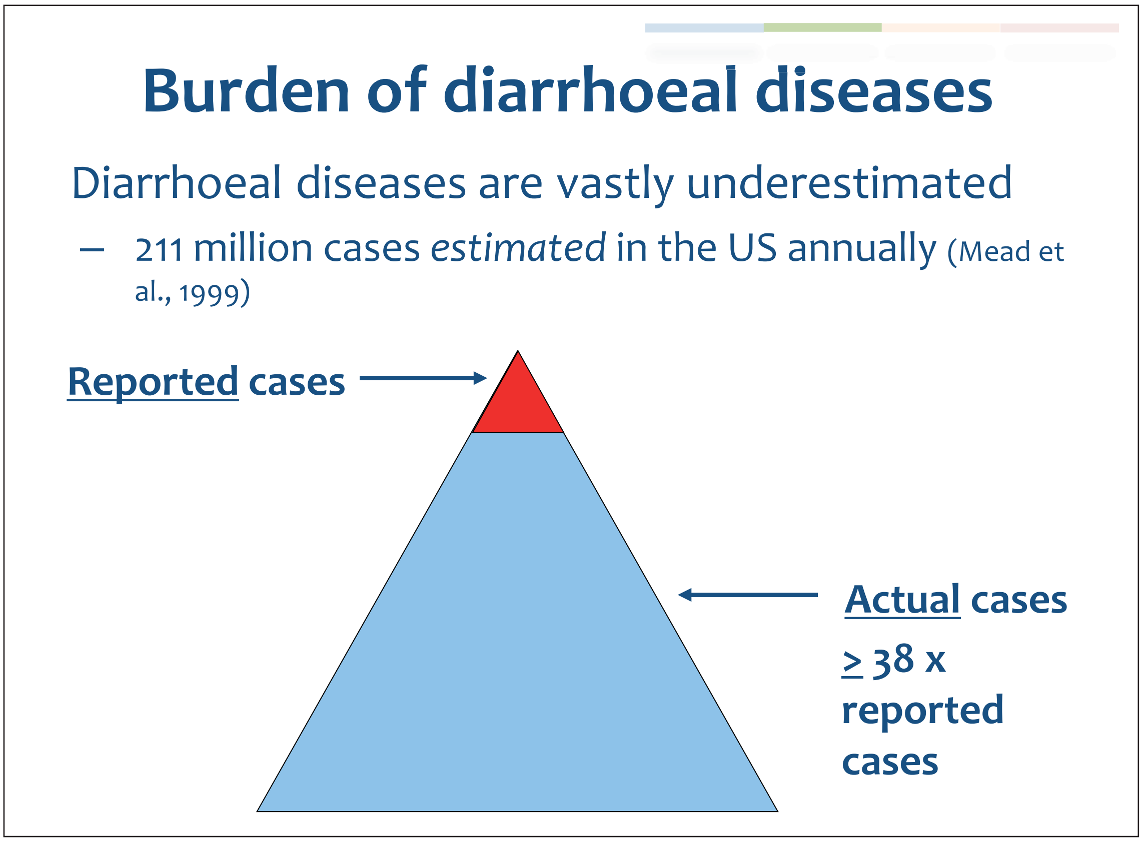
Diarrheal diseases are a significant global health problem and, as this chart shows, they are the largest contributor to water-borne disease burden world-wide.

Given the global problem associated with diarrheal diseases and its common association with water, our discussion of climate and water-borne disease will focus primarily on enteric pathogens and gastroenteritis.

In the figure also note the relative significance of Drownings as a source of DALYs.

Source: *Prüss-Üstün et al. 2008. Safer Water, Better health: costs, benefits and sustainability of interventions to protect and promote health.*

12



Despite the global burden of diarrheal diseases, they remain vastly under-reported even in nations with highly developed surveillance systems. This is related to multiple factors including lack of diagnosis, lack of specimen collection, lack of reporting, and lack of treatment sought. This translates into what is known as the “tip of the iceberg” scenario where very few of the actual number of cases of gastroenteritis are ever reported and etiology determined. For something like salmonellosis, among the most common bacterial sources of gastroenteritis world-wide, the actual number of cases is estimated to be 38-fold greater than the numbers that are reported.

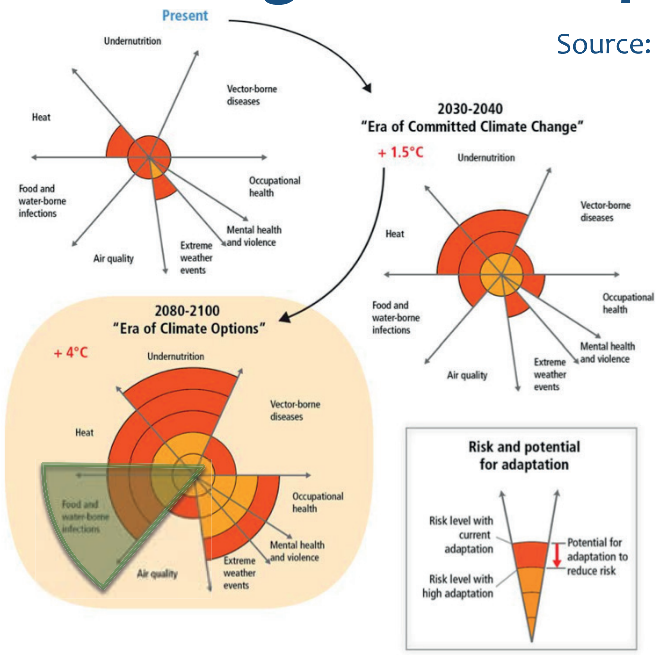
The lack of good health data for diarrheal diseases is a common problem for investigating food and water-borne disease, especially when attempting to find associations with environmental and climate drivers.

Source: *Mead et al. 1999. Food-related illness and death in the United States. Emerg Infect Dis 5(5):607–625 (1999). (Not for the figure, only for the estimation of 211 million of cases)*

13

Direction & magnitude of climate change health impacts

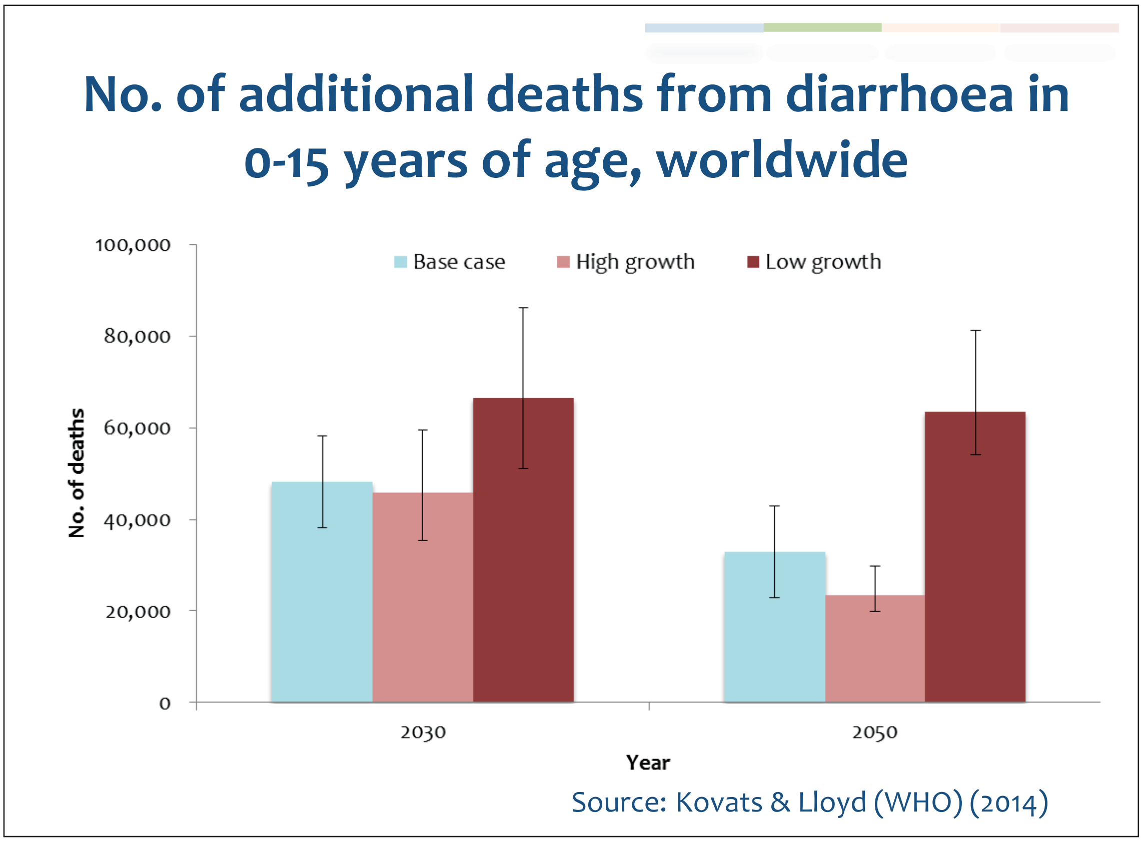
Source: IPCC AR5 (2014)



In fact, the IPCC 5th Assessment Report (Working Group II) indicates that the burden of diarrheal disease will increase as climate changes over the next century. The magnitude of food and waterborne infections are expected to be increased very high by the end of 21st century, next to the undernutrition. Moreover, proportion of the risk that is preventable with high adaptation is smaller.

Source: *IPCC AR5 (2014)*

14



While projections include increasing diarrheal disease as the global climate changes, at local levels we are already witnessing disease events that can be linked to climate. This map and descriptions (figure from Hall et al., 2002) indicate some of these weather or climate linked water-borne disease events from around the world. We will touch upon some of these in more detail.

According to updated estimation of burden of diarrhoeal disease by WHO, overall premature deaths will increase up to 66 403 (51 032-86275) in 2030 and 63442 (54 110–81 330) in 2050. Economic growth is closely related to the deaths from diarrhoeal disease, resulting in decreasing tendency of deaths in the future expectations.

Source: *Drawn from Table 4.7, Kovats S, Lloyd S. Diarrhoeal disease In: Hales S, Kovats S, Lloyd S, Campbell-Lendrum D, eds. Quantitative risk assessment of the effects of climate change on selected causes of deaths. 2030s and 2050s. World Health Organiozation, 2014, p. 48.*

15

3

How climate & weather affects water-borne disease

Let's now look at how climate & weather affects diarrhoeal diseases & food- & water-borne pathogens.

Of the critical issues in studying the specific impacts of climate on health, and specifically the impacts on water-borne disease, are the need to (1) identify broad trends in disease outcome, and (2) identify mechanisms that lead to these trends, especially in terms of the biology and physiology of specific pathogens.

16

How climate influences water-borne disease trends

Local temperature	• Replication in the environment or associated with food products • Persistence
Local rainfall	• Loading into the environment (contamination) • Increased concentration of contaminants (drought)
Changes in hydrologic cycle	• Increased drought • Increased storm intensity
Change in frequency of 'extreme events'	• Hurricanes • Ocean-atmosphere oscillations: ENSO, IOD, others
Sea level rise	• Influx of marine pathogens • Flooding (storm surge), contamination, loss of infrastructure

As we begin to shift to a discussion of how water-borne diseases may be impacted by climate variability and change, we need to focus a bit on climate change scenarios and which climate parameters are expected to have the greatest impact on water-borne pathogens and diseases.

We will go through each of these mechanisms in detail next, and provide some specific examples of research that is addressing these issues. Where possible, examples of the two ways of examining climate change impacts will be addressed - that is, studies that look at specific health end points and studies that address mechanisms or pathways.

So, as shown in this table, climate change scenarios predict:

- Rising temperatures
- Changes in the hydrological cycles (especially frequency of high intensity storms and drought)
- Other extreme events, including tropical cyclones and interannual variability associated with pressure shifts over large areas of oceans, which result in far reaching changes in precipitation and temperature patterns (e.g., El Niño Southern Oscillation, Pacific Decadal Oscillation, North Atlantic Oscillation, among others)
- Sea level rise.

16

How climate influences water-borne disease trends

Local temperature	• Replication in the environment or associated with food products • Persistence
Local rainfall	• Loading into the environment (contamination) • Increased concentration of contaminants (drought)
Changes in hydrologic cycle	• Increased drought • Increased storm intensity
Change in frequency of 'extreme events'	• Hurricanes • Ocean-atmosphere oscillations: ENSO, IOD, others
Sea level rise	• Influx of marine pathogens • Flooding (storm surge), contamination, loss of infrastructure

These expected changes will certainly impact many sectors, but these parameters are expected to impact water-borne pathogens both directly (i.e., temperature) indirectly (i.e., rainfall and flooding).

They can also affect a wide range of enteric pathogens, especially those with an environmental reservoir.

Specific parameters within climate change scenarios that are likely to affect water-borne disease were mentioned earlier. Now we will take those parameters and narrow them down to specific impacts, which include:

Another issue that is more difficult to measure or predict is range expansion, either for a specific pathogen or for hosts in zoonotic pathogens.

As we investigate specific disease patterns, it is important to keep in mind that many of these waterborne/diarrheal diseases often display marked seasonal patterns. In some cases, the evidence of seasonality and information related to the drivers of seasonality can be used as a starting point to inform further investigations into the longer-term trends associated with climate change.

We'll now go into four of these influences – Seasons, Temperature, Precipitation and Sea-Level Rise - one by one, with examples drawn from Asia and the Pacific.

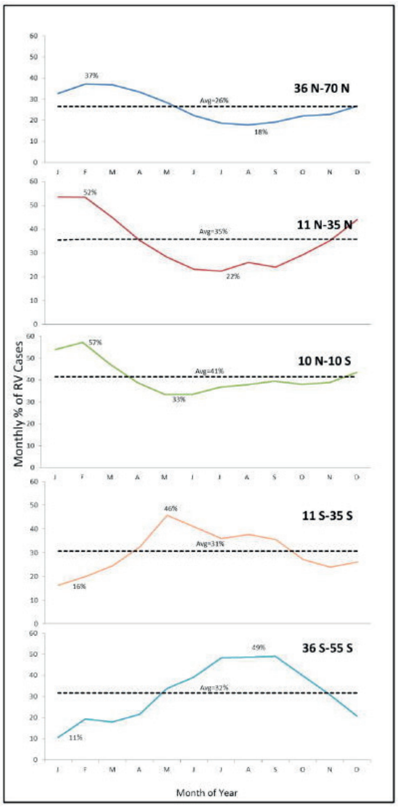
17

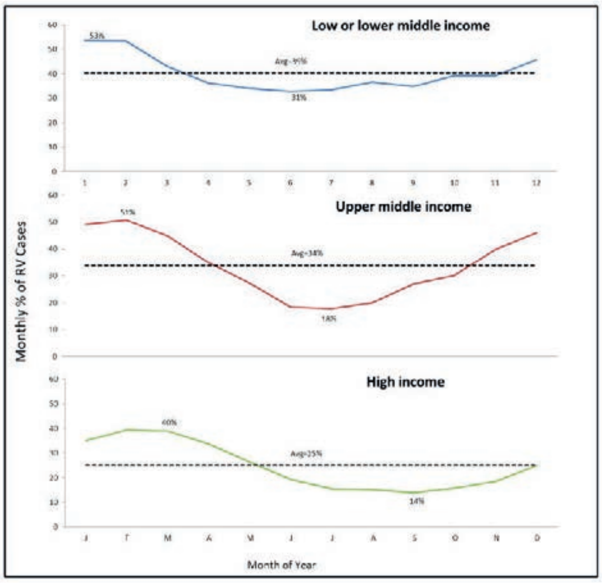
3 How climate & weather affects food- & water-borne disease: Seasons

The first area of impact of climate and weather on diarrhoeal diseases and food- and water-borne diseases is seasons.

18

Seasonal trends in Rotavirus infections





Source: Patel et al. (2013)

This chart of hospitalization rates for children with rotavirus infections shows the powerful trends in seasonality that are evident in many enteric (diarrheal) diseases.

Here we can see trends by latitude for the 99 studies since 1995 from Americas, Europe and Africa, and Asia and Oceania. Data are presented for each column from north to south.

In all regions, rotavirus rates become increasing modal as latitudes increase, with the highest rates in the winter months for temperate zones in both the northern and southern hemispheres. In the lower latitudes of the tropics, this marked seasonality is damped down and finally, in the equatorial zones, there is almost no seasonality.

This series of charts does not indicate relative rates of infection between these areas, but it clearly shows that disease trends vary less by season in the warmest parts of the world. While this cannot be used to predict future scenarios, this is the kind of evidence that can be used to guide specific investigations into possible disease trends under a changing climate. For example, if seasonality is related to temperature, can we expect an expansion of the tropical patterns into temperate areas?

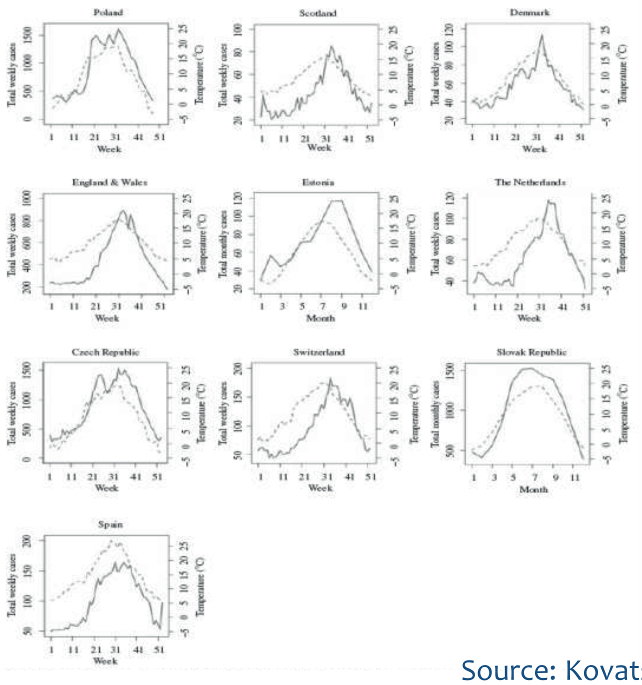
Another factor is socioeconomic status. Series of charts on the right side shows a difference in the magnitude of seasonality between countries with different economic status. Lower-income countries have more prominent seasonality pattern.

While this slide shows baseline information for posing questions about disease trends and climate change, the next series of slides will illustrate how these next questions might be addressed.

Source: *Patel et al. 2013. Global seasonality of rotavirus disease. Pediatr Infect Dis J 2013;32(4):e134-e147.*

19

Seasonal patterns of Salmonellosis



Source: Kovats et al. (2004)

In the next few slides we will move onto specific diarrheal diseases, with a focus on *Salmonella* infections. This make up the most common causes of bacterial-associated gastroenteritis world-wide. These bacteria are also zoonotic, found commonly among both livestock and wild-life populations, and they also both show a similar seasonality with distinct peaks in reported cases occurring in the summer months, world-wide.

Kovats et al. have investigated these trends across continental scales to determine the contribution of temperature to disease incidence.

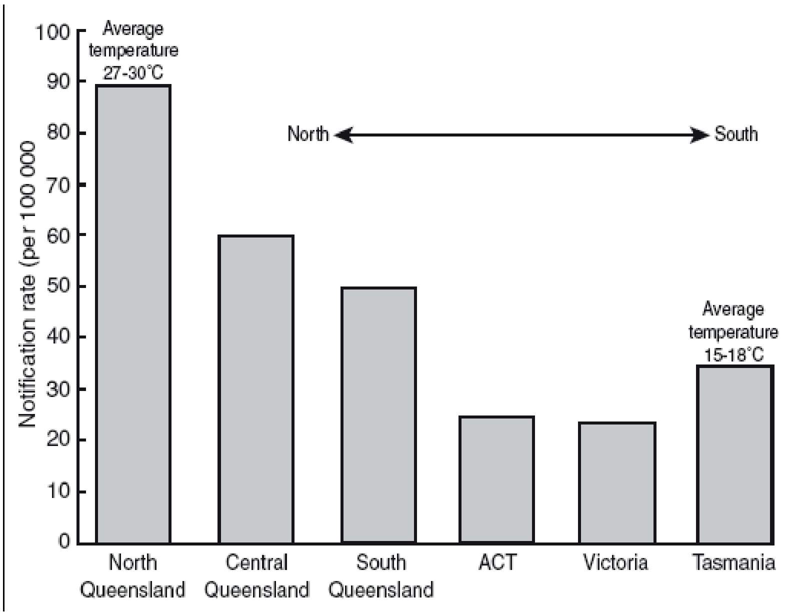
In this figure, reported cases (solid line) are plotted with mean weekly temperature (dotted line) for nine countries. All show striking similar trends with peak salmonellosis cases occurring within one week of peak annual temperatures.

An estimated threshold level of 6°C was determined for the studied nations, such that the response to temperature was linear for temperatures greater than 6°C. Using this scenario, the authors found that as much as 41% of the cases could be attributable to climate (temperature).

Source: *Kovats et al. 2004. The effect of temperature on food poisoning: a time-series analysis of salmonellosis in ten European countries. Epidemiol Infect. 2004 Jun; 132(3): 443–453.*

20

Salmonella trends: Eastern Australia 2001



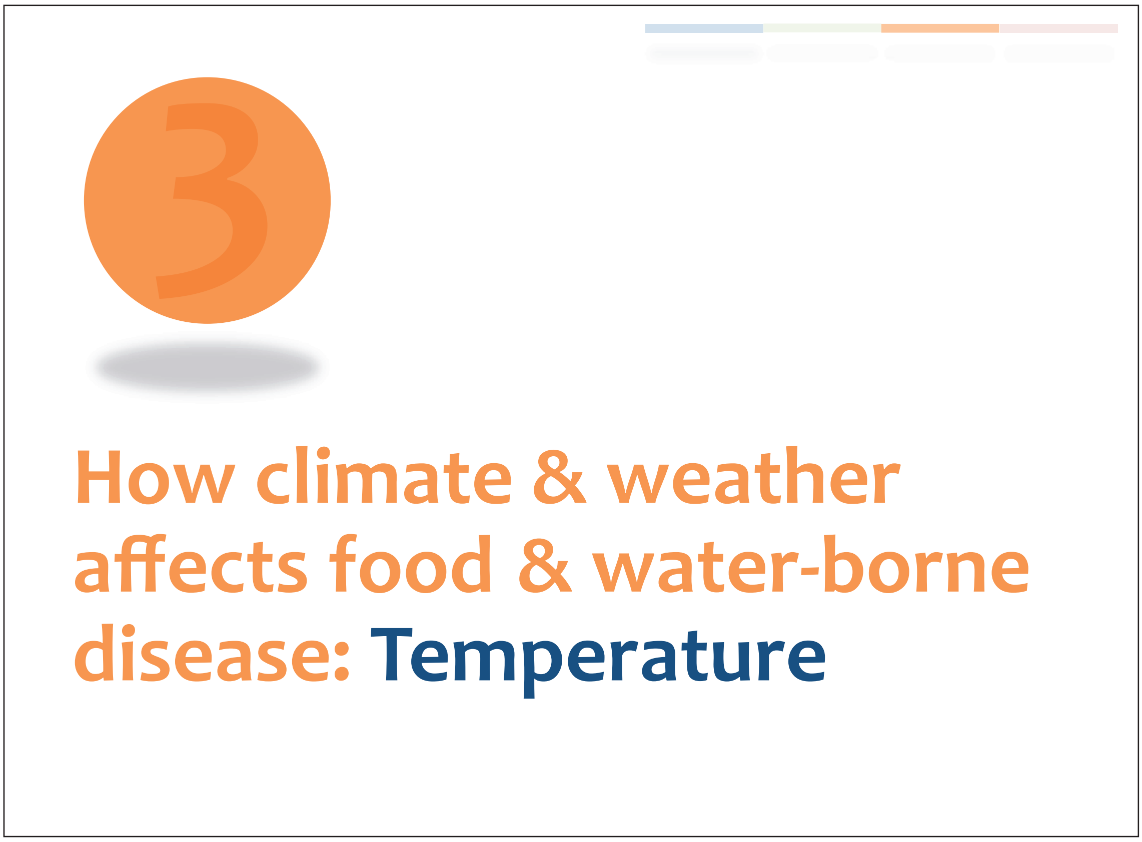
Source: Hall et al. (2002)

In addition to consistent patterns between temperature and peak incidence of disease across very wide geographic ranges, *Salmonella* infection also displays similar trends across latitudinal ranges.

In this figure, the rates of reported cases of salmonellosis show an increasing trend as you move toward territories in the lower latitudes in Australia. The trends are consistent with higher mean annual temperatures.

Source: *Hall et al. 2002. Foodborne disease in the new millennium: out of the frying pan and into the fire? Med J Aust 2002; 177 (11): 614-618.*

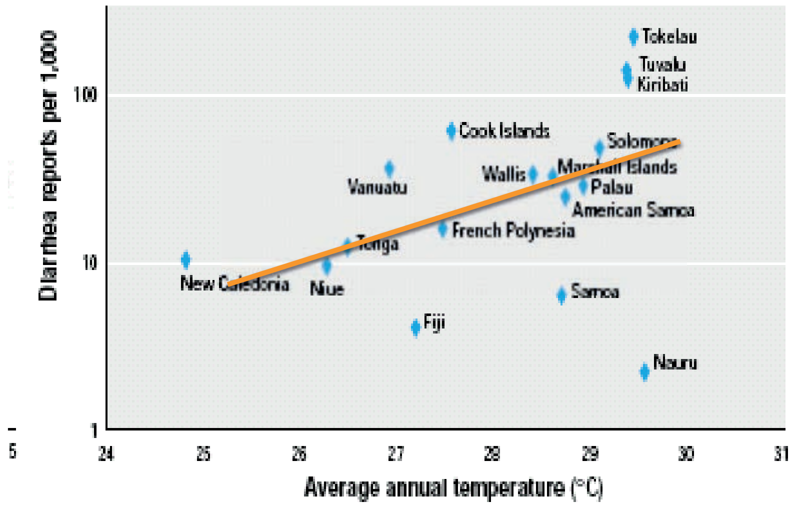
21



The second area we'll look at where climate & weather affects diarrhoeal diseases & food- & water-borne pathogens is temperature.

22

Annual temperature & reported diarrhoeal disease, Pacific Islands (1986 – 1994)



3% increase of diarrhoea for each 1°C increase in the previous month

Source: Singh et al. (2001)

In this study by Singh et al. (2001), the authors examined the relationship between annual average temperature at multiple Pacific Islands with rates of reported diarrheal diseases (no emphasis on the specific pathogen).

They noted a significant positive effect on temperature, which can be seen in this chart. As the annual average temperature increases, the rate of diarrheal cases increases.

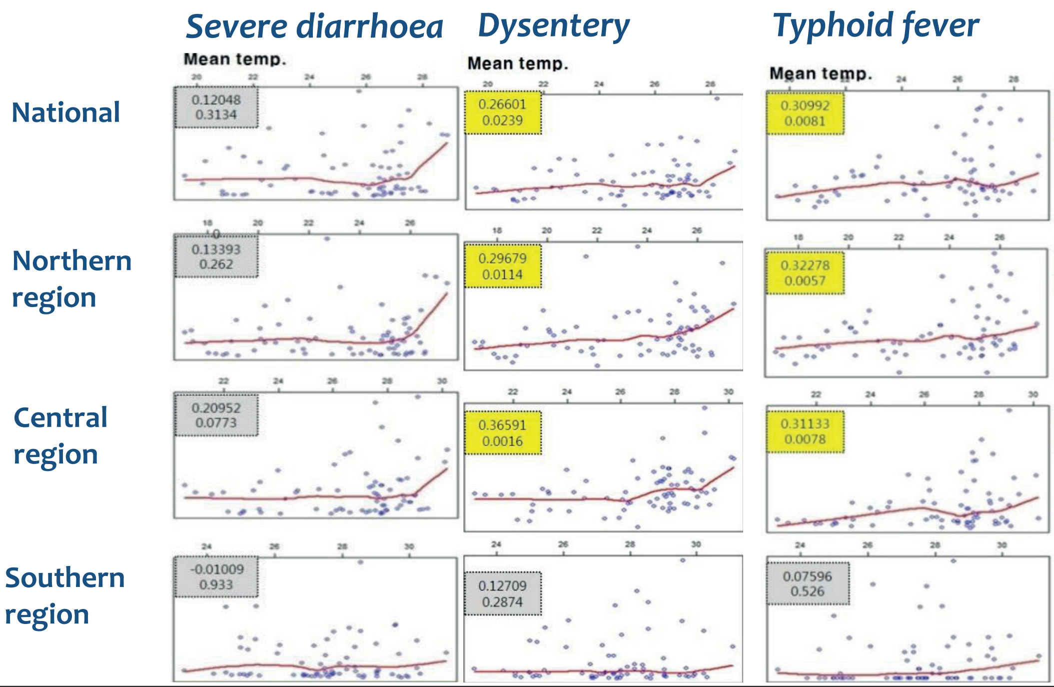
CLICK to animate line. When modeled by month, there was a 3% (confidence interval 1.2–5.0%) in reported diarrhea for each 1°C increase in the previous month, controlled for season.

Source: *Singh RB et al. 2001. The influence of climate variation and change on diarrheal disease in the Pacific Islands. Environ Health Perspect. 109(2): 155–159.*

23

Correlation of temperature & water-borne diseases in Lao PDR

Source: Fengthong et al. (2005)



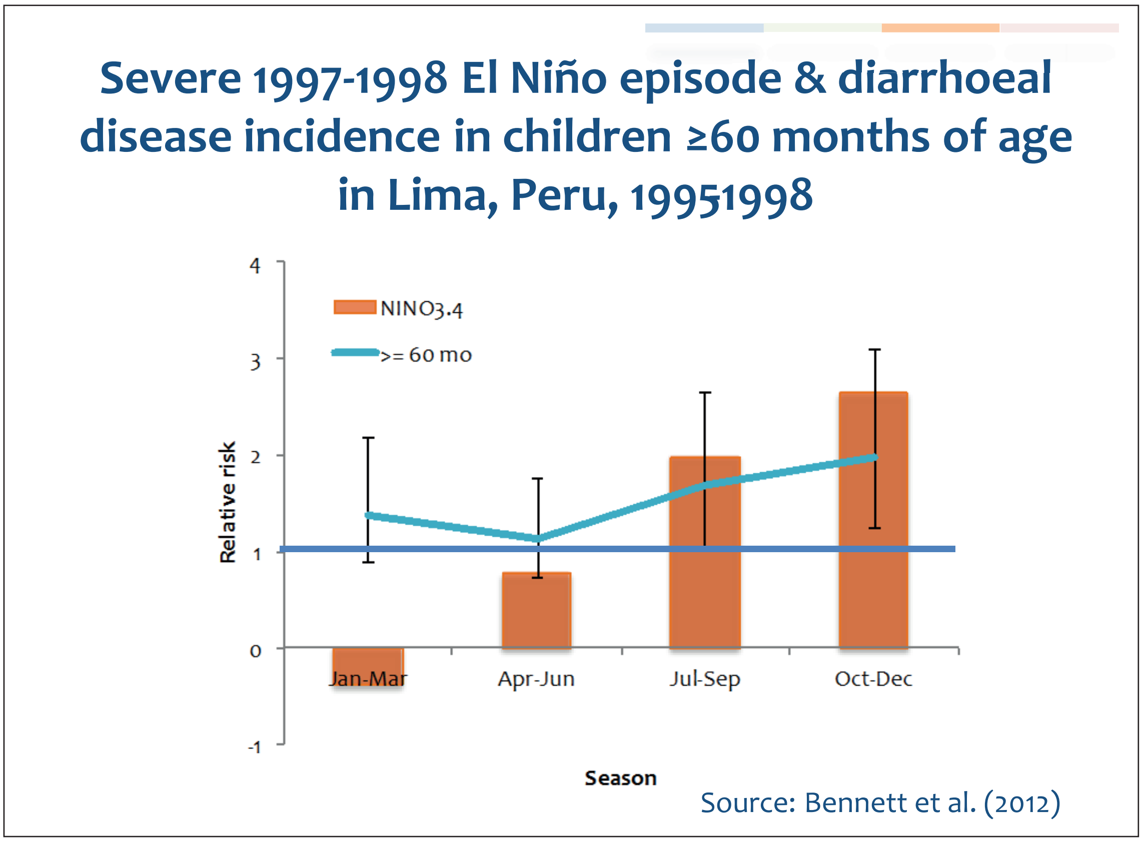
This study in Lao PDR also shows a correlation between various water-borne diseases and mean temperature. Dysentery and typhoid fever have linear correlation with mean temperature. However, severe diarrhoea has a threshold between 26 and 28°C.

Source: *Kim H et al. Climate change and health adaptation strategy in Lao PDR: final report. World Health Organization Western Pacific Regional Office, 2011*

24

Let's now look at the affect of precipitation on food & water-borne disease.

25



In addition to vibrio outbreak, El Niño also brought about an outbreak of diarrhoeal disease in Peru. Cohort study on the children in Lima shows that risk of diarrhoeal disease markedly increased during the episode of El Niño.

Source: *Drawn based on the table 4 of Bennett A et al. Effects of the 1997–1998 El Niño Episode on Community Rates of Diarrhea. Am J Public Health. 2012 July; 102(7): e63–e69.*

26

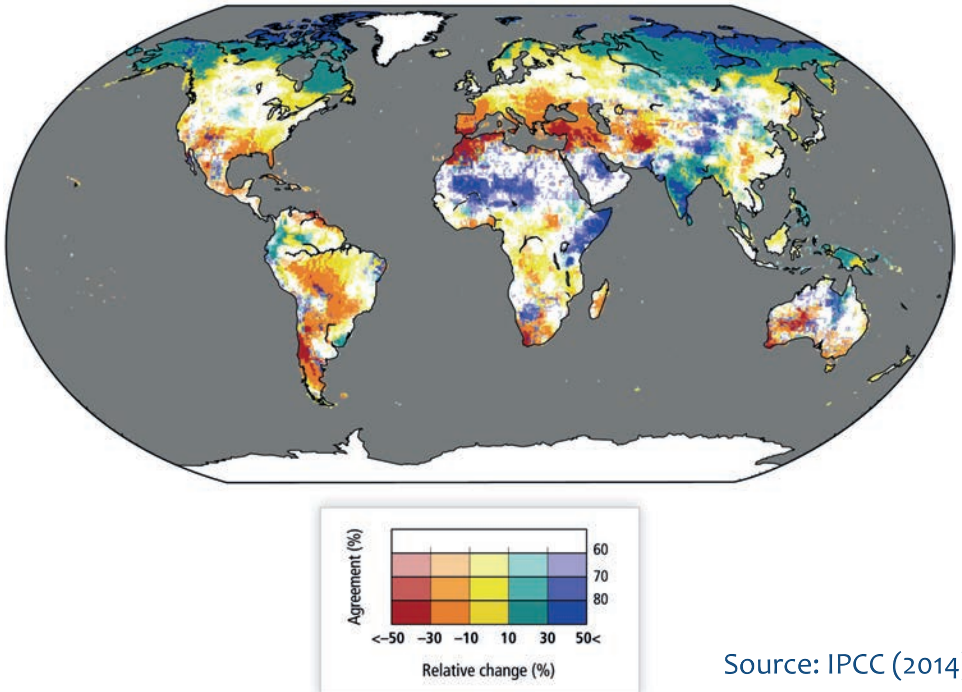
Local rainfall influences levels of pathogens in water, & exposure risk to humans

- Run-off
- Flooding
- Drought

In addition to temperature, changes in the hydrologic cycle leading to either flooding (and run-off) or drought can influence both the levels of pathogens in waters and exposure risks to humans. We'll look at examples of the influence of run-off, flooding and drought on water and food-borne diseases now.

27

Climate change impacts on run-off



Source: IPCC (2014)

Predicted changes in precipitation and snowmelt patterns will also be evident in streamflow.

This map shows percentage change of mean annual streamflow for a global mean temperature rise of 2°C above 1 980–201 0 (2.7°C above pre-industrial).

Colour hues show the multi-model mean change across 5 General Circulation Models (GCMs) and 1 1 Global Hydrological Models (GHMs), and saturation shows the agreement on the sign of change across all 55 GHM–GCM combinations (percentage of model runs agreeing on the sign of change) (Schewe et al., 2013).

Source: *IPCC 5th Assessment Report – Working Group II*

28

Flooding: Risk factors

- Direct contact with contaminated water
  - Skin
  - Respiratory
  - Ear & eye infections
- Ingestion of contaminated water (wells, etc.)
  - Gastroenteritis
- Insufficient water treatment (i.e. problem at the tap)
- Additional secondary spread

The major issues associated with flooding that influence water-borne disease include:

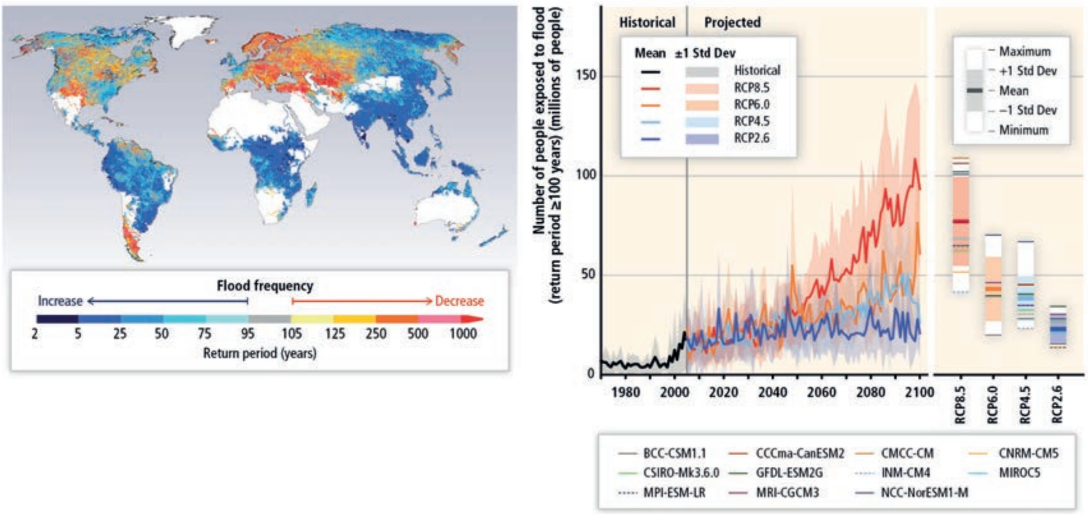
Direct exposure/contact with contaminated water. Following large flood events, sewage overflows and failed septic systems are common and can result in contaminated standing water. Direct exposure to flood waters commonly lead to infections of the skin, respiratory system, eyes, and ears.

Floods can also result in contaminated water sources and gastroenteritis due to ingestion of untreated or insufficiently treated water.

Floods can also facilitate the secondary spread of disease due to poor hygiene following flood events and the displacement of people.

Climate change & flooding

(A) (B)



Source: IPCC AR5 (2014)

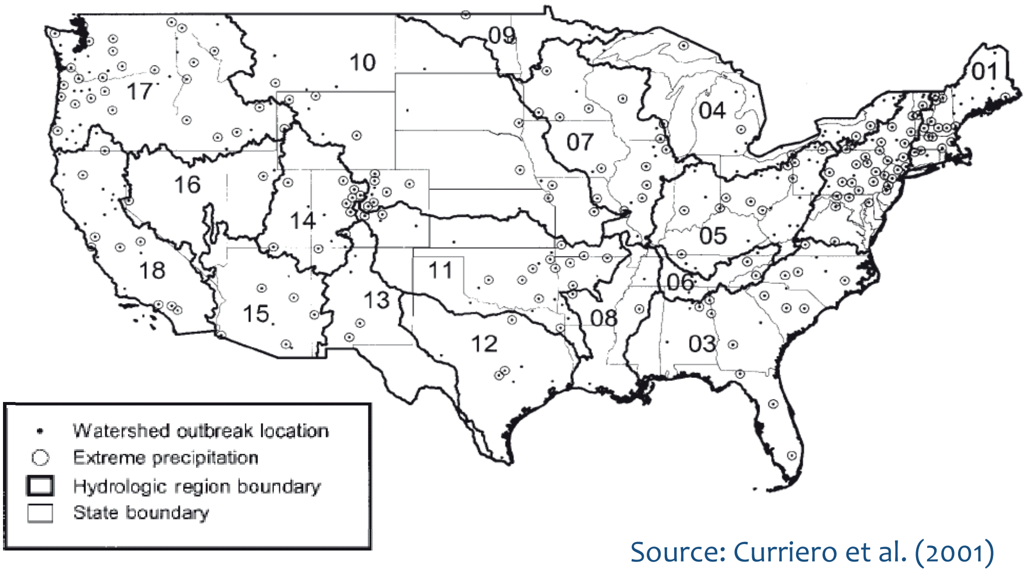
(a) Multi-model median return period (years) in the 2080s for the 20th century 100-year flood (Hirabayashi et al., 201 3), based on one hydrological model driven by 11 Coupled Model Intercomparison Project Phase 5 (CMIP5) General Circulation Models (GCMs) under Representative Concentration Pathway 8.5 (RCP8.5). At each location the magnitude of the 100-year flood was estimated by fitting a Gumbel distribution function to time series of simulated annual maximum daily discharge in 1971–2000, and the return period of that flood in 2071–2100 was estimated by fitting the same distribution to discharges simulated for that period. Regions with mean runoff less than 0.01 mm day–1, Antarctica, Greenland, and Small Islands are excluded from the analysis and indicated in white.

(b) Global exposure to the 20th-century 100-year flood (or greater) in millions of people (Hirabayashi et al., 2013). Left: Ensemble means of historical (black thick line) and future simulations (colored thick lines) for each scenario. Shading denotes ±1 standard deviation. Right: Maximum and minimum (extent of white), mean (thick colored lines), ±1 standard deviation (extent of shading), and projections of each GCM (thin colored lines) averaged over the 21 st century. The impact of 21 st century climate change is emphasized by fixing the population to that of 2005. Annual global flood exposure increases over the century by 4 to 14 times as compared to the 20th century (4 ± 3 (RCP2.6), 7 ± 5 (RCP4.5), 7 ± 6 (RCP6.0), and 14 ± 10 (RCP8.5) times, or 0.1 % to 0.4 to 1.2% of the global population in 2005). Under a scenario of moderate population growth (UN, 2011), the global number of exposed people is projected to increase by a factor of 7 to 25, depending on the RCP, with strong increases in Asia and Africa due to high population growth.

Source: *IPCC. 2014. AR5.*

30

Extreme precipitation & water-borne disease outbreaks



Source: Curriero et al. (2001)

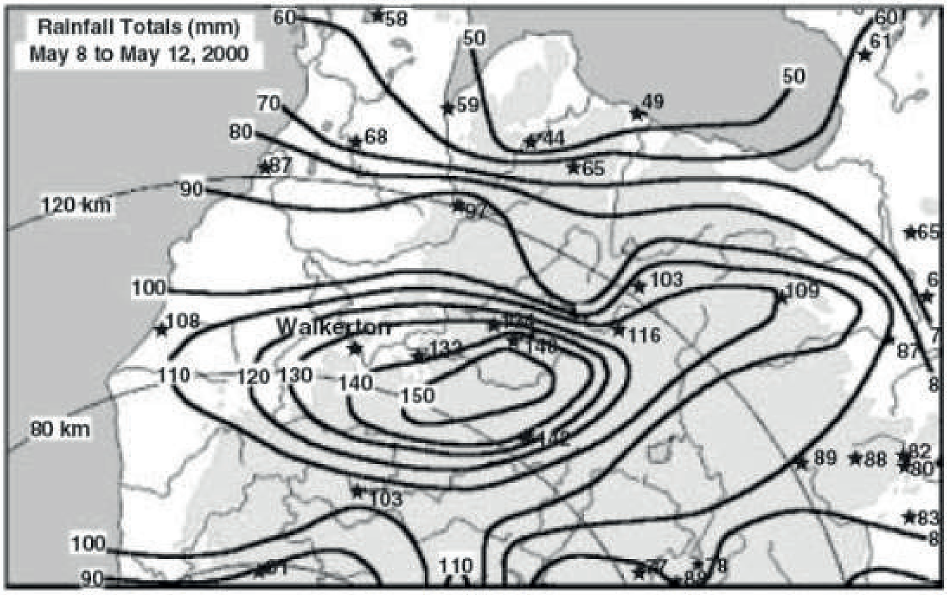
In looking at the end point of outbreaks of water-borne disease in association with rainfall, Curriero et al. (2001) reported that 51% of drinking water outbreaks in the United States between 1948 and 1994 occurred following rainfall events in the 90th %-ile and 68% were preceded by rainfall events in the 80th percentile, on a watershed level. Associations were noted for both surface water and groundwater.

This map shows large watershed boundaries and each dot represents a water-borne disease outbreak. The open circles designate a > 90th %-ile rain event.

Source: *Curriero FC et al. 2001. The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994. Am J Public Health. 2001 Aug;91(8):1194-9.*

31

E.g. Walkerton (Canada) rainfall, 2000



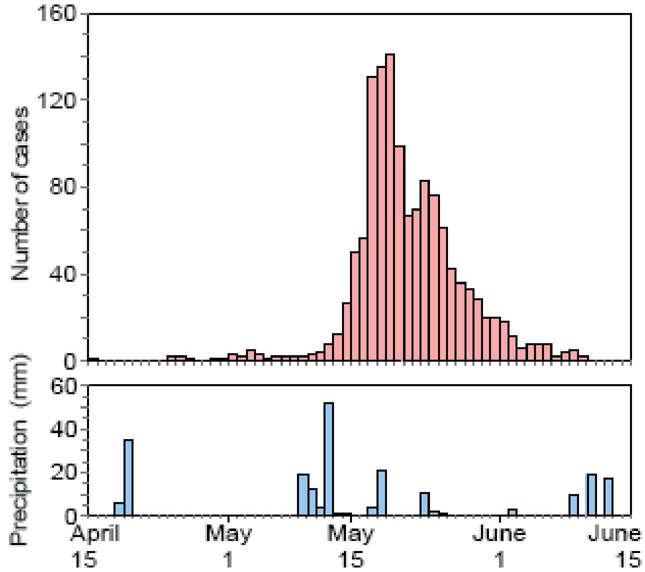
Source: Auld et al. (2004)

An example of the effects of extreme precipitation on water-borne disease where we can elucidate some of the mechanisms, in addition to the health end points, is the Walkerton, Ontario outbreak of May 2000.

Rainfall levels were historically high in the days preceding the disease outbreaks. Near the outbreak area, rainfall reached up to 150 mm within a 4-day period. This was estimated to be a 60- to 100-year event for this area.

Source: *Auld H et al, 2004. Heavy rainfall and waterborne disease outbreaks: the Walkerton example. J Toxicol Environ Health A. 67(20-22):1879-87.*

E.g. Walkerton (Canada) outbreak Illness onset dates & precipitation



Source: Howard (2004)

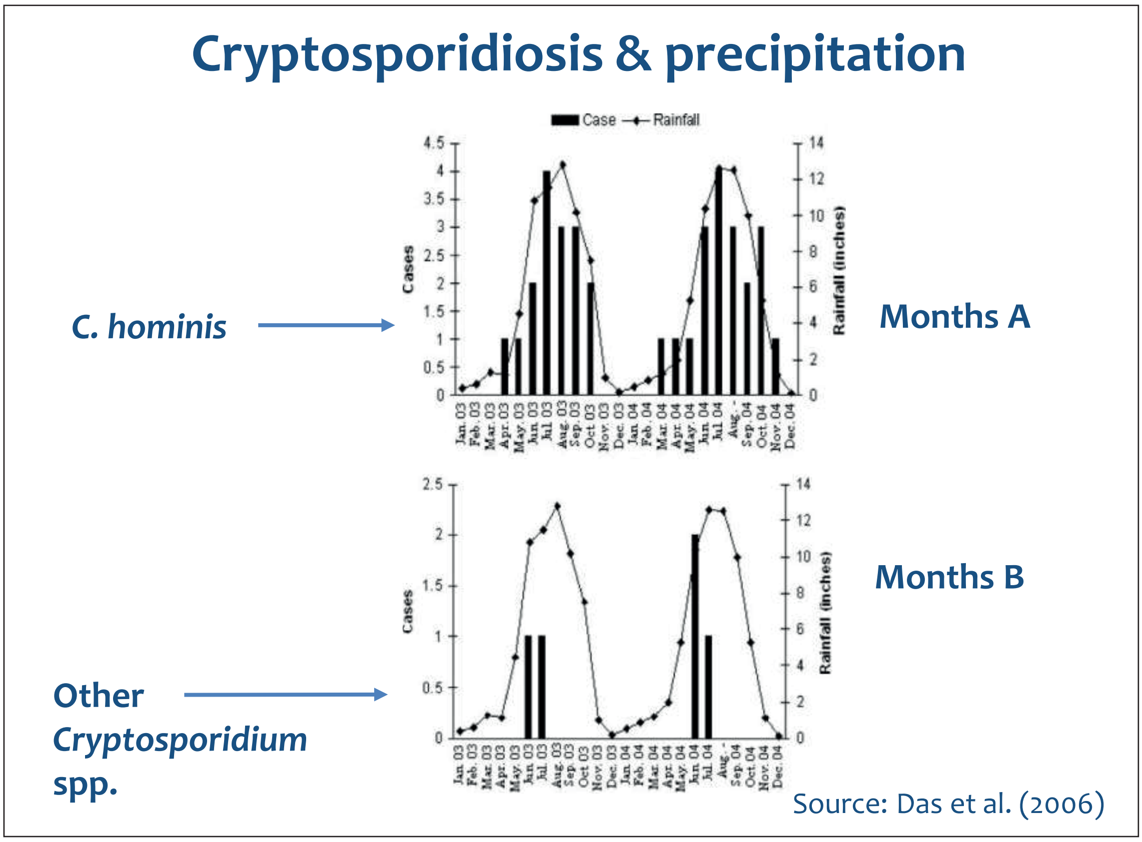
Over a short timeframe, 2300 people became ill in a community with a total population of 4800. Of these, 7 deaths were reported (mostly children). The outbreak was primarily due to *Campylobacter* and *E. coli* O157:H7 infections.

This outbreak was linked to faecal contamination in a groundwater well. Although inquiries showed a breakdown in the multiple barrier approach to water protection, the outbreak was ultimately related to extremely high rainfall amounts preceding the outbreak, which resulted in contamination of the well.

In this chart, the progression of the outbreak is noted in the top graph while daily precipitation is shown in the bottom.

Source: *Howard KWF, 2004. Microbial pollution of groundwater in the town of Walkerton, Canada. In: Tellam JH et al. eds. Urban Groundwater management and sustainability. IV Earth and Environmental Sciences Vol 74. NATO Science Series. Dordrecht; Springer*

33



Cases of the protozoan parasitic disease, cryptosporidiosis, can also be linked to preceding rainfall levels, as shown in this chart, which reflects cases and rainfall by month in Kolkata, India.

Like both *E. coli* and *Campylobacter*, *Cryptosporidium* is a zoonotic agent and is often associated with cattle, water fowl, and other reservoirs that can contribute to contamination, in addition to human waste. Results from this study indicate that infections from both human specific strains (*C. hominis*) and zoonotic strains (i.e., *C. parvum*) follow similar patterns with increasing incidence with increased rainfall. This illustrates that contamination from run-off with either human or animal waste results in clinical cases.

Source: *Das P et al. 2006. Molecular characterization of Cryptosporidium spp. from children in Kolkata, India. J Clin Microbiol. 44(11):4246-9*

34

Rainfall, run-off & pathogen contamination

- Building evidence for the association between diarrhoeal disease & increased precipitation, especially with heavy rainfall events
- In addition, several studies note increased pathogen loads related to floods, run-off, & heavy precipitation including:
  - Enteric viruses (e.g. enteroviruses, noroviruses, adenoviruses)
  - Protozoan parasites (e.g. *Cryptosporidium*, *Giardia*, others)
  - Enteric bacteria (e.g. *Salmonella*, *Campylobacter*, *E. coli*, fecal indicator bacteria)

There is now building evidence for the association between diarrhoeal disease & increased precipitation, especially with heavy rainfall events

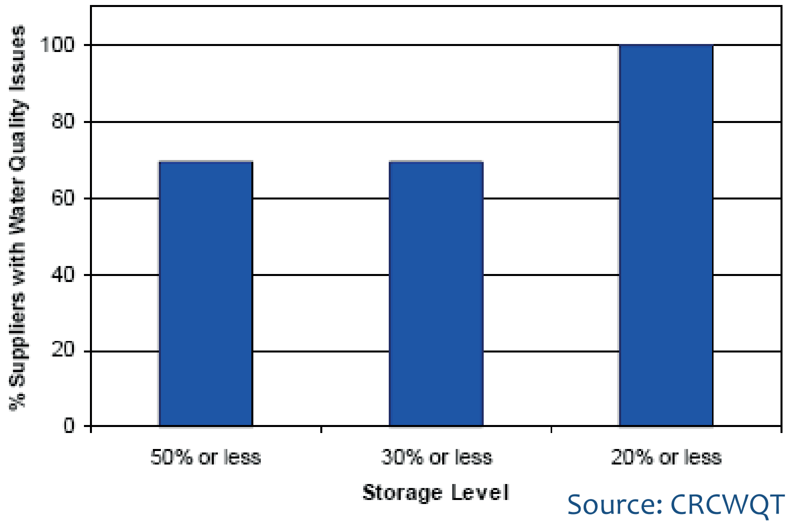
In addition, several studies note increased pathogen loads related to floods, run-off, & heavy precipitation including:

- Enteric viruses (e.g. enteroviruses, noroviruses, adenoviruses)
- Protozoan parasites (e.g. *Cryptosporidium*, *Giardia*, others)
- Enteric bacteria (e.g. *Salmonella*, *Campylobacter*, *E. coli,* fecal indicator bacteria).

35

Drought effects on water quality

Correlation between storage level & supplies with water quality issues



Source: CRCWQT (2005)

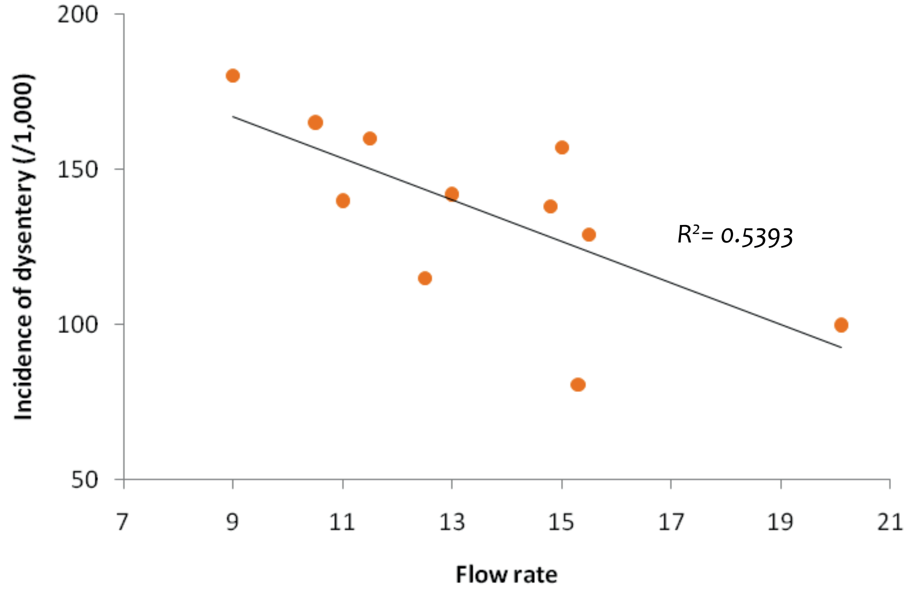
While there are fewer specific studies relating water-borne disease incidence to drought and projection of changes in disease incidence with drier conditions, it is accepted that reductions in water supply can be expected to result in increasing pressures on limited water sources. Additionally, as water sources are more limited they potentially experience increasing concentrations of pathogens due to a variety of influences, including increased water use for multiple purposes and the contribution of wastewater (treated or untreated) to the total water volume.

The effects of reservoir storage volume on water quality in general is noted in this figure. When volume is at 20% or less of capacity, all users will experience water quality issues.

Source: *CRCWQT. 2005. Drought and Water Quality: Background Paper for Workshop, 2nd August 2005 – Brisbane. Report No. DC05119. July. Cooperative Research Centre for Water Quality and Treatment*

36

Drought & Shigellosis



Source: Modified from NICD data, Mongolia (2009)

Data are sourced from Mongolia. Reports on the annual flow rate of the Tul River, which flows across Ulaanbataar in Mongolia, in which more than half of the population lives, is highly correlated with the incidence of dysentery – on the vertical axis. Shortage of water – represented in the flow rate on the horizontal axis - may be related with a lowered aquifer, leading to the shortage of water supply. Shigella outbreak is strongly related to water shortage, bringing about a typical water-washed disease.

Source: *Modified from NICD data, Mongolia. 2009.*

37

3

How climate & weather affects food- & water-borne disease: Sea level rise

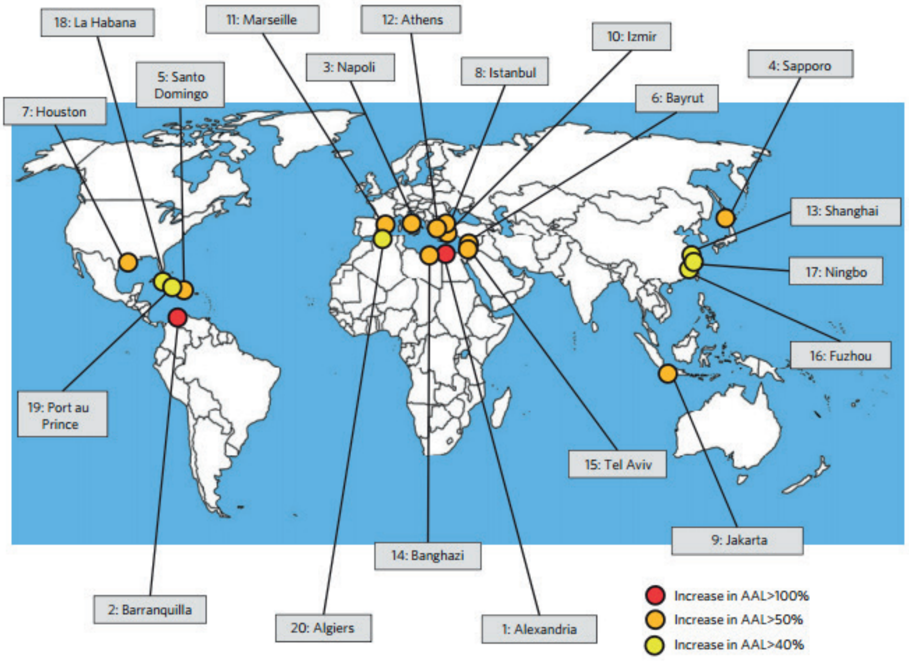
The fourth area of impact of climate and weather on diarrhoeal diseases and food- and water-borne diseases is sea level rise.

Sea levels are expected to rise world-wide, associated with both melting glaciers, polar ice caps, and thermal expansion.

The effects of sea level rise will impact coastal zones via periodic flooding (storm surge) as well as incremental rise in water level. These will result in a decrease in fresh water availability, loss of infrastructure (due to flooding), and an influx of marine pathogens.

38

Cities vulnerable to sea level rise



Source: Hallegatte et al. (2013)

This figure shows the areas considered to be highly vulnerable to increased sea levels due both their elevation and population sizes. Many of these are in delta areas that must already deal with periodic flooding.

The 20 coastal cities where average annual losses (AALs) increase most (in relative terms in 2050 compared with 2005) in the case of optimistic sea level rise, if adaptation maintains only current defense standards or flood probability (PD).

Source: *Hallegatte et al. Future flood losses in major coastal cities. Nature Climate Change 2013;3:802-806.*

39

Vibrio spp.

- *Vibrio* are commonly estuarine & marine bacteria & include at least 12 known pathogens to humans
  - *V. vulnificus*
  - *V. parahaemolyticus*
  - *V. cholerae*
- In general, this group replicates easily in natural waters & biota, especially under high temperatures
  - Directly related to increasing water temperatures

Among the bacteria, *Vibrio* species also show a strong seasonal trend, with the highest cases reported in summer months, and a direct relationship with increasing temperatures.

This genus includes common marine species, only a few of which are pathogenic to humans; however, among this group are three significant pathogens – *V. vulnificus*, *V. parahaemolyticus,* and *V. cholerae*.

All of these replicate in the marine or estuarine environment, especially at warm water temperatures (growth begins at temperatures > 15°C). Both *V. vulnificus* and *V. parahaemolyticus* infections are commonly associated with shellfish. *V. cholerae* is unique in its ability to grow in fresh waters and can be transmitted through drinking water. Additionally, *V. cholerae* is unique in its ability to be transmitted person-to-person.

Because these are primarily "environmental" bacteria rather than primarily "enteric" and they proliferate easily in the environment, more is known about the mechanisms linking climate drivers to the pathogen itself.

40

Cholera: South Asia

- Yearly epidemics correspond to natural environmental cycles & contamination
  - Influx of estuarine water
  - Plankton blooms
  - Monsoons
  - Warm temperatures
- Cycles can be modelled for year-to-year changes in outbreaks

Because the *Vibrio* species are native marine bacteria, this group may be expected to be among the primary concerns with water-borne disease associated with sea level rise. In many areas of the world that are particularly prone to sea level rise (many parts of south Asia), cholera (*V. cholerae*) is already an ongoing problem.

Because cholera has both an environmental (water) and human host (gut) life stage, outbreaks can be initiated or perpetuated by either influx of estuarine water or by wastewater contamination (during outbreaks).

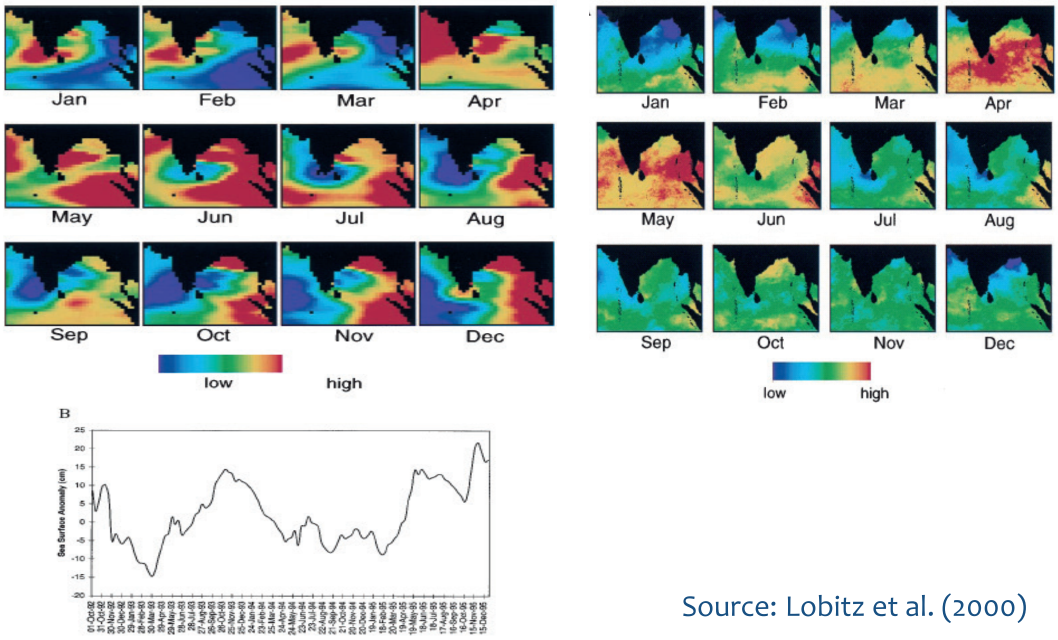
We know much about the mechanisms that result in *V. cholerae* growth in the environment and how it may intersect with various climate or weather parameters.

V. cholerae proliferates:

- in warm waters
- *in association with plankton*

Additionally, cholera outbreaks are linked tightly with monsoon seasons (which may be more related to spread from contaminated sources rather than influx from the environment).

Bay of Bengal: Sea surface height & sea surface temperature



Source: Lobitz et al. (2000)

In 2000, Lobtiz et al. described the use of remote sensing to model the highest risk period for cholera in the Bay of Bengal.

The authors investigated multiple types of remotely sensed data to attempt these models.

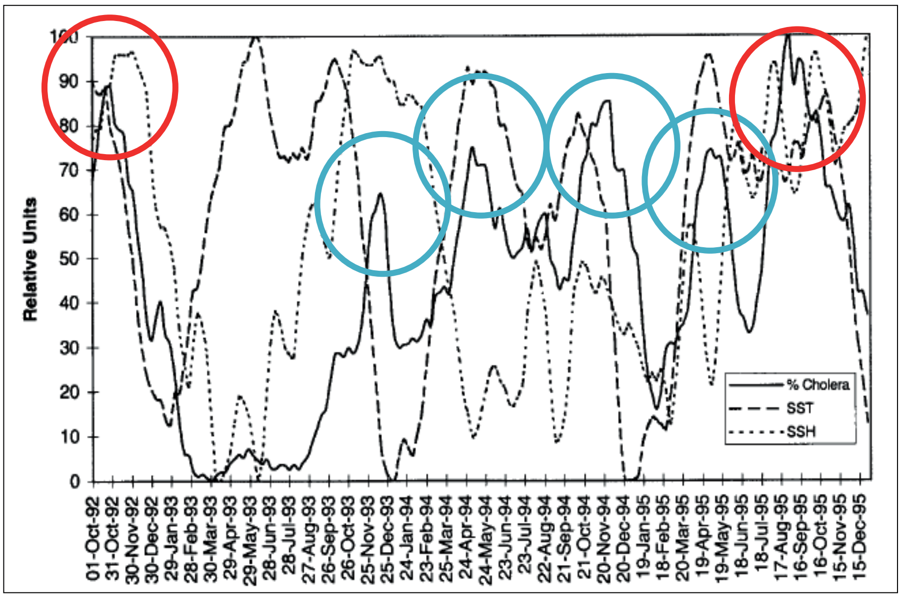
Here are the Advanced Very High Resolution Radiometer (AVHRR) satellite images that show changes in sea surface height by month. The red color indicates high water levels and blue indicates low water levels. These data act as a proxy for marine/estuarine water influx.

Sea surface temperature data were also captured over the same space and time scales. Higher temperatures are noted in orange and red.

Source: *Lobitz B et al. 2000. Climate and infectious disease: Use of remote sensing for detection of Vibrio cholerae by indirect measurement. PNAS 2000;97(4):1438-1443.*

42

Bay of Bengal: Cholera & sea surface height



Source: Lobitz et al. (2000)

By combining both sea surface height data and sea surface temperature data, trends with cholera rates begin to emerge.

Peaks in cholera cases over the study period (solid lines) correspond with peaks in either sea surface height or sea surface temperature (highlighted with **red and blue** circles). When peaks in sea surface height (marine water intrusion and proxy for sea level rise scenario) coincide with peaks in sea surface temperature (proliferation of the bacteria), we see the greatest peaks in cholera.

From this we might speculate that increases in both temperature and sea level as projected in climate change scenarios, would increase the burden from cholera.

Source: *Lobitz et al. 2000. Climate and infectious disease: Use of remote sensing for detection of Vibrio cholerae by indirect measurement. PNAS 2000;97(4):1438-1443.*

4

Measures to address water- & food-borne diseases associated with climate change

Let's finish Module 9 by looking at measures that can be taken to address water- & food-borne diseases associated with climate change.

The image in the top right is an example, is a project called SWASHTHA - Strengthening Water, Air, Sanitation and Hygiene Treasuring Health in Nepal, which is a practical programme attempting to address the fact that water sanitation related diseases are amongst the top killers in Nepal.

44

Water-borne disease: summary

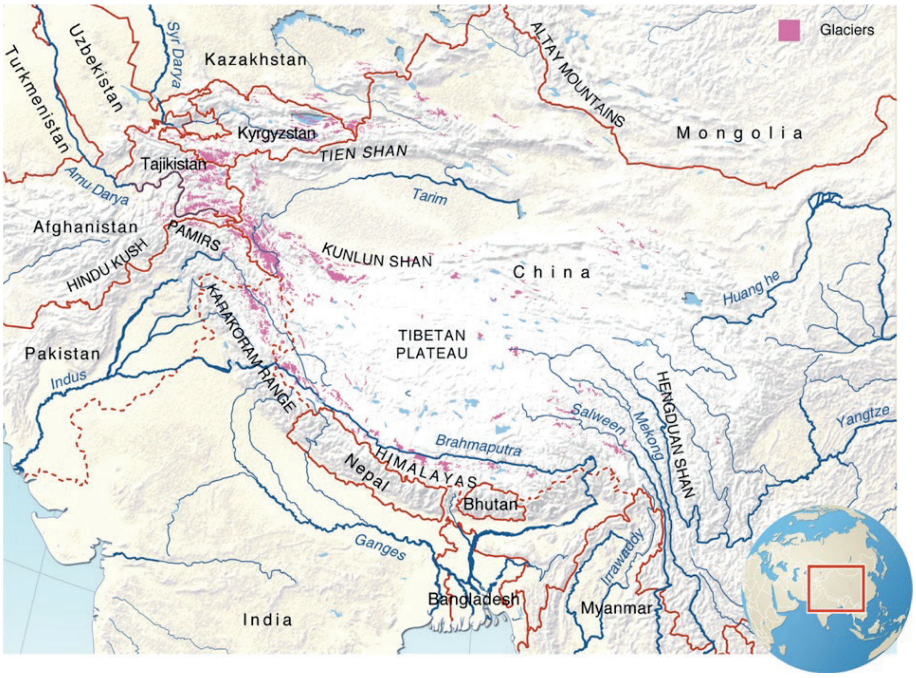
- Climate projections for increased warming & increased extreme events suggest water-borne diseases may increase
- Mitigation & adaptation will be enhanced by understanding the ecology of pathogens
  - What underlying factors provide the link to climate?
  - How do changing landscapes affect disease incidence under changing climate conditions?

In summary, evidence, although limited, suggests that water-borne diseases will increase under projected climate change scenarios due to effects from increased temperatures, heavy storm events, drought, and sea level rise.

As we move forward, it is important that we continue to collect basic surveillance data on these climate sensitive diseases as well as improve our understanding of the mechanisms by which climate influences these pathogens.

45

The water tower of Asia



Rapid glacier melting would result in a drastic reduction in the contribution to the river flow. Current permanent rivers would become seasonal.

Melting glaciers together with disturbed rainfall patterns will increase the amount of water-induced hazards such as floods, flash floods, landslides, debris flows, and droughts. Rainfalls will increase in high latitudes and decrease in most subtropical land regions, many of which are already affected by drought.

Population growth and increasing demand for water due not only to higher temperatures – demand for irrigation water will increase by 10% for an increase in temperature of 1°C – but also to higher standards of living, could adversely affect more than a billion people by the 2050s. Increasing withdrawal rates of groundwater and decreasing recharge time of the aquifers will accelerate the water crisis, notably in drier areas (Gosain et al., 2006).

The water tower of Asia

River	Area sq km	Mean discharge (m³/s)	% of Glacier melt in river flow	Population x 1,000	Population density	Water per person m³/year
Indus	1 081 718	5 533	44.8	178 483	165	830
Ganges	1 016 124	18 691	9.1	407 466	401	~2 500
Brahma	651 335	19 824	12.3	118 543	182	~2 500
Irrawaddy	413 710	13 565	small	33 097	80	18 614
Salween	271 914	1 494	8.8	5 982	22	23 796
Mekong	805 604	11 048	6.6	57 198	71	8 934
Yangtze	1 722 193	34 000	18.5	368 549	214	2 265
Yellow	944 970	1 365	1.3	147 415	156	361
Tarim	1 152 448		40.2	8 067	7	754
Total				1 324 800		

Source: ICIMOD (2008)

Rapid glacier melting would result in a drastic reduction in the contribution to the river flow. Current permanent rivers would become seasonal.

Melting glaciers together with disturbed rainfall patterns will increase the amount of water-induced hazards such as floods, flash floods, landslides, debris flows, and droughts. Rainfalls will increase in high latitudes and decrease in most subtropical land regions, many of which are already affected by drought.

Population growth and increasing demand for water due not only to higher temperatures – demand for irrigation water will increase by 10% for an increase in temperature of 1°C – but also to higher standards of living, could adversely affect more than a billion people by the 2050s. Increasing withdrawal rates of groundwater and decreasing recharge time of the aquifers will accelerate the water crisis, notably in drier areas (Gosain AK et al. 2006. Climate change impact assessment on hydrology of Indian river basins).

Source: *ICIMOD. 2009. Climate change and its impacts on glaciers and water resource management in the Himalayan Region*

47

Measures to address water- & food-borne diseases

- The effects of climate change on water- & food-borne diseases can be mitigated
  - Focus on public health response
  - Focus on basic infrastructure
  - Increased attention to treatment options
- We have the tools to address problems & prevent disease
- Understanding how climate may increase risk can be used to prioritize adaptation or rapid response measures

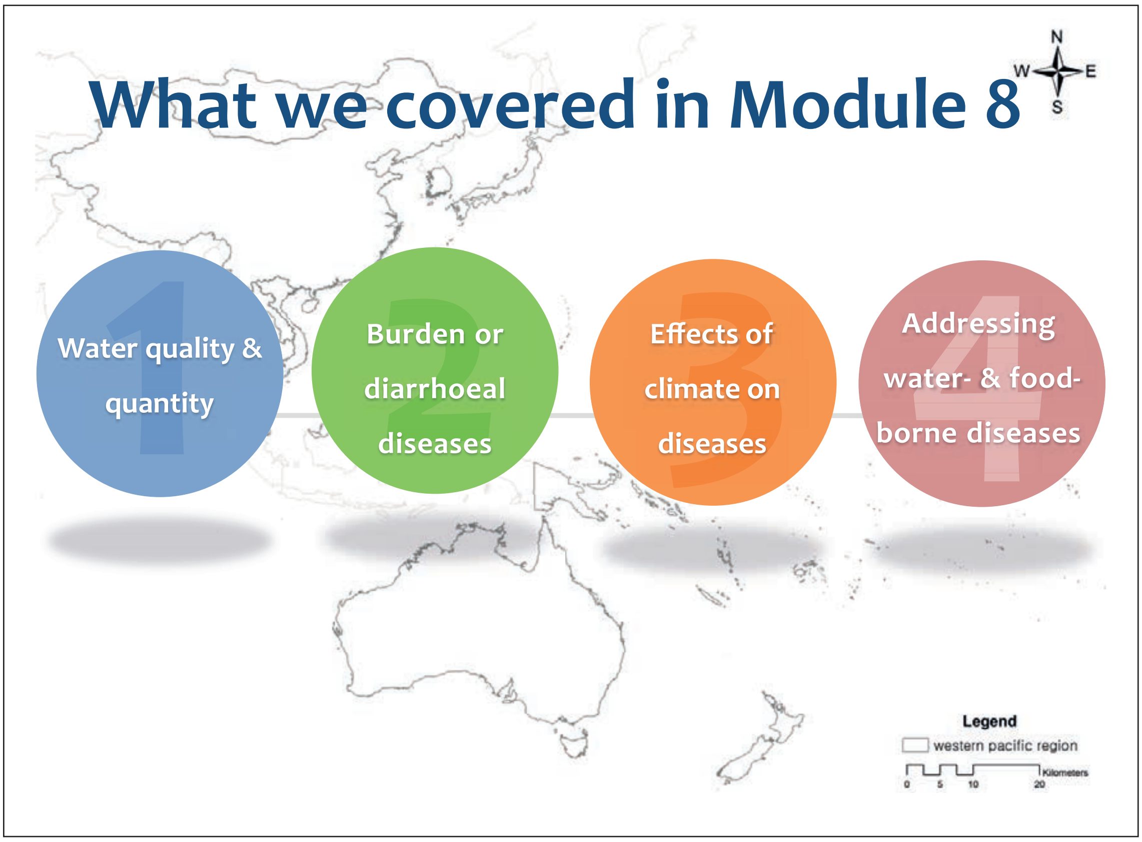
Our ability to adapt to and implement basic public health practices to protect water quality may mitigate the projected disease trends.

These measure include following the same sound practices that the public health community always uses to prevent disease including awareness of vulnerabilities, investments in the upkeep and development of infrastructure to ensure clean water, and focused attention on best management practices for treatment of water.

While trends suggest that the risk to human health due to water stress and water and foodborne disease, adequate attention and investment in sound sanitation practices and education of the public will go a long way in mitigating these risks.

Recommended reading: 2007 IPCC reports: The Physical Science Basis, page 53, Box TS5

48



Here's what we covered in Module 8:

1. Water quantity and quality
2. Burden of diarrhoeal diseases
3. How climate and weather affects diarrhoeal diseases and food- and water-borne pathogens
   - Season
   - Temperature
   - Precipitation (flooding and drought)
   - Sea level rise
4. Measures to address water- & food-borne diseases.

49

Key messages in Module 8

- Water-borne diseases are mostly transmitted by faecal-orally transmitted diseases
- Climate can influence water-borne diseases in different ways depending on the local environment & population
- Mitigation & adaptation will be enhanced by understanding the ecology of pathogens

The key learnings to take away from Module 9 are: (**CLICK** for each)

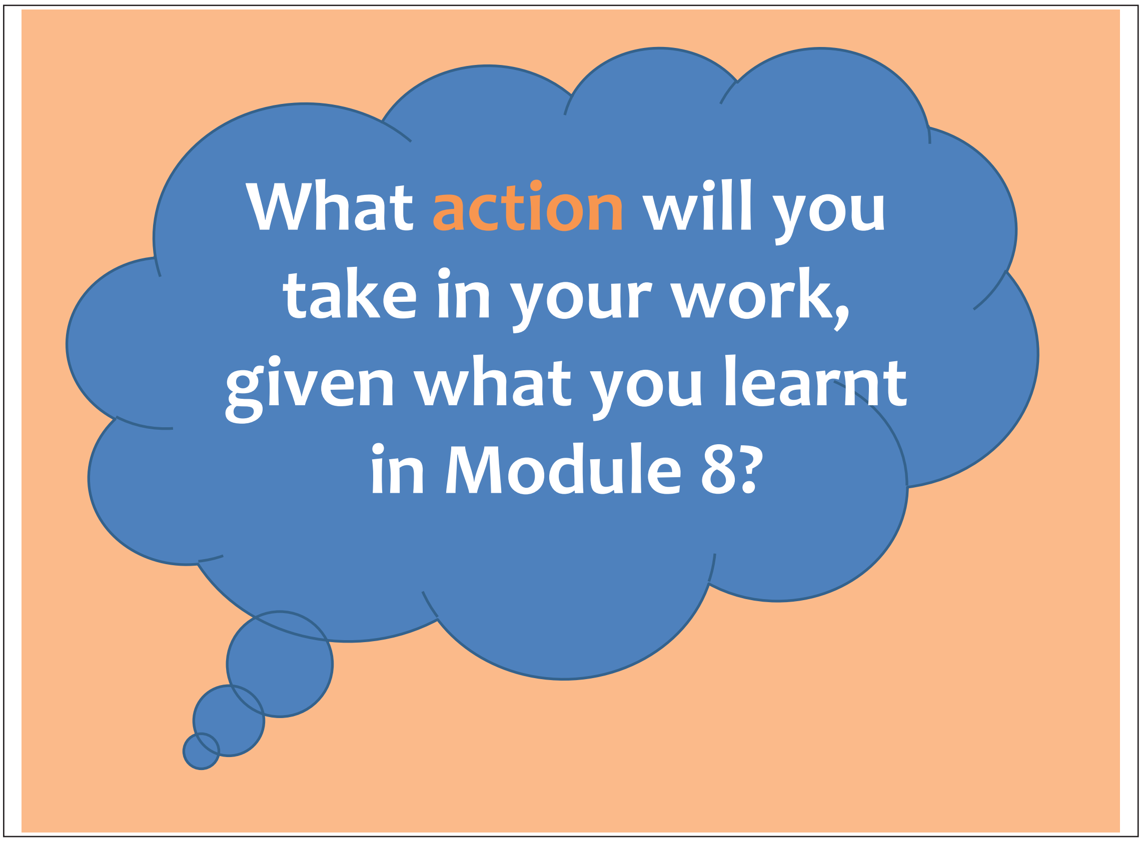
Water-borne diseases are mostly transmitted by faecal-orally transmitted diseases

Climate can influence waterborne diseases in different ways depending on the local environment & population

Mitigation & adaptation will be enhanced by understanding the ecology of pathogens

Q: Are there any questions on these?

50



To finish off Module 8, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around water- and food-borne diseases.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes**: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 9

Food security and malnutrition

Key learning messages in Module 9

- Nutrition-related factors are together responsible for about 35% of child deaths & 11% of the total global burden of disease
- Millennium Development Goal 5 on Child Mortality will not be reached
- Food security is already a significant challenge & climate change is likely to worsen global food security
- There are clear steps that can be taken to help mitigate the anticipated challenges to food security attributable to climate change.

Estimated length: 70 minutes

Structure of Module 9

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Define terms related to food insecurity, and look at its causes	4–9	
2. The burden of disease from undernutrition	10–18	EXERCISE on slide 11: What disease impacts are you seeing in your country or region from undernutrition? Discuss in groups of three on their table, 3 minutes.
3. How climate change is affecting food security	19–24	
4. How climate change is likely to affect crop production and food security	25–35	
5. Steps that can improve food insecurity	36–41	
Module outline	42	
Learning from Module 9	43	
Learning reflection, action generation	44	

Required resources

- Data projector and slide changer
- Module 9 slides
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 9

There's a possibility that the contents of Module 9 may elicit an emotional reaction from some participants, particularly on slides related to the impact of undernutrition for children and those most vulnerable, and that climate change will worsen hunger and malnutrition. Acknowledge the sadness of this situation, and scan the group for body language that may show you participants are keen to discuss or debrief the contents of the module.

Section 5 (slides 37 – 42) is important to place emphasis on, showing that there are real steps the health sector (and others) can take to improve the outlooks for food security and nutrition under climate change.

Key terms introduced in Module 9

- Malnutrition
- Undernutrition
- Obesity
- Hunger
- Food security
- Stunting
- Millennium Development Goal on Hunger
- Global food crisis
- Livestock
- Food system
- Crop models.

References (in order of presentation)

- FAO. 2002. http://www.fao.org/economic/ess/ess-fs/en/
- Black et al. 2008. Maternal and child under nutrition: global and regional exposures and health consequences. Lancet. 2008 Jan 19;371(9608):243-60)
- Onis et al. 2010. Prevalence and trends of stunting among pre-school children, 1990–2020. Public Health Nutrition
- Von Braun. 2008. 'High Food Prices: The What, Who and How of Proposed Policy Actions', Washington DC, International Food Policy Research Institute (IFPRI), Policy Brief, http://www.ifpri.org/pubs/ib/foodprices.asp.

- FAO. 2014. Food price and crop yield data from FAO (http://www.fao.org/worldfoodsituation/foodpricesindex and http://faostat.fao.org/) and oil price data from US Department of Energy (EIA). 2014. http://www.eia.gov.
- International Food Policy Research Institute*, website 2014. available from: http://www.ifpri.org/tools/2014-ghi-map*
- FAO. 2002. The State of Food Insecurity in the World 2002
- FAO. 2008. The State of Food Insecurity in the World 2008
- Battisti and Naylor. 2009. Historical warnings of future food insecurity with unprecedented seasonal heat. Science. 2009 Jan 9;323(5911):240-4.
- Naylor R 2005. Losing the Links Between Livestock and Land;
- Gerber, P., Wassenaar, T., Rosales, M., Castel, V. & Steinfeld, H**.** 2007. Environmental impacts of a changing livestock production: overview and discussion for a comparative assessment with other food production sectors
- Fischer G et al. 2005. Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990-2080
- Tubiello, F.N. and G. Fischer. 2007. Reducing climate change impacts on agriculture: Global and regional effects of mitigation, 2000–2080. *Technological Forecasting & Social Change*. 74:1030–1056.
- Fischer, G., M. Shah, H.V. Velthuizen, and F.O. Nachtergaele. 2001. Global Agro-ecological Assessment for Agriculture in the 21st Century. International Institute of Applied Systems Analysis.
- Bell et al. 2013. *Mixed responses of tropical Pacific fisheries and aquaculture to climate change*. Nature Climate Change 2013; 3:591-599.
- IPCC. 2014. Fifth Assessment Report.
- FAO 2006. *World Agriculture: Towards 2030/2050.* Interim Report, June. Available: http://www.fao.org/ES/esd/AT2050web.pdf.
- McMichael et al. 2008. Food, agriculture, energy, climate change and health. *The Lancet* 370:1253−1263

Module 9:
Food security & malnutrition

In Module 9 we're going to look at the important issue of food security, and its relationship with climate change and malnutrition.

2

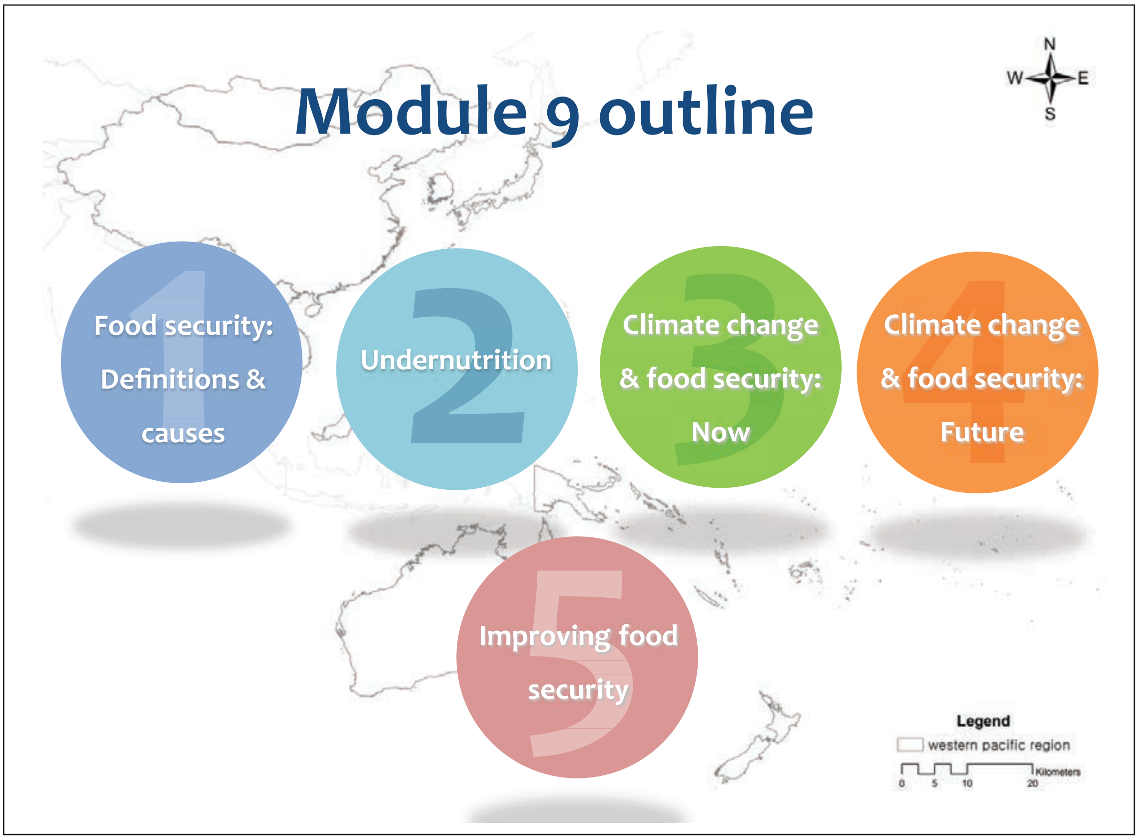
Key messages in Module 9

- Nutrition-related factors are together responsible for about 35% of child deaths & 11% of the total global burden of disease
- Millennium Development Goal 5 on Child Mortality will not be reached
- Food security is already a significant challenge & climate change is likely to worsen global food security
- There are clear steps that can be taken to help mitigate the anticipated challenges to food security attributable to climate change

The key messages we'll be covering in Module 9 are: (CLICK to show each of the four)

- Nutrition-related factors are together responsible for about 35% of child deaths & 11% of the total global burden of disease
- Millennium Development Goal 5 on Child Mortality will not be reached
- Food security is already a significant challenge & climate change is likely to worsen global food security
- There are clear steps that can be taken to help mitigate the anticipated challenges to food security attributable to climate change

3

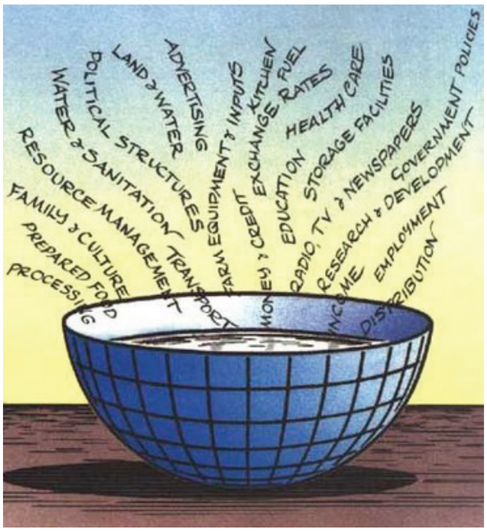


In Module 9 we will look at the following five areas:

1. Define terms related to food insecurity, and look at its causes
2. Learn about the burden of disease from undernutrition
3. See how climate change is affecting food security
4. Look at how climate change is likely to affect crop production and food security
5. Examine steps that can improve food insecurity

1

Food security: Definitions & causes



Let's start off by defining some key terms related to food insecurity, and look at its causes.

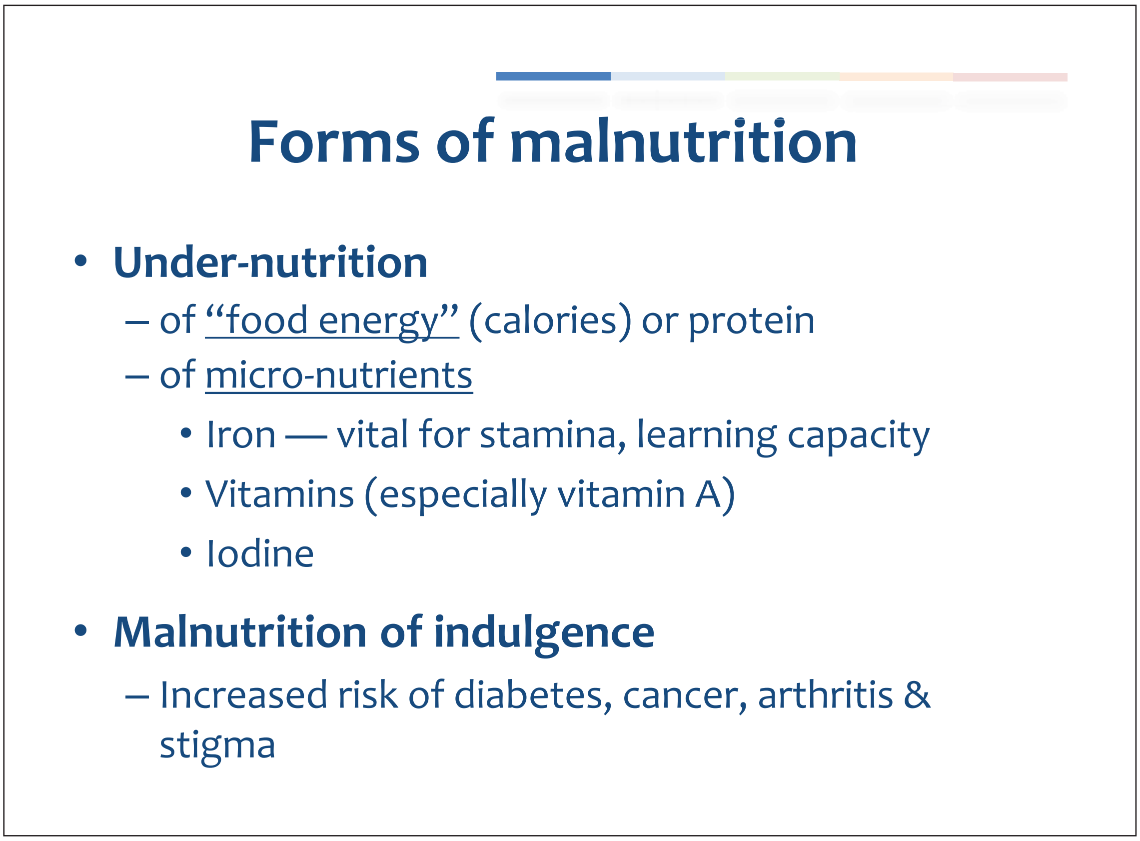
5

Malnutrition: Definitions

- **Undernutrition:** deficiencies of essential vitamins & minerals (collectively referred to as micronutrients)
- **Obesity:** over-consumption of specific nutrients: another form of malnutrition
- **Hunger:** discomfort from not eating
- Undernutrition is an important determinant of maternal & child health

Here are some key definitions related to malnutrition – read.

6



The word "malnutrition" is often used, rather loosely, to refer to hunger and undernutrition. However, many obese people are also poorly, or malnourished.

The number of people with micronutrient deficiency greatly exceeds those with macronutrient deficiency — perhaps by a factor of three (especially with iron deficiency). Virtually all people with macronutrient deficiency will also experience a degree of micronutrient deficiency.

7

Characteristics & impacts of undernutrition

- Undernourished often have co-existent disease, including parasites
  - Increased demand for calories
  - Can limit nutrient absorption
- Both forms of undernourishment:
  - Often co-exist
  - Reduce cognitive potential, height, strength, stamina & learning capacity, causing a multiple burden
  - Increase stigma

People, often the poor in a society, who suffer from diseases such as malaria, upper respiratory illnesses, diarrhoea, tuberculosis, and HIV/AIDS, especially if associated with fever, have increased caloric demand.

Those chronically ill from some parasitic infections are unable to absorb nutrients, even if swallowed. Those needing to perform physical labour and in challenging settings will also have increased caloric demand.

Chronic under-nourishment often leads to or contributes to obvious poverty, and often physical and cognitive stunting. People who are significantly overweight are also often stigmatised.

8

Food security & right to food

- **Food security** defined as:

  "When people, at all times, have physical, social & economic access to sufficient, safe & nutritious food preferences for an active & healthy life"

  (FAO, 2002)

- The right to food is universal
  - –International Covenant on Economic, Social & Cultural Rights (UN-OHCHR, 2008)
  - –The related concept of food entitlement was identified by 1998 Nobel Laureate Amartya Sen

The Food and Agriculture Organization (FAO) defines food security as a ''situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." This definition comprises four key dimensions of food supplies: availability, stability, access, and utilization (FAO, 2002).

Right to adequate food is a human right, inherent in all people, to have regular, permanent, and unrestricted access, either directly or by means of financial purchases, to quantitatively and qualitatively obtain adequate and sufficient food corresponding to the cultural traditions of people to which the consumer belongs, and which ensures a physical and mental, individual and collective fulfilling and dignified life free of fear (more at FAO, 2008d).

Entitlement means that in a well-governed society, people do not starve because the food that exists is distributed sufficiently evenly to avoid famine. People may either be given food, vouchers, or provided with publicly funded work, which enables them to buy food.

Sen's analysis originally focused on the famine in WWII in Bengal, which Sen witnessed as a child, and in which about 3 million people died. Although there had been poor harvests at the time, Sen showed that in the year of the maximum number of deaths, the harvest had improved. There are numerous other examples of national and regional famine which have occurred during times of adequate national or regional food production – among the best known are the Irish famine of the late 1840s and exports of food from India during periods of severe famine in the 19th century (see Davis, 2000), and appropriation of crops from occupied Vietnam by Japan, during WWII.

contd...

8

Food security & right to food

- **Food security** defined as:

  "When people, at all times, have physical, social & economic access to sufficient, safe & nutritious food preferences for an active & healthy life"

  (FAO, 2002)

- The right to food is universal
  - –International Covenant on Economic, Social & Cultural Rights (UN-OHCHR, 2008)
  - –The related concept of food entitlement was identified by 1998 Nobel Laureate Amartya Sen

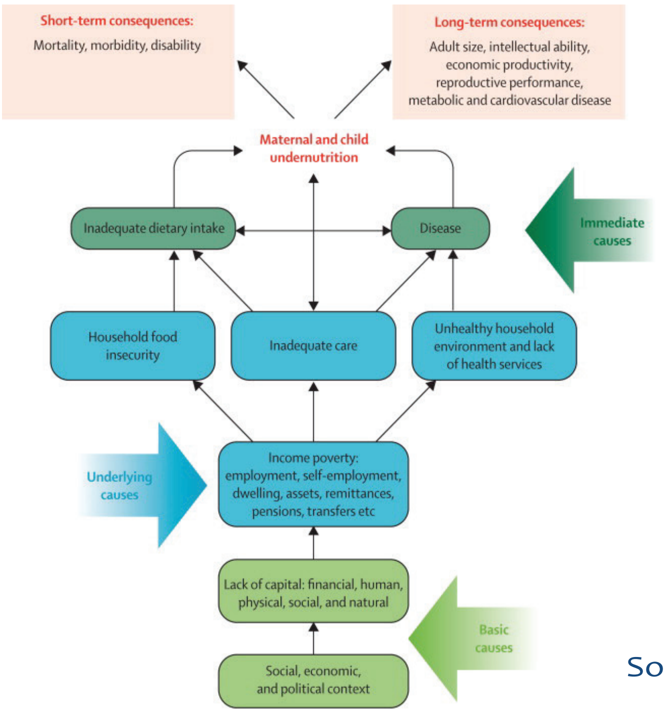
Sen's work was important in challenging an opinion which until then was overly-influential – that famines were most often caused by "natural" disasters. In reality the explanation is often more complex. The primary cause of the great Chinese famine (1959-1962) was social/political, but it also had secondary environmental factors. The more recent North Korean famine has complex social, political, and environmental causes, including recurrent flooding. However, the disconnection of North Korea from the global economy, including the global system of food relief, has been a major factor, together with a gross national maldistribution.

An important cause of the lack of food entitlement is that the chronically hungry lack the cognition, social connections, and political influence to organise in ways that are sufficiently effective to remedy their situation. More "proximal" causes of lack of entitlement include scarcity of fertile land, water, seeds, credit, and access to markets.

Source: *FAO. 2002. http://www.fao.org/economic/ess/ess-fs/en/*

9

Causes of food insecurity



Source: Black JL et al. (2008)

This figure is a framework of the relations between poverty, food insecurity, and other underlying and immediate causes to maternal and child under nutrition and its short-term and long-term consequences. I'll enlarge is now so we can see it in more detail.

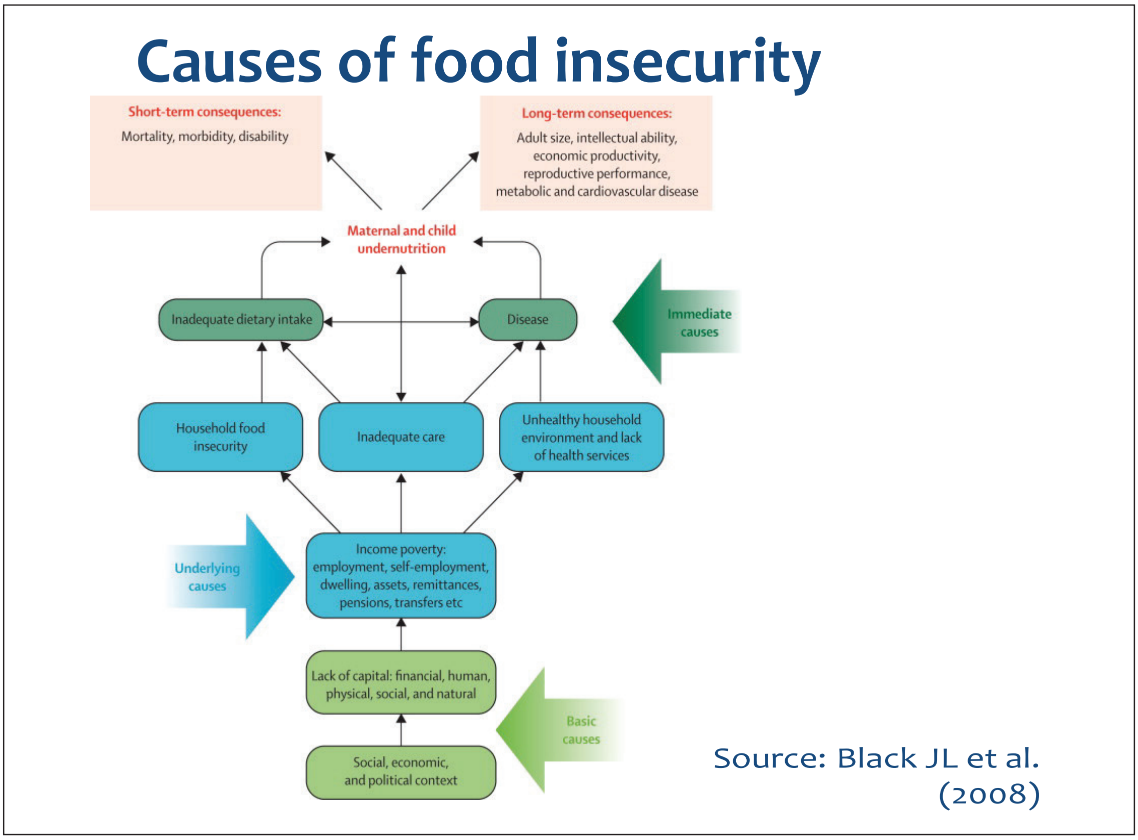
A framework (from Black JL et al. 2008. Maternal and child under nutrition: global and regional exposures and health consequences. Lancet. 2008 Jan 19;371(9608):243-60) recognizes the basic and underlying causes of under nutrition, including the environmental, economic, and sociopolitical contextual factors, with poverty having a central role (UNICEF).

There is no "single" cause of food security. Instead, there are numerous causal factors, all of which are inter-connected. It is more accurate to think of these factors as a system – a network of related, connected factors, rather than a hierarchical list. Nevertheless, of the many factors which contribute, it is still necessary to list them in order. But the order used here does not mean that there is necessarily quantitative evidence to show that these causes are ranked in priority. The following slides will provide more detail about these factors.

Lack of "food entitlement" – inequality, appropriation, poor governance, and subsidies by powerful countries which distort production geography – discussed in some detail.

The "stork and plow" – struggle between increases in population and food. This theme is mentioned several times, but not in detail. Note, however, that a major cause of continuing population growth is poverty, poor education, poor nutrition, and inequality. Thus the causes contribute to the consequence, leading to what some commentators call "entrapment" (Ehrlich et al., 1995; King, 1990).

contd...



Total (growing) consumer demand combines with apparent proximity to further yield growth of key crops. Some scientists argue that there are apparent flattening in the yields of some crops – meaning additional land will need to be harnessed for further crop growth. Others argue that genetic engineering may overcome some of these limitations; however, to date, the success of GMO crops has not equaled hope.

Under-investment in agricultural research; excessive reliance on long hoped for "Gene Revolution" – this overlaps a point in the previous slide.

Conflict and poverty — this is often presented as an external factor, a surprise which undermines food security or poverty relief. Instead, it can be argued that poverty and periodic conflict are highly likely, though temporally unpredictable manifestations of under-nutrition, and local, regional, and global inequality.

Diversion of human and other forms of energy to grow food crops for animal feed or vehicle fuels. This practice could become increasingly unacceptable in a food constrained world, unless there are major technological breakthroughs.

Global environmental change: climate change, plus + (atmospheric, water, and soil factors) climate change models are discussed in detail; many other cautionary elements are mentioned as caveats.

Global economic failure, rising cost of oil, fertiliser, transport, and other inputs contributed to the recent food price bubble. Given the long-term trajectory of these inputs is upward is another reason to be concerned about future global food security.

10

2

Burden of disease from undernutrition

In this second section we'll look at the burden of disease that stems from undernutrition

11

"I'm sure you're all aware of the sad impacts of undernutrition in your country and region.

I'll ask you to turn to two others near you and share your experience of what disease impacts you're aware of that are stemming from undernutrition in your country. You'll have three minutes to share as a group."

Give time countdowns: At 2 mins 30 secs: "Ok, please finish off your sharing in the next 30 seconds, making sure everyone's had a chance to contribute". Wrap up at 3 minutes using the bell/noise maker and thank people.

"It sounds like there are sadly a range of disease impacts being experienced in your countries and regions contributed to by undernutrition. We'll now look at this important issue in the global context."

12

Global burden of disease - undernutrition

- 21% disability-adjusted life-years (DALYs) for children younger than 5 years

- 35% child deaths – 11% of total global Burden of Disease (BoD)

Source: Black JL et al. (2008)

According to Black et al., 2008, in 2005 stunting, severe wasting, and intrauterine growth restriction together were responsible for 2.2 million deaths and 21% of DALYs for children younger than 5 years.

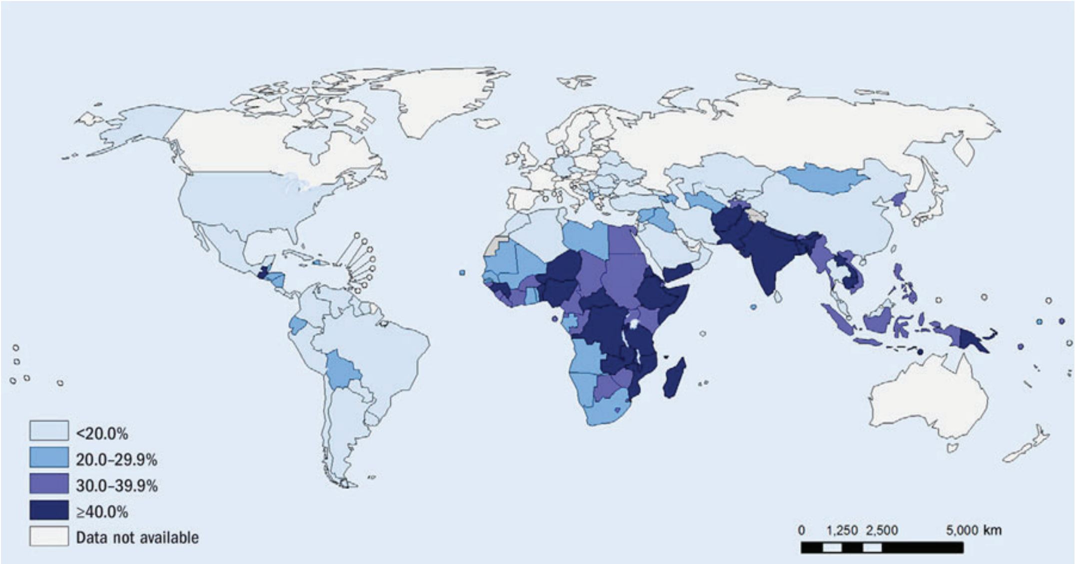
Deficiencies of vitamin A and zinc were estimated to be responsible for 0.6 million and 0.4 million deaths, respectively, and a combined 9% of global childhood DALYs.

Suboptimum breastfeeding was estimated to be responsible for 1.4 million child deaths and 44 million DALYs (10% of DALYs in children younger than 5 years).

In an analysis that accounted for co-exposure of these nutrition-related factors, they were together responsible for about 35% of child deaths and 11% of the total global disease burden (Black JL et al. 2008. Maternal and child under nutrition: global and regional exposures and health consequences. Lancet. 2008 Jan 19;371(9608):243-60).

13

Prevalence of stunting in children under 5 years (2005)



Source: Onis et al. (2010)

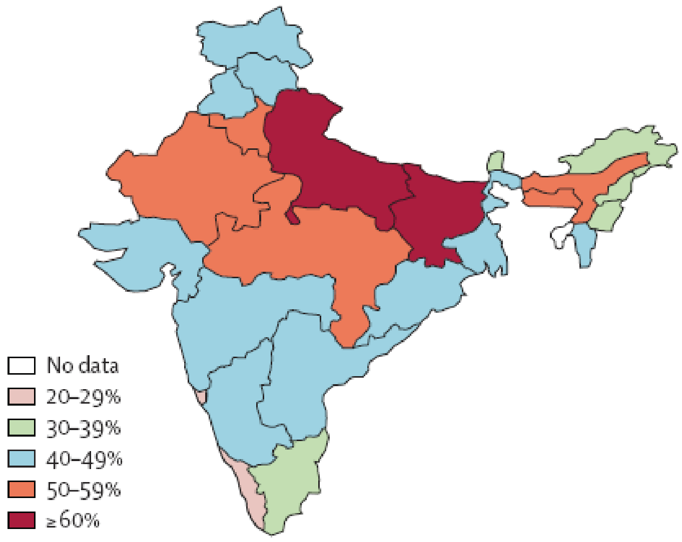
Figure shows the distribution of stunting in children.

Relatively high levels of stunting are seen throughout the South-East Asia (SEA) Region along with some countries in Africa.

Source: *Onis et al. 2010. Prevalence and trends of stunting among pre-school children, 1990–2020. Public Health Nutrition*

14

Prevalence of stunting in children under 5 years in India (2005)



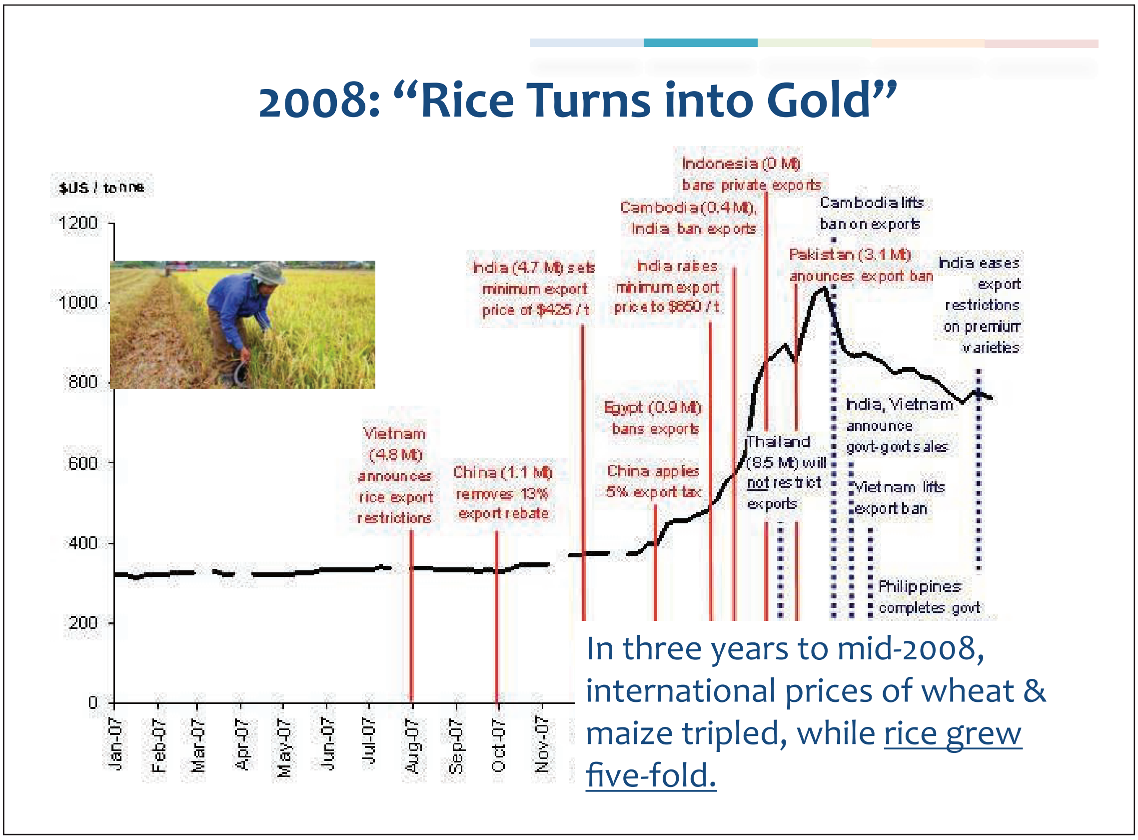
India has more than 61 million stunted children - 51% of the national population & 34% of the global total.

However, stunting prevalence varies substantially by state.

Source: Black et al. (2008)

India has more than 61 million stunted children, 51% of the national population & 34% of the global total. However, stunting prevalence varies substantially by state. Northern states facing Himalayas has highest prevalence and next higher in adjacent states.

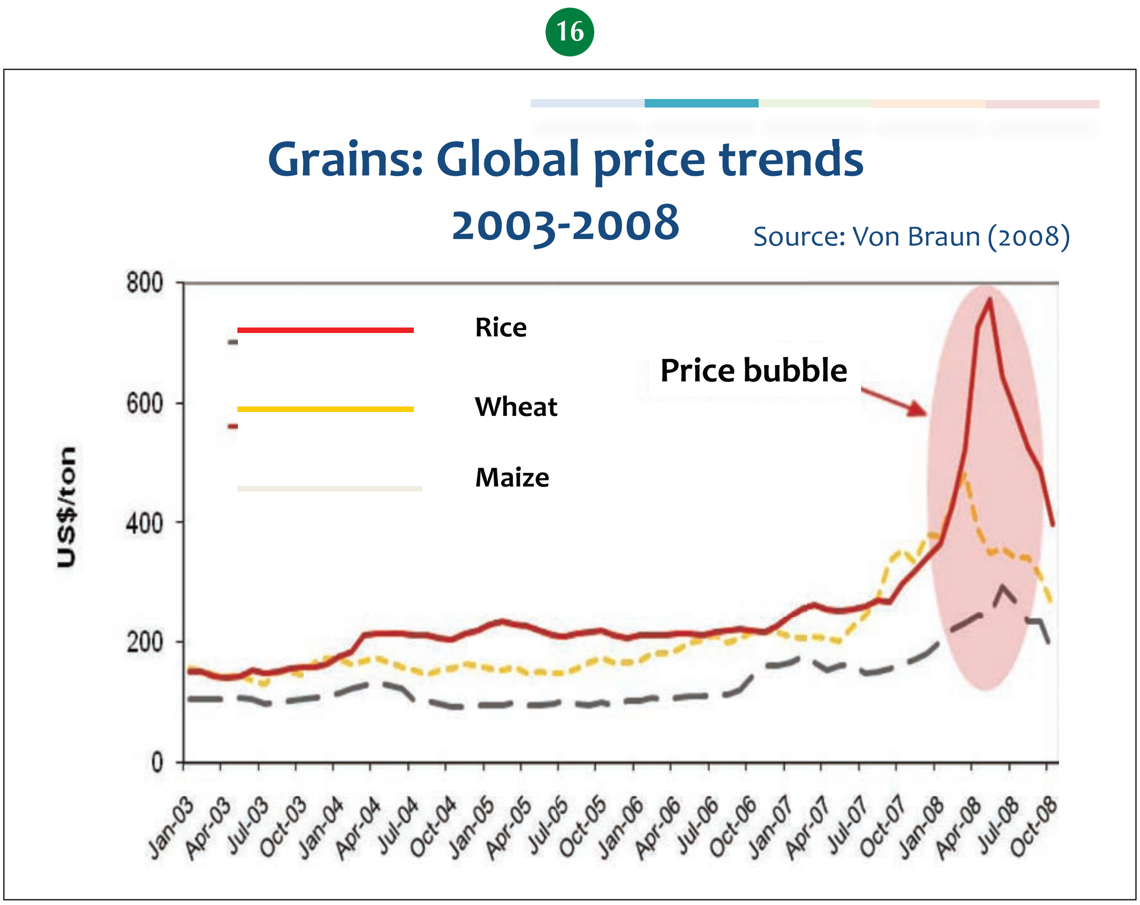
Source: *Black JL et al. 2008. Maternal and child under nutrition: global and regional exposures and health consequences. Lancet. 2008 Jan 19;371(9608):243-60*



Food prices dramatically increased in early 2008, resulting in a dramatic escalation of the number of hungry, globally. CLICK to show text box over right hand side of graph.

The director of the World Food Program wrote in early 2008, “In the fight against hunger we could now be facing a perfect storm of challenges, including climate change and increasingly severe droughts and floods, soaring food prices and the tightest supplies in recent history, declining levels of food aid, and HIV/AIDS, which also aggravates food insecurity.”

SOURCE: *Von Braun et al, 2008. ‘High Food Prices: The What, Who and How of Proposed Policy Actions’, Washington DC, International Food Policy Research Institute (IFPRI), Policy Brief, http://www.ifpri.org/pubs/ib/foodprices.asp.*



According to von Braun (2008): The price of nearly every agricultural commodity sharply increased in the past two years, creating a global food price bubble. At their peaks in the second quarter of 2008, world prices of wheat and maize were three times higher than at the beginning of 2003, whereas the price of rice was five times higher (Figure). Dairy products, meat, palm oil, and cassava also experienced sharp price hikes. The prices of butter and milk, for example, tripled between 2003 and 2008, and the prices of beef and poultry doubled. Food inflation has put upward pressure on general inflation around the globe. In 2007–2008, average food inflation has been higher than average overall inflation in 27 of the 31 countries with a high proportion or number of undernourished people.

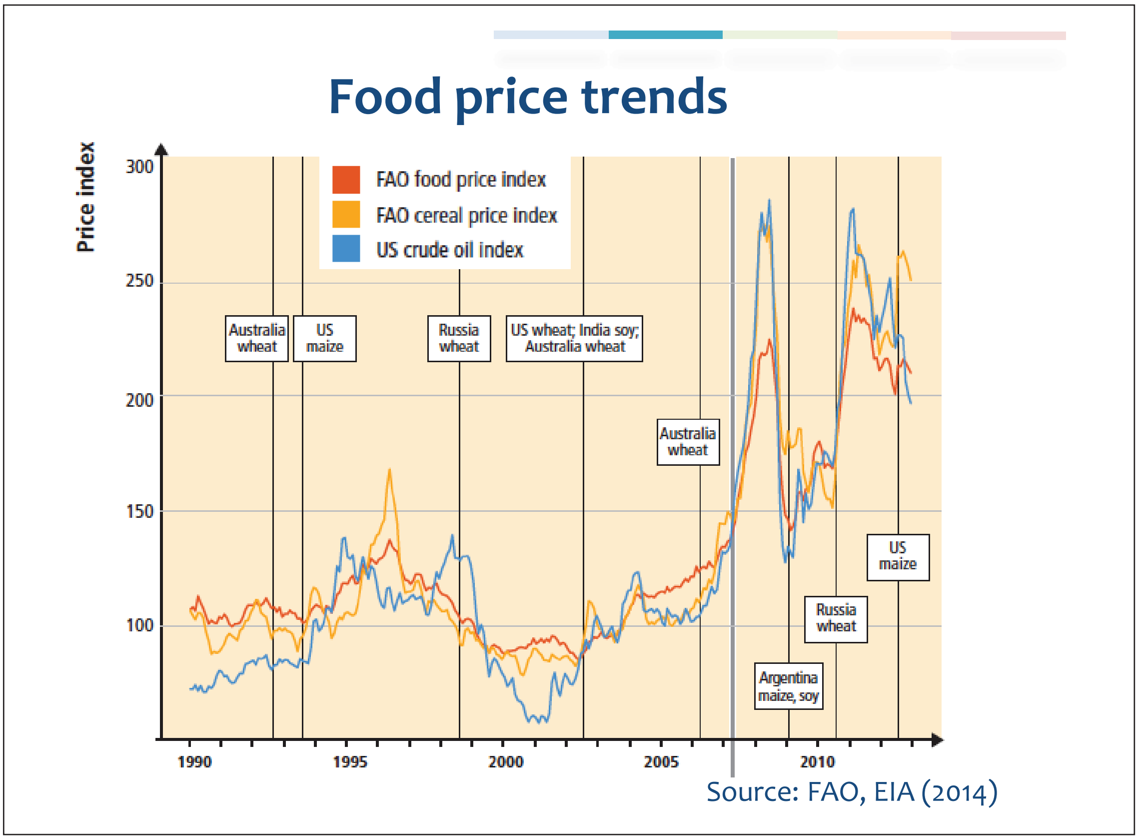
*(**Source:** International Food Policy Research Institute. 2008. Title?)*

More recently, the price of food and other commodities have declined by about 30 to 40% as a result of the economic slowdown and favorable weather conditions, but they remain high compared with three years ago. This short-term price relief is insufficient, however, to ensure that the poor have access to adequate amounts of nutritious food.

For 2009, FAO estimates that despite the decline of international cereal prices, food prices remain at high levels in developing countries and in several continue to increase, affecting the food security of large numbers of vulnerable populations.

Source: *Von Braun 2008. 'High Food Prices: The What, Who and How of Proposed Policy Actions', Washington DC, International Food Policy Research Institute (IFPRI), Policy Brief, http://www.ifpri.org/pubs/ib/foodprices.asp.*

17

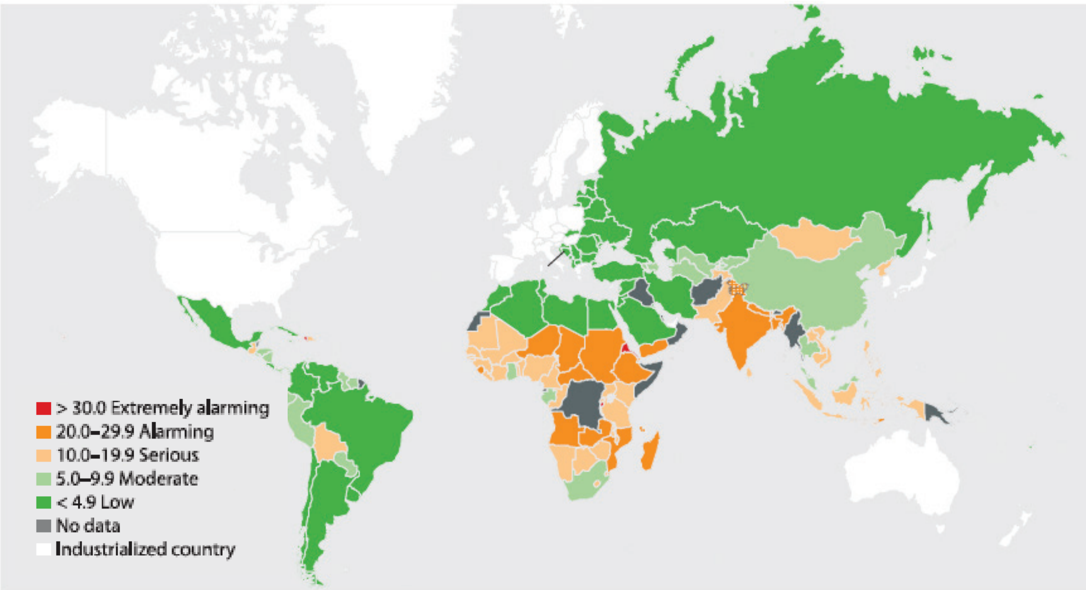


Since the AR4, international food prices have reversed historical downward trend. The plot shows the history of FAO food and cereal price indices (composite measures of food prices), with vertical lines indicating events when a top five producer of a crop had yields 25% below trend line (indicative of a seasonal climate extreme). Australia is included despite not being a top five producer, because it is an important exporter and the drops were 40% or more below trend line. Prices may have become more sensitive to weather-related supply shortfalls in recent years. At the same time, food prices are increasingly associated with the price of crude oil (blue line), making attribution of price changes to climate difficult. Thus, there is clear evidence since AR4 that prices can rise rapidly, but the role of weather in these increases remains unclear. All indices are expressed as percentage of 2002–2004 averages.

Source: *Food price and crop yield data from FAO (http://www.fao.org/worldfoodsituation/foodpricesindex and http://faostat.fao.org/) and oil price data from http://www.eia.gov.>*

18

Global hunger map: 2012



Source: IFPRI (2014)

Most hunger is concentrated in South Asia and sub-Saharan Africa. For the last decade, the population of North Korea has also suffered persistent famine. Haiti also suffers consistently.

In addition, ≈ 840 million are undernourished from insufficient calories or protein.

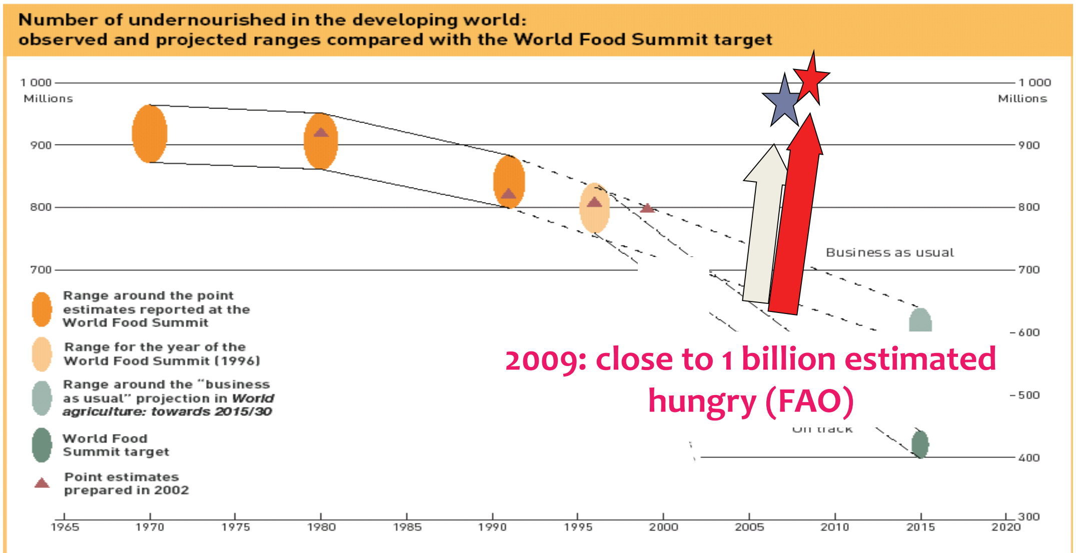
And additional 1-2 billion experience under-nourishment from inadequate micronutrients (vitamins, minerals).

The situation has worsened since 2006.

Source: *IFPRI website. 2014. available from: http://www.ifpri.org/tools/2014-ghi-map*

19

Millennium Development Goal on Hunger: falling even further behind



Source: FAO (2002) (2008)

In 2002 when this slide was produced, there was already concern that the Millennium Development Goal related to hunger was slipping out of reach. In the last two years, the trend of falling hunger in absolute terms has worsened.

Between 1990 and 2015, the proportion of people whose income is less than one dollar a day and who suffer from hunger reduced by 50%. A much more modest goal than from the 1996 World Food Summit (Pogge, 2004).

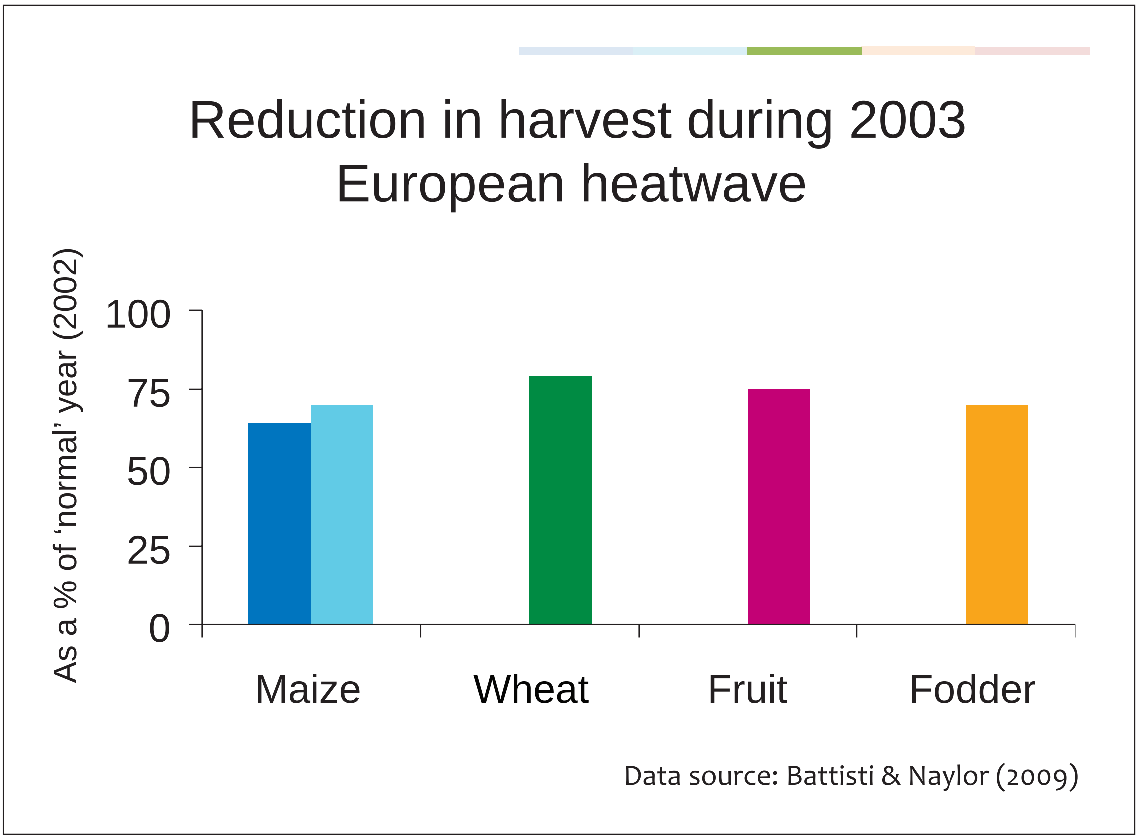
Source: *FAO. 2002. The State of Food Insecurity in the World 2002*

Source: *FAO. 2008. The State of Food Insecurity in the World 2008*

20

How climate change is affecting crop production & food security: Now

We've seen how climate change is likely to affect food security in the future. Let's now look at how climate change is already affecting food security.



Record high daytime and nighttime temperatures over most of the summer growing season reduced leaf and grain-filling development of key crops such as maize, fruit trees, and vineyards; accelerated crop ripening and maturity by 10 to 20 days; caused livestock to be stressed; and resulted in reduced soil moisture and increased water consumption in agriculture.

Italy experienced a record drop in maize yields of 36% from a year earlier, whereas in France maize and fodder production fell by 30%, fruit harvests declined by 25%, and wheat harvests, which had nearly reached maturity by the time the heat set in, declined by 21%.

Source: *Battisti and Naylor. Science. 2009 Jan 9;323(5911):240-4. doi: 10.1126/science.1164363. Historical warnings of future food insecurity with unprecedented seasonal heat.*

22

A global food crisis is brewing

"The stress on crops & livestock will become global in character. It will be extremely difficult to balance food deficits in one part of the world with food surpluses in another, unless major adaptation investments are made soon to develop crop varieties that are tolerant to heat."

Battisti & Naylor (2009)

Unfortunately, a global food crisis is brewing.

Read quote.

Source: *Battisti and Naylor. 2009. Historical warnings of Future Food insecurity with unprecendented seasonal heat.*

23

Climate impact of global livestock

Responsible for 20% GHG emissions:

– CO_2 from land clearance, fertiliser, harvest, shipping

– CH_4 from digastrics (sheep, cattle, goats)

– CH_4 from manure

– NO_2 from fertiliser

Livestock production is a major source of GHG emissions, responsible for 20% GHG emissions. These four sources are specifically large contributors:

- CO_2 from land clearance, fertiliser, harvest, shipping
- CH_4 from digastrics (sheep, cattle, goats)
- CH_4 from manure
- NO_2 from fertiliser

24

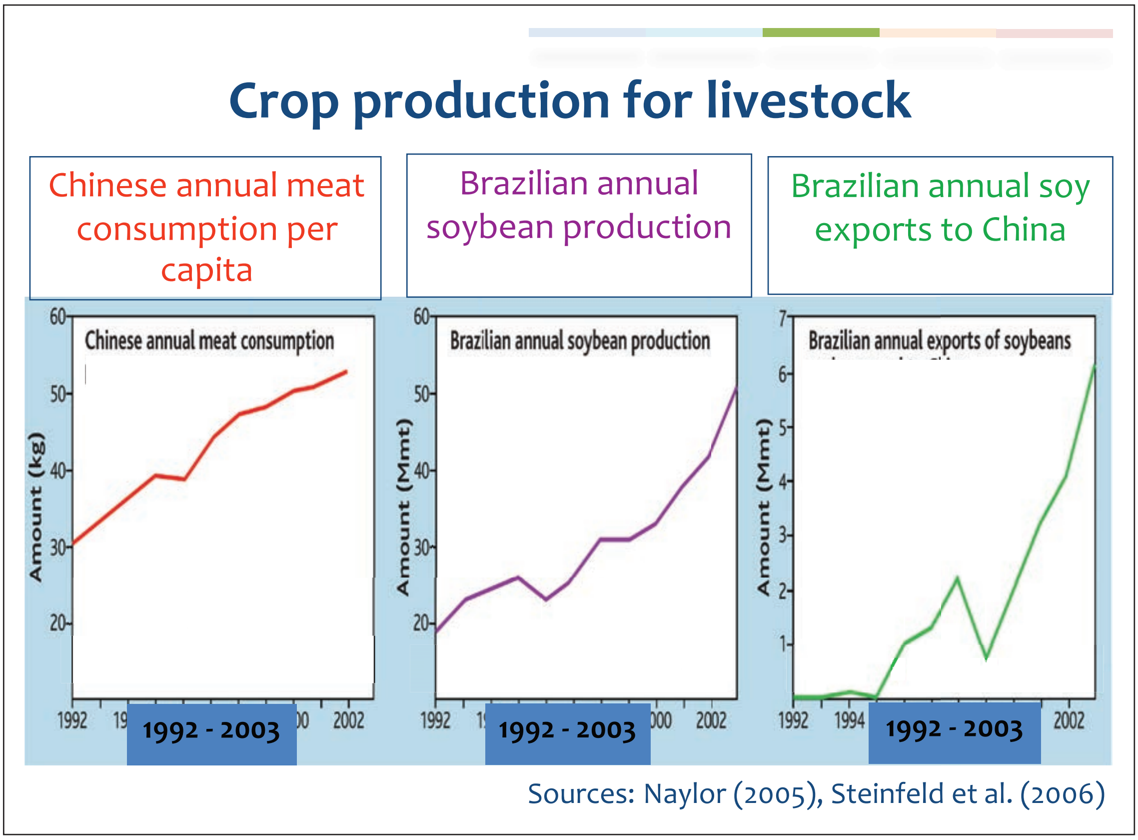
Climate impact of global livestock

- Creates incentives for forest clearance
  - Loss of biodiversity, carbon sinks, other ecosystem services
- Livestock production requires the most water resources in the food chain

Livestock production also contributes to climate change by reducing the capacity of existing carbon sinks as native habitat is converted for pasture/feed uses.

In addition, excess meat consumption also harms human health (e.g., heart disease, cancer, obesity). Consequently, a "contract and converge" policy to stabilise global meat consumption at 90 gm per capita per day has been called for (Gerber, P., Wassenaar, T., Rosales, M., Castel, V. & Steinfeld, H. 2007. Environmental impacts of a changing livestock production: overview and discussion for a comparative assessment with other food production sectors).

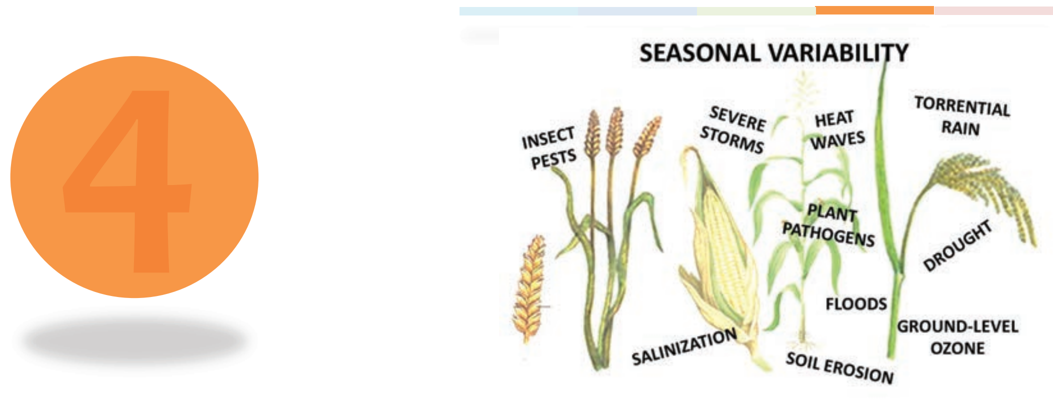
25



"If the world's population today were to eat a Western diet – roughly 220 gm meat per capita per day, the land required for feed production would be about 2.5 billion hectares – two-thirds more than is presently used."

The increasing demand for meat consumption is paralleled by an increase in soy bean production that is mainly used as animal feed. An expansion of agricultural land used for soybean production could reduce the land reserved for staple food production.

Sources: *Naylor R 2005. Losing the Links Between Livestock and Land;*
Gerber, P., Wassenaar, T., Rosales, M., Castel, V. & Steinfeld, H. 2007. Environmental impacts of a changing livestock production: overview and discussion for a comparative assessment with other food production sectors.



How climate change is likely to affect crop production & food security: Future

In the fourth section of Module 10 we'll look at how climate change is likely to affect crop production and food security.

27

Climate change: Likely to harm many vulnerable populations

- Four out of five major global climate models project consistent expansion of arid areas in developing countries
  - Areas home to almost 1 billion people
  - More than 180 million people in Africa alone

Source: Fischer G et al. (2005)

A consistent conclusion running through the climate change food modelling literature is that already vulnerable populations will be among those most harmed.

Source: *Fischer G et al. 2005. Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990-2080*

28

Climate change & global cereal production: Change from 1990 to 2080

	Range (% change)
World	**-0.6 to -0.9**
Developed countries	+2.7 to +9.0
Developing countries	-3.3 to -7.2
South-East Asia	-2.5 to -7.8
South Asia	-18.2 to -22.1
Sub-Saharan Africa	-3.9 to -7.5
Latin America	+5.2 to +12.5

Source: Tubiello & Fischer (2007)

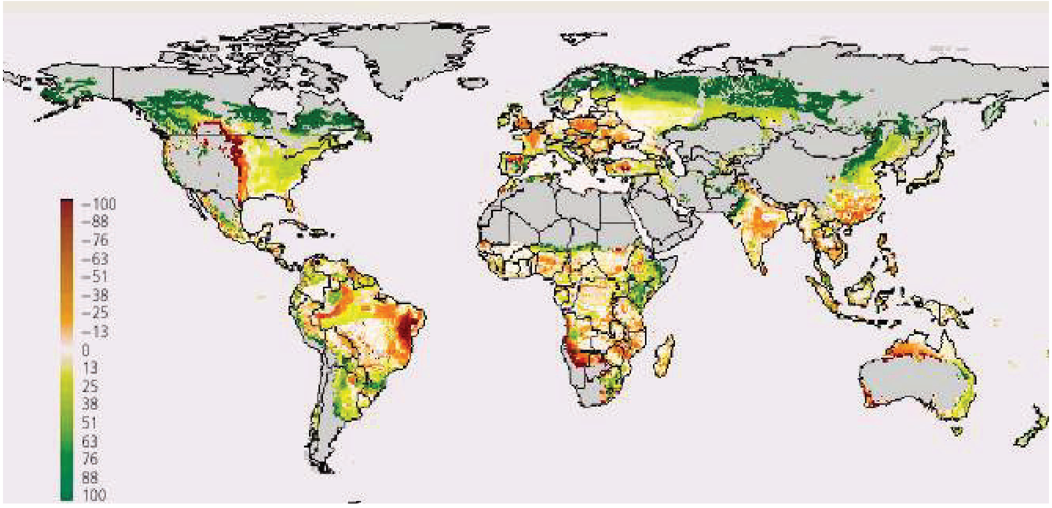
Here you can see the likely impacts of climate change on cereal production, globally and in South and South-East Asia.

The negative impact of predicted decline in grain production in South Asia and South-East Asia will be exacerbated by anticipated population increases.

Source: *Tubiello, F.N. and G. Fischer. 2007. Reducing climate change impacts on agriculture: Global and regional effects of mitigation, 2000–2080. Technological Forecasting & Social Change. 74:1030–1056.*

29

Rain-fed cereal production & climate change model: 2080



Source: Fischer et al. (2001)

This 2001 model shows rain-fed potential cereal production by 2080. It assumes one crop per year with a high level of inputs on land currently under cultivation, and shows a net decrease of some 100 million tons at the global level. However, again, the greatest decrease is in developing countries, especially India and sub-Saharan Africa.

Method for figure: Climate change impacts by grid cell are visualized using a normalized difference index. They are calculated by dividing the difference in cereal production capacity between future and current production potential by their sum. The index ranges from a value of –100 to +100; the former indicates complete loss of production, the latter occurs in areas where cereal production is not possible under current climate conditions but would be feasible with climate change.

Model: ECHAM4 (Max Planck Institute of Meteorology).

Source: *Fischer, G., M. Shah, H.V. Velthuizen, and F.O. Nachtergaele. 2001. Global Agro-ecological Assessment for Agriculture in the 21st Century. International Institute of Applied Systems Analysis.*

30

Modelling climate change & future food security

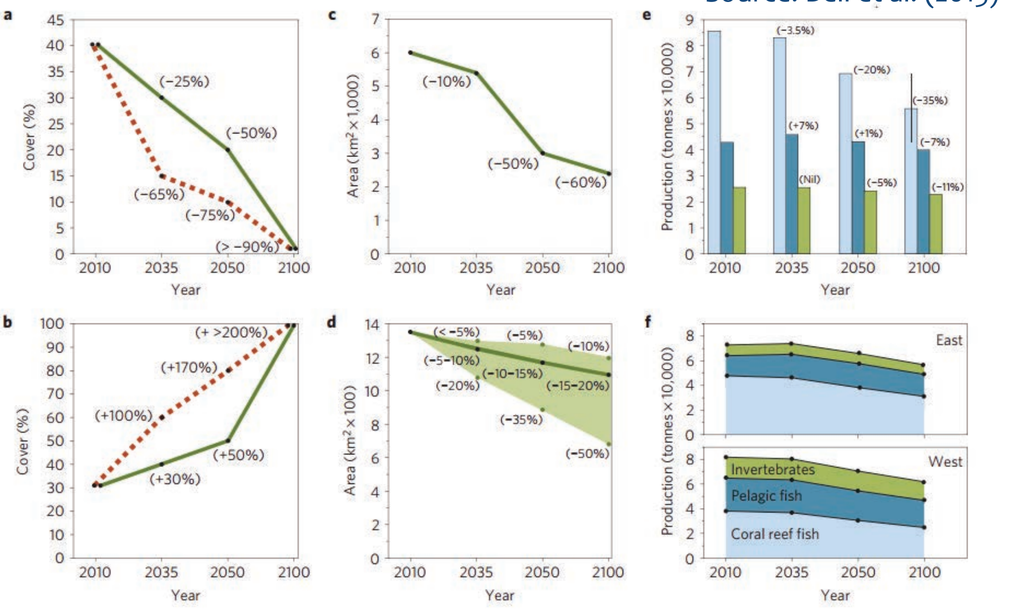
- Current models vary by:
  - – Pathways of greenhouse gas emissions
  - – Climate 'sensitivity' to CO_2 equivalent levels
  - – Strength of carbon fertilisation effect
  - – Incorporation of food trade

Models of climate change and food production include:

1. Pathways of greenhouse gas emissions (depending on different scenarios, described in the IPCC, such as the SRES scenarios).
2. Climate "sensitivity" to CO2 equivalent levels: any given future CO2 equivalent level will have different effects on temperature and rainfall.
3. Strength of carbon fertilisation effect: CO2 has been considered as having a natural "fertilising" effect, as CO2 is vital for photosynthesis.
4. Incorporation of food trade. Global food security also depends on how food is traded; this trading system can greatly compensate the under-production of food in any region. Most of the maps available today show food productivity in different regions, under different climate change scenarios; some, but not all, specifically mention that food trade is incorporated into the models.

Modelling climate change & future food security

Source: Bell et al. (2013)



Climate change will also modify future global fish production. However, models incorporating climate change as a factor affecting global fish production were not identified. Limits to global fish production include falling per capita global wild fish catch and limits to aquaculture.

In addition, global fish production is also at risk from ocean acidification, overfishing, and other ecosystemic damage. Fish is a major source of protein and valuable fatty acids, and is especially important for many poor coastal populations. Recent modelling on the production from fisheries in the tropical Pacific shows that climate change will facilitate live coral cover (a), seaweed cover (b), total mangrove area (c), and seagrass area (d), which in turn results in marked decrease in the total catches of from coastal fisheries (e) and catches in pelagic fish catch (f).

Source: *Bell et al. 2013. Mixed responses of tropical Pacific fisheries and aquaculture to climate change. Nature Climate Change 2013;3:591-599.*

32

Climate-sensitive elements of the food system

COMPONENT

- Photosynthesis
(temperature & soil moisture)
- Weeds
- Pests
- Pathogens

- Floods, storms
- Droughts

- Conflict
- Poverty

- Transport
- Processing
- Distribution
- Storage
- Preparation

Basic current modeling

Food yield

Stability of food supply

Access to food

Food end-use

So far, modeling to date has focused on climate change impacts based mainly on the photosynthetic yield, a function of temperature and soil moisture.

There are many other paths by which climate change can affect food yields, such as constancy of supply, storage, distribution, access to production factors, etc.

33

Limits of current crop models with climate change

- Current models do not account for likely impacts from climate change, including:
  - Heat stress – to rice yield, flowering & pollinators
  - Extreme weather events (e.g. winds, waterlogging)
  - Sea level rise, salt water intrusion
  - Aquifer depletion & water contamination
  - Loss of land due to urbanisation & to biofuels production
  - Rising cost of oil & fertiliser
  - Future shortage of potassium — an essential element
  - Atmospheric brown cloud (‘solar dimming’)
  - Political economy & conflict — ‘entitlement’ factors

These factors are also not explicitly included in the models.

These factors, combined, mean that forecasts of food security arising from climate change need to be considered as likely to be too optimistic.

34

Simulated yield changes in the three major crops by regions

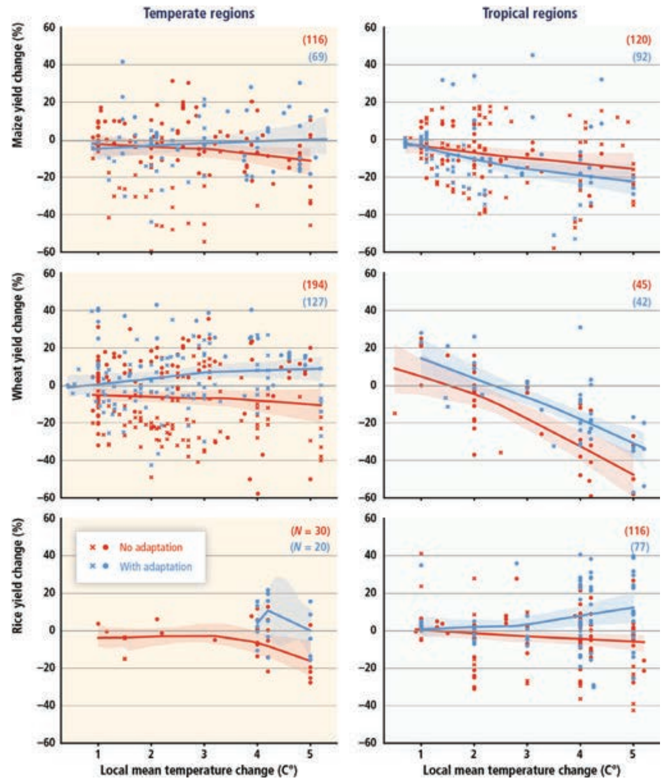
Source: IPCC AR5 (2014)

The recent Assessment Report of IPCC describes that the yield from three major crops is likely to change under climate change modelling.

CLICK to go to next slide with full screen figure

Source: *IPCC. 2014. Fifth Assessment Report.*

35



With medium confidence, in mid- to high-latitude regions moderate warming will raise crop and pasture yields compared to the summary points from AR4. Sight warming will decrease yields in low-latitude regions. Extreme climate and weather events will, with high confidence, reduce food production. The benefits of adaptation vary with crops and across regions and temperature changes; however, on average, they provide approximately a 10% yield benefit when compared with yields when no adaptation is used (WGII AR4 Section 5.5.1).

Source: *WGII_AR5_Fig7-4.*

36

Climate change & current crop models: Summary

Most models:

- Predict a small benefit, little change, or slight harm to the North
- Predict varying degrees of harm in the South
- Thus predict increased global inequality
- Assume strong carbon fertilisation

Many minor factors are excluded from the models of climate change.

Some of these factors (such as the adverse relationship between excessive nocturnal temperature and yield) are covered in more detail in the following slides. Most are not. Together, it seems likely that the cumulative effect of these excluded factors is significant, and is likely to be adverse.

37

We've looked at the causes of malnutrition, and the current and likely future impacts of climate change on food security and malnutrition. Let's finish by examining steps that can improve food insecurity.

38

Contraction & convergence of meat consumption

- Reduce average daily meat consumption to 90 grams/day by those consuming more
- Increase meat consumption for those below 90 grams/day threshold (‘under- consumers’)
- Limit global livestock ‘climate footprint’ to current level, accounting for population growth
- Benefits
  - Improved human health
  - Climate change mitigation

Source: McMichael et al. (2008)

This graph show trends in consumption of livestock products per person (milk, eggs, and dairy products, excluding butter).

This shows a projected global increase in average animal product consumption.

Source: *FAO. 2006. World Agriculture: Towards 2030/2050. Interim Report, June. Available: http://www.fao.org/ES/esd/AT2050web.pdf.*

Contraction & convergence of meat consumption

- Reduce average daily meat consumption to 90 grams/day by those consuming more
- Increase meat consumption for those below 90 grams/day threshold ('under- consumers')
- Limit global livestock 'climate footprint' to current level, accounting for population growth
- Benefits
  - Improved human health
  - Climate change mitigation

Source: McMichael et al. (2008)

Source: *McMichael et al. 2008. Food, agriculture, energy, climate change and health. The Lancet 370:1253–1263*

40

Steps to improve future food security

- Improve governance & leadership
- Secure food entitlement
- Pursue & encourage technological breakthroughs
  - Water quantity & water quality
  - More investment in research for sustainable agriculture

Global food security is already very poor, manifestly deteriorating, and likely to get even worse.

Here are some of the things that can be done to improve future food security. CLICK to animate the first three improvement steps.

The world should hope and work for fairer entitlement, which will also lower global population growth. It should work and hope for technological breakthroughs, but these will not, on their own, be enough. In particular, there should not be excessive reliance on a "gene revolution" – much more can be done with conventional plant breeding, and investing more in research for sustainable agriculture.

41

Steps to improve future food security

- Address food demand & supply
  - Population growth not 'fixed': can be reduced by reducing global inequality
  - Limit meat consumption to 90 grams/day
- Improve food production models
  - Account for likely climate change impacts
- Pursue climate change mitigation

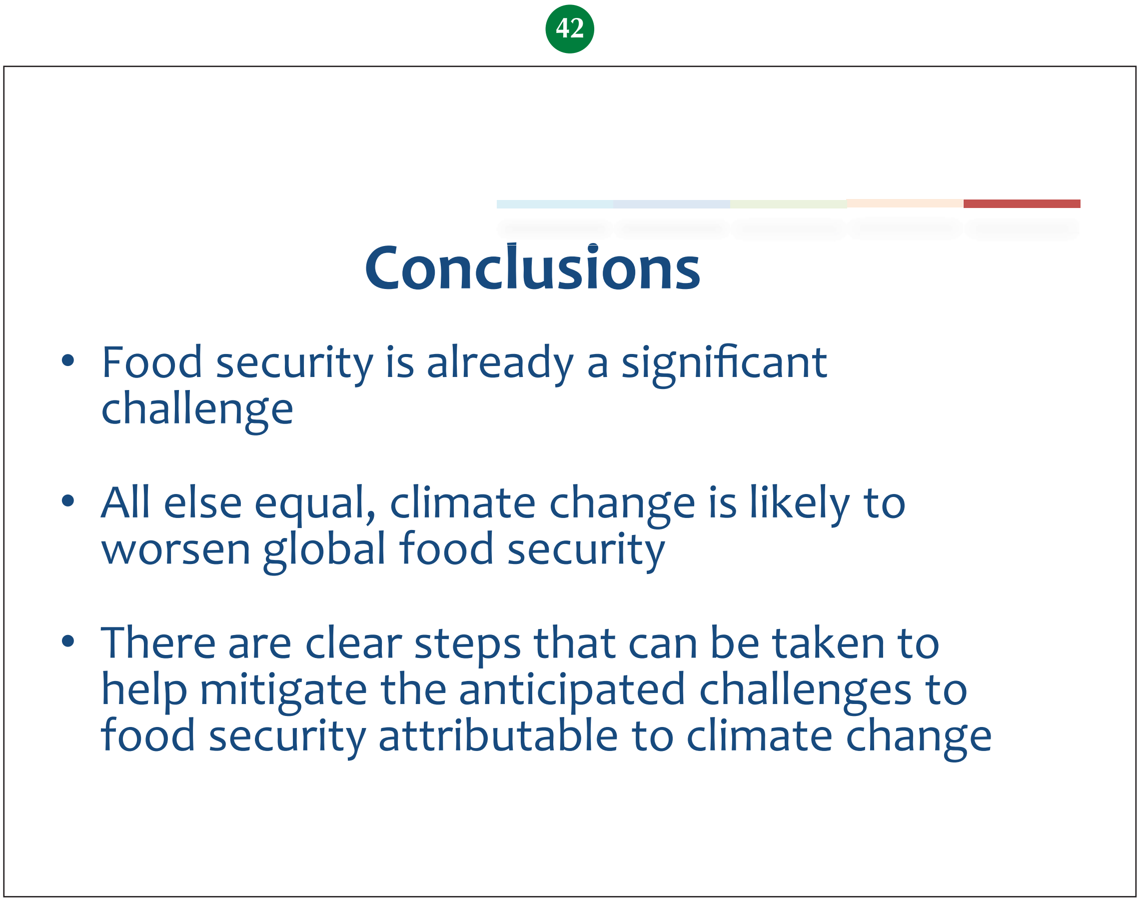
Further things that can be done to improve future food security include.... (CLICK to animate the last two improvement steps)

Population growth at the medium projection (of 9.2 billion by 2050) is not "fixed," and can be lowered by increased academic and political leadership, and by more investment in education and in family planning.

Also not "fixed" is an increased global consumption of livestock – if global meat consumption by the poor converges toward 90 gramms per day, while it contracts among the over-fed toward a similar level, then the climate footprint of the global livestock industry need not increase.

There is a need to account for likely impacts of climate change in food production models to avoid overly optimistic projections that are integrated into large-scale planning efforts.

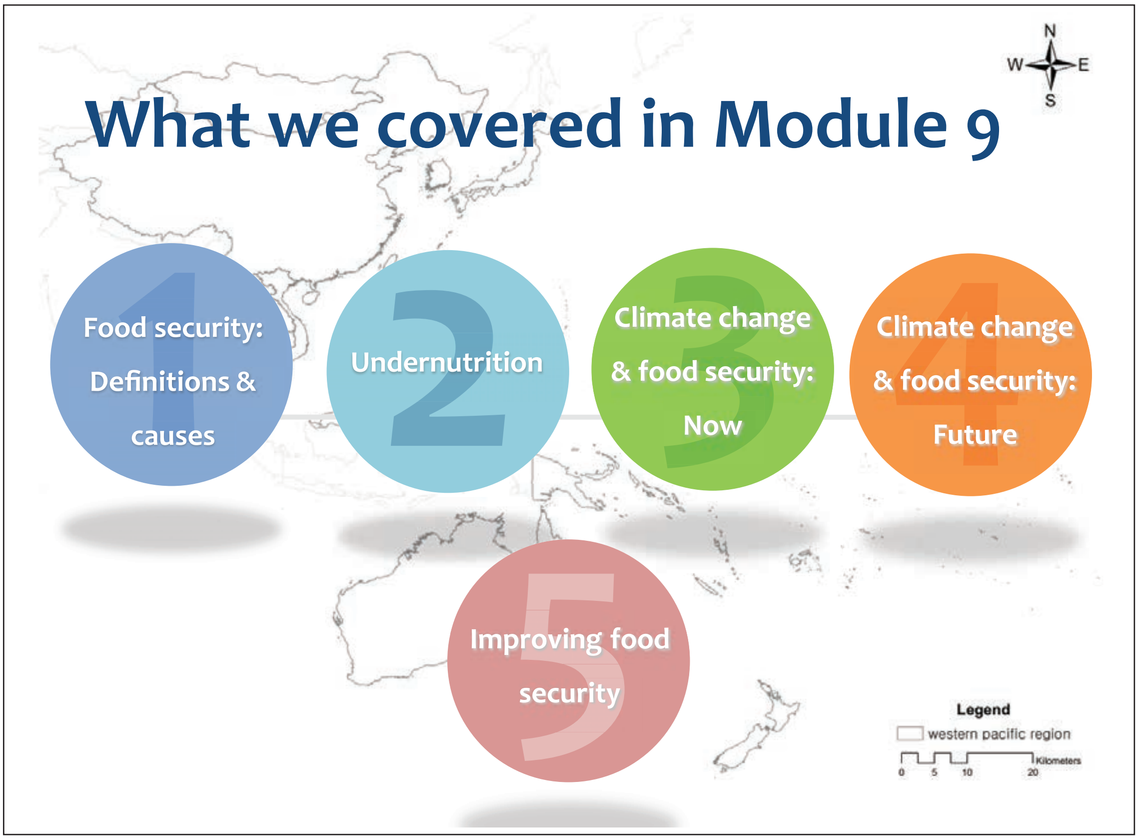
Steps that help limit future climate change will improve food security.



So to conclude, if the adverse climate change scenarios for developing countries come to pass, then much global cooperation and goodwill will be needed to avert widespread famine, including the potential radicalisation of some disentitled populations.

However, important steps can be taken to improve future food security in the face of the challenges that climate change will present.

Recommended further reading: 2007 IPCC reports: The Physical Science Basis, FAQ 5.1, page 111



In Module 9 we covered:

1. Defining terms related to food insecurity, and look at its causes
2. The burden of disease from undernutrition
3. How climate change is affecting food security
4. How climate change is likely to affect crop production and food security
5. Steps that can improve food insecurity

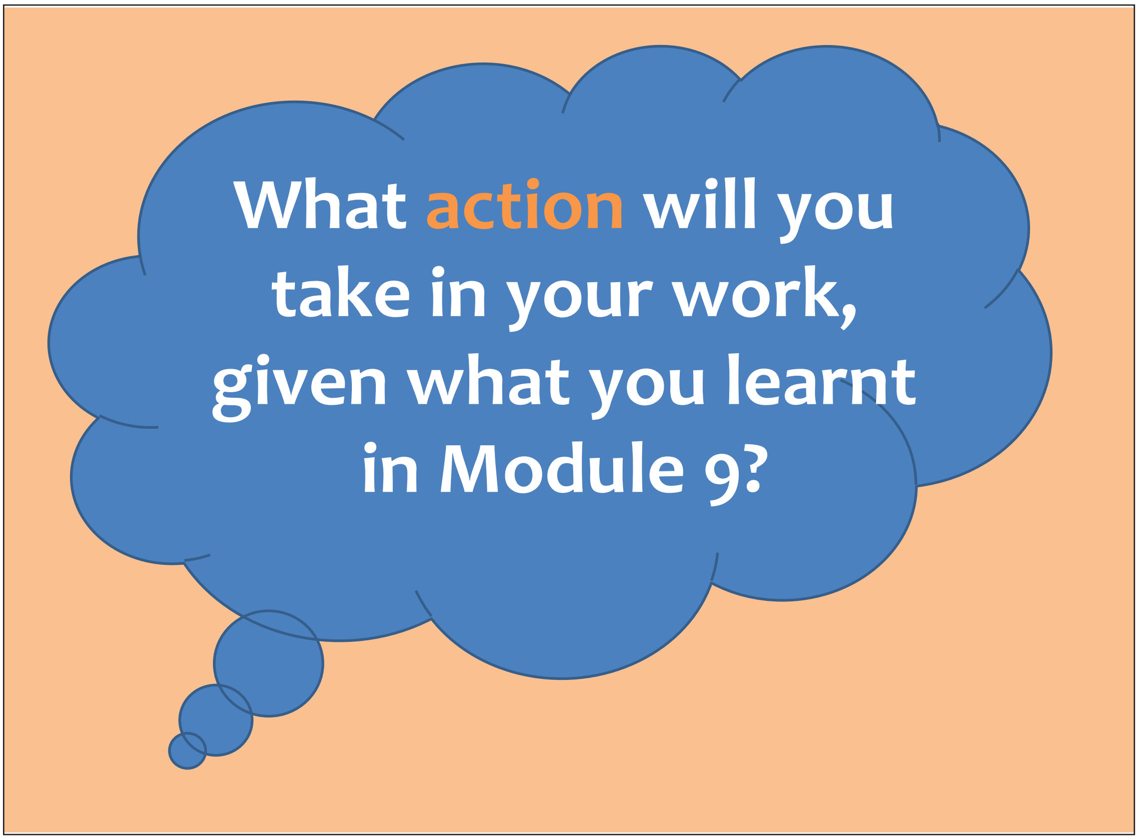
Learning from Module 9

- Nutrition-related factors are together responsible for about 35% of child deaths & 11% of the total global burden of disease
- Millennium Development Goal 5 on Child Mortality will not be reached
- Food security is already a significant challenge & climate change is likely to worsen global food security
- There are clear steps that can be taken to help mitigate the anticipated challenges to food security attributable to climate change

The key messages to take away from Module 9 are: (CLICK for each of the four)

- Nutrition-related factors are together responsible for about 35% of child deaths & 11% of the total global burden of disease
- Millennium Development Goal 5 on Child Mortality will not be reached
- Food security is already a significant challenge & climate change is likely to worsen global food security
- There are clear steps that can be taken to help mitigate the anticipated challenges to food security attributable to climate change

45



To finish off Module 9, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around food security and malnutrition under climate change.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes**: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 10

Air quality

Key learning messages in Module 10

- The mixtures of air pollutants produced by burning of fuels and by wildfires, can adversely affect human health directly and indirectly
  - Elevated concentrations of particulate matter and ozone cause significant mortality
- Climate variability can influence air quality, resulting in adverse health consequences
  - Includes affects on aero-allergens like pollen
- Reducing the sources of air pollutions would prevent avoidable premature mortality.

Estimated length: 60 minutes

Structure of Module 10

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Introduction to air pollutants and their characteristics	4–11	
2. Exposures to air pollution	12–21	EXERCISE on slide 13: What are the main sources of air pollution exposure in your country? What is being done to manage these sources? 2 minute conversation with someone near you
3. Health impacts of air pollution	22–33	Q on slide 25: Do any of you have experience with time series analyses?
4. Benefits of air quality policies	34–37	
Module outline	38	
Learning from Module 10	39	
Learning reflection, action generation	40	

Required resources

- Data projector and slide changer
- Module 10 slides
- Stopwatch
- Bell or noise maker

Key terms introduced in Module 10

- Air pollution
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Lead (Pb)
- Sulfur dioxide (SO_2)
- Particulate matter (PM2.5, PM10)
- Ozone (O_3)
- Forest fires
- Ambient air quality
- Pollen
- Respiratory system
- Time series analyses
- Prospective cohort studies
- Atmospheric brown cloud
- Air quality guidelines.

References (in order of presentation)

- Queensland Government Environmental Protection Agency, 2013. https://www.qld.gov.au/environment/pollution/monitoring/air-pollution/ozone/
- Gillett et al. 2004. *Detecting the effect of climate change on Canadian forest fires*. Geophysical Research Letters 31, L18211, doi:10.1029/2004GL020876.
- Clean Air Initiative for Asian Cities (CAI-Asia) Center. 2010. *Air Quality in Asia: Status and Trends*, 2010 Edition. Pasig City, Philippines.
- WHO Climate Change and Human Health Atlas. 2012. http://who.int/globalchange/publications/atlas/en/
- Climate Central. 2014. http://www.climatecentral.org/.
- Air Better. 2014. http://www.airbetter.org/wp-content/uploads/2014/10/Pollution_effects-620x597.jpg.
- UCLA Institute of the Environment & Sustainability. 2008. http://www.environment.ucla.edu/reportcard/article1700.html.
- Lim et al. 2012. *A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010*. Lancet; December 15:380(9859): 2224–2260. doi:10.1016/S0140-6736(12)61766-8.
- WHO. 2014. http://www.who.int/phe/health_topics/outdoorair/databases/en/
- WHO. 2012. Climate Change and Human Health Atlas 2012. http://www.who.int/globalchange/publications/atlas/en/.
- Fang et al. 2013. *Impacts of 21st century climate change on global air pollution-related premature mortality*. Climatic Change 121:239–253. DOI 10.1007/s10584-013-0847-82013.
- WHO. 2008. http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/.
- WHO. 2014. http://www.who.int/mediacentre/factsheets/fs313/en/.
- West et al. 2013. *Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health*. Nature Climate Change;3; DOI: 10.1038/NCLIMATE2009.

Module 10: Air quality

Welcome to Module 10, where we'll be looking at the health impacts from air quality and their connection to climate change.

2

Key messages in Module 10

- The mixtures of air pollutants produced by burning of fuels & by wildfires, can adversely affect human health directly & indirectly
  - Elevated concentrations of particulate matter & ozone cause significant mortality
- Climate variability can influence air quality, resulting in adverse health consequences
  - Includes affects on aero-allergens like pollen
- Reducing the sources of air pollutions would prevent avoidable premature mortality

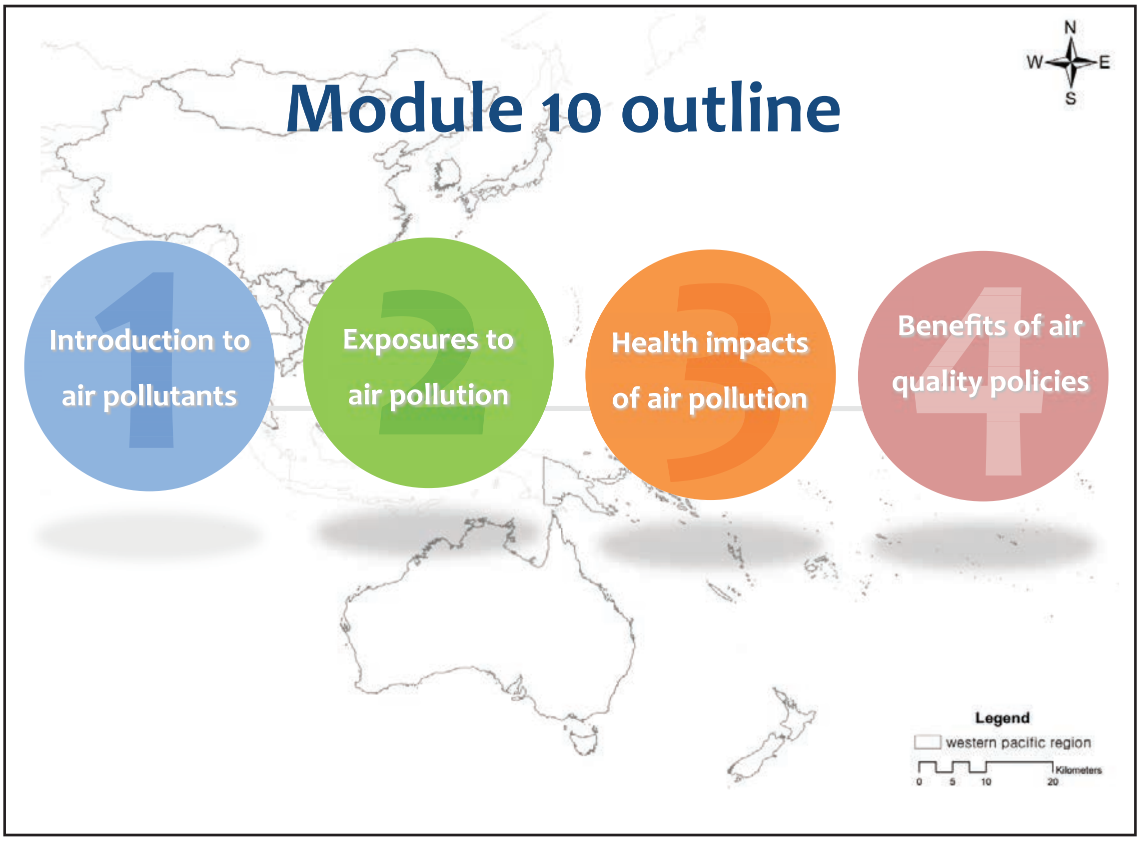
Here are the key messages we'll cover in Module 10. In summary, air quality, climate, and health intersect in many ways.

CLICK to see each key message and sub message.

Fuel combustion is responsible for most of the air pollutants that adversely affect human health. This fuel combustion is also responsible for most of anthropogenic climate change. Therefore, human health and climate change are inextricably linked at the concentrations of emissions of air pollution. The interactions are complex in that there are benefits to health to the energy generated by much fossil fuel combustion, such as through energy used to produce safe water and improved sanitation, refrigeration, and other technologies that continue to improve human health and well-being, At the same time, air pollutants are known to cause a variety of adverse health impacts, as will be discussed in this module. The module on mitigation will provide a more in-depth discussion of how reducing greenhouse gas emissions can benefit human health.

Climate variability can influence air quality in a variety of ways. For example, horizontal and vertical air motions in the atmosphere transport and dilute air pollutants emitted by human activities. Temperature, humidity, rainfall, and winds also may influence the generation of some unwanted air contaminants, including smoke from wildfires and allergenic pollens.

3



Here's how we'll break down Module 10:

1. Introduction to air pollutants and their characteristics
2. Exposures to air pollution
3. Health impacts of air pollution
4. Benefits of air quality policies

4

1

Introduction to air pollutants & their characteristics

	MAJOR SOURCES	HEALTH EFFECTS
SO_2	Industry	Respiratory and cardiovascular illness
NO_x	Vehicles; industry	Respiratory and cardiovascular illness
PM	Vehicles; industry	Particles penetrate deep into lungs and can enter bloodstream
CO	Vehicles	Headaches and fatigue, especially in people with weak cardiovascular health
Lead	Vehicles (burning leaded gasoline)	Accumulates in bloodstream over time; damages nervous system
Ozone	Formed from reaction of NO_x and VOCs	Respiratory illness
VOCs	Vehicles; industrial processes	Eye and skin irritation; nausea; headaches; carcinogenic

So let's start with an introduction to air pollution, and their characteristics.

5

Air pollutants

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Lead (Pb)
- Sulfur dioxide (SO_2)
- Particulate matter (PM2.5, PM10)
- Ozone (O_3)

Strong evidence for causal relationship between air pollution & premature death

- Time series studies of acute effects
- Cohort or cross-section studies of chronic effects

These six pollutants have been the focus of most air quality regulations at the national level. In the US, they are called "criteria pollutants." Aside from lead, which historically was a petroleum fuel additive, these pollutants tend to occur wherever fuel combustion takes place. In urban areas, concentrations in the air often reach unhealthy levels In the developed world, emissions controls and other technological innovations have reduced CO, NO_2, Pb, and SO_2 concentrations markedly since the 1960s. However, some of these pollutants remain serious challenges in many developing world cities. Ozone and PM remain serious concerns in developing and developed countries. We will consider these two pollutants in greater detail.

There is strong evidence for causal relationships between these pollutants and morbidity and premature death.

The two most important pollutants from the perspective of climate change and health are ozone and particulate matter.

We'll now go through each of these six pollutants one by one.

6

Carbon monoxide

- Produced by incomplete combustion
- Inhibits the capacity of blood to carry oxygen to organs & tissues
- People with chronic heart disease may experience chest pain when CO levels are high
- At very high levels, CO impairs vision, manual dexterity & learning ability, & can be fatal

This slide summarizes relevant information on carbon monoxide.

7

Nitrogen dioxide

- Produced from high-temperature combustion
- Affects lung function in persons with asthma
- Contributes to acid rain & secondary particle formation
- Is a precursor of ground-level ozone

And these are the relevant points on nitrogen dioxide.

8

Sulfur dioxide

- Emitted from combustion of sulfur-containing coal & oil, & from metal smelting operations
  - Emissions reduced using scrubbers
- Contributes to acid rain & to formation of PM2.5 through atmospheric reactions
- Associated with reversible declines in lung function of people with asthma, & exacerbates respiratory symptoms in sensitive individuals

Sulfur dioxide is… (read)

9

Particulate matter (PM2.5, PM10)

- Can be primary or secondary
  - Produced by combustion, atmospheric reactions & mechanical processes
- Associated with a wide range of human health impacts, including premature deaths
- Higher temperatures may favor secondary formation
- Some particle types contribute to climate warming, others to cooling

Particulate matter is a term that refers to any solid or liquid material suspended as small particles in air. The numerical subscripts (2.5 or 10) refer to the upper size limit for a particular category of particulate matter. For example, PM2.5 includes all suspended particles that are smaller than 2.5 micrometers (one millionth of a meter) in aerodynamic diameter. The concept of aerodynamic diameter adjusts for the effects that particle density and shape have on the motion of particles in air. For a spherical water droplet, physical diameter equals aerodynamic diameter. These size matter in terms of health impacts because they are respirable and can stay in the lungs; smaller particles typically are breathed in and out, and larger particles are typically removed before reaching deep lung tissue.

Particles can be directly emitted (primary) or can form through reactions in the atmosphere (secondary). Major physical processes of primary production include combustion of fuels and other organic matter, and mechanical processes like wind and friction.

Because PM can include any suspended solid or liquid material, the physical and chemical properties vary tremendously.

Based largely on epidemiology studies, PM exposures have been linked to a wide range of human health effects, including premature deaths.

Some secondary particles, such as sulfates, may form more rapidly at higher temperatures.

Particles have complex impacts on the global radiation balance, with some having positive radioactive forcing (e.g., black carbon), and others having negative radioactive forcing (e.g., sulfates).

10

Ozone

- Main pollutant responsible for photochemical smog
  - Formed via reactions in the atmosphere from primary pollutants (NO_x & VOCs) in the presence of sunlight
  - Higher temperatures favor ozone formation
- Ozone is also a greenhouse gas
- Strong oxidant that damages cells lining the respiratory system, resulting in a variety of adverse health outcomes including lung function decrease, asthma attacks & premature death

Ozone or O_3 is a gas comprised of three oxygen atoms. Tropospheric or "ground level" ozone is a secondary pollutant, meaning that it is not directly emitted but rather forms via reactions in the atmosphere involving primary pollutants (nitrogen oxides and volatile organic compounds) and sunlight. Ozone mainly occurs in warm, sunny periods, with the rate of formation temperature dependent.

Ozone is a strong oxidant that, upon inhalations, reacts with and damages the epithelial cells lining the respiratory system, from the nose to the deepest parts of the lung where oxygen is absorbed. Cells in the deep lung are most vulnerable because they are not protected by a mucus layer.

Ozone also is an important greenhouse pollutant that absorbs energy in the infrared spectrum.

Not counting methane, biological sources emit an estimated 1150 teragrams of carbon per year in the form of volatile organic compounds (VOCs). The majority of VOCs are produced by plants, the main compound being isoprene. The remainder are produced by animals, microbes, and fungi, such as molds.

The strong odor emitted by many plants consists of green leaf volatiles, a subset of VOCs. Emissions are affected by a variety of factors, such as temperature, which determines rates of volatilization and growth, and sunlight, which determines rates of biosynthesis. A major class of VOCs is terpenes, such as myrcene.

contd...

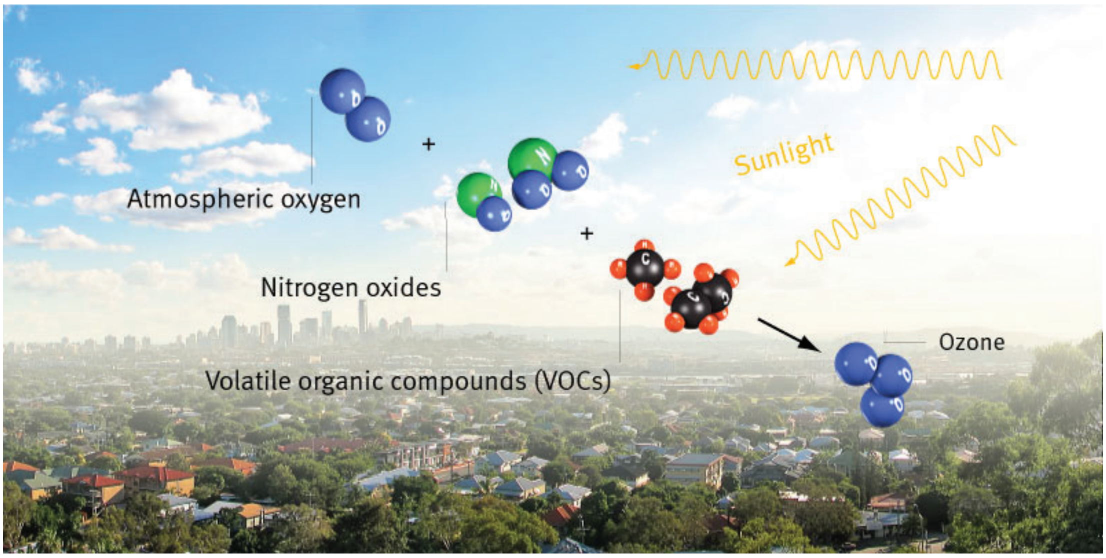
Ozone

- Main pollutant responsible for photochemical smog
  - Formed via reactions in the atmosphere from primary pollutants (NO_x & VOCs) in the presence of sunlight
  - Higher temperatures favor ozone formation
- Ozone is also a greenhouse gas
- Strong oxidant that damages cells lining the respiratory system, resulting in a variety of adverse health outcomes including lung function decrease, asthma attacks & premature death

Industrial use of fossil fuels produces VOCs either directly as products (e.g., gasoline) or indirectly as byproducts (e.g., automobile exhaust). Another major source of man-made VOCs are coatings, especially paints and protective coatings. Approximately 12 billion litres of paints are produced annually. Chlorofluorocarbons, which are banned or highly regulated, were widely used cleaning products and refrigerants. Tetrachloroethene is used widely in dry cleaning and by industry.

11

Ground-level ozone formation



Source: Queensland Government Environmental Protection Agency (2013)

This slide shows a schematic description of ground-level (tropospheric) ozone formation in urban areas. Precursor gases emitted, mainly by fossil fuel combustion and evaporative emissions, react in the presence of sunlight to form ozone. Because these reactions take some time to play out, high ozone levels are often observed down-wind of the urban source areas, over broad regions.

Source: *Queensland Government Environmental Protection Agency, 2013. https://www.qld.gov.au/environment/pollution/monitoring/air-pollution/ozone/*

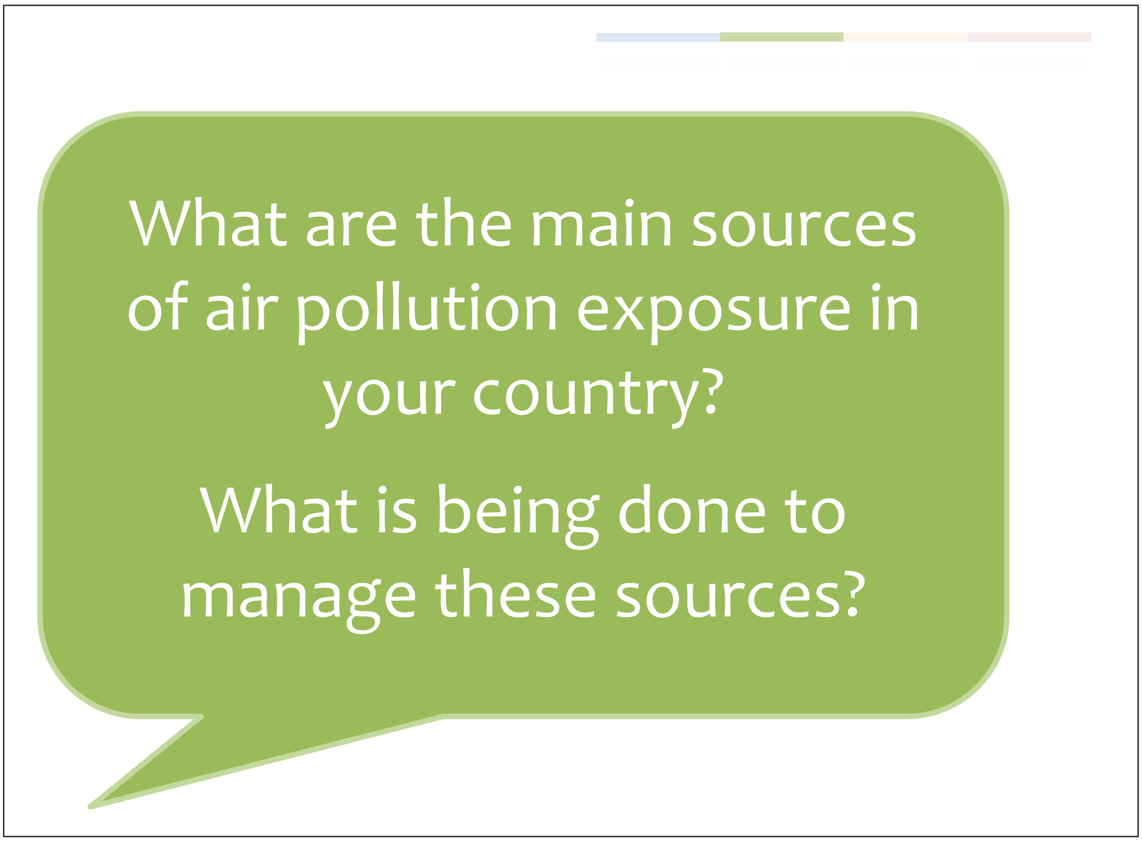
12

2

Exposure to air pollutants

We've covered the main air pollutants, so now let's look at where exposure to these pollutants occurs.

13



Before we look at some of the global trends in exposure to air pollution, what is the situation in your country?

Please turn to someone near you and have a **2 minute** conversation – **What are the main sources of air pollution exposure in your country? What is being done to manage these?**

Give a time countdown at **1 min 30**: “Please finish your conversation over the next 30 seconds.”

“Thank you. Could we hear from a few of your pairs? Volunteers?”

Facilitate responses: “What were the main sources of air pollution exposure in your countries? Any management steps to limit these exposure levels that you know of? Thank you.” Gather another 1 – 2 responses.

So we’ve seen that this is an issue faced by a wide range of countries. Let’s now look at some of the general trends and some examples.

14

Multiple sources of air pollutants

These photos illustrate some of the sources of air pollutants.

One of the photos is of a cooking stove, a common source of indoor smoke, which is a serious health risk for some 3 billion people who cook and heat their homes with biomass fuels and coal.

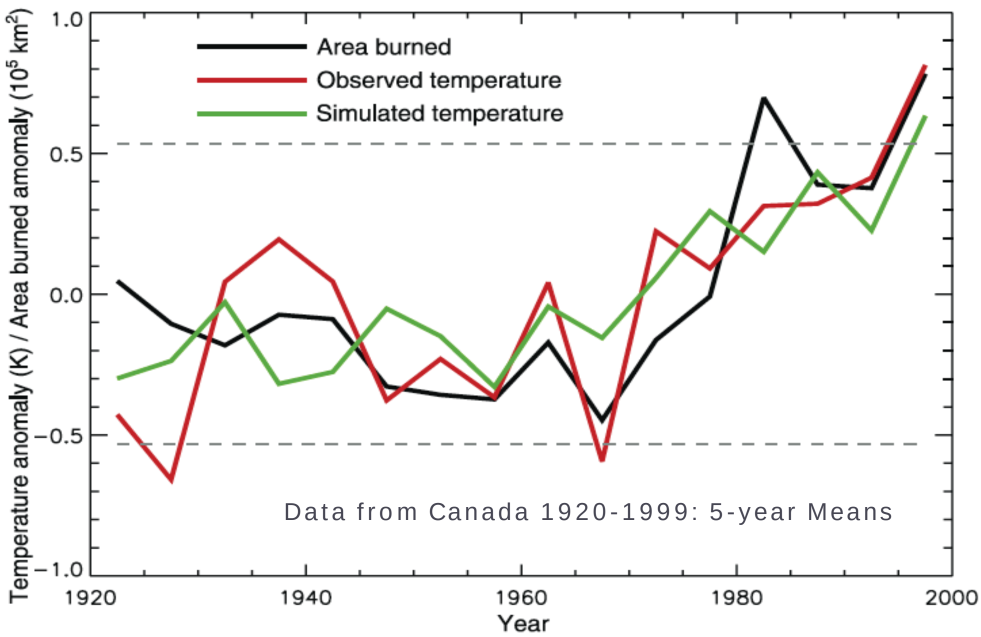
15

Forest fires

Smoke from natural or man-made fires is another form of air pollution that can affect public health.

16

Forest fires & temperature trends



Source: Gillett et al. (2004)

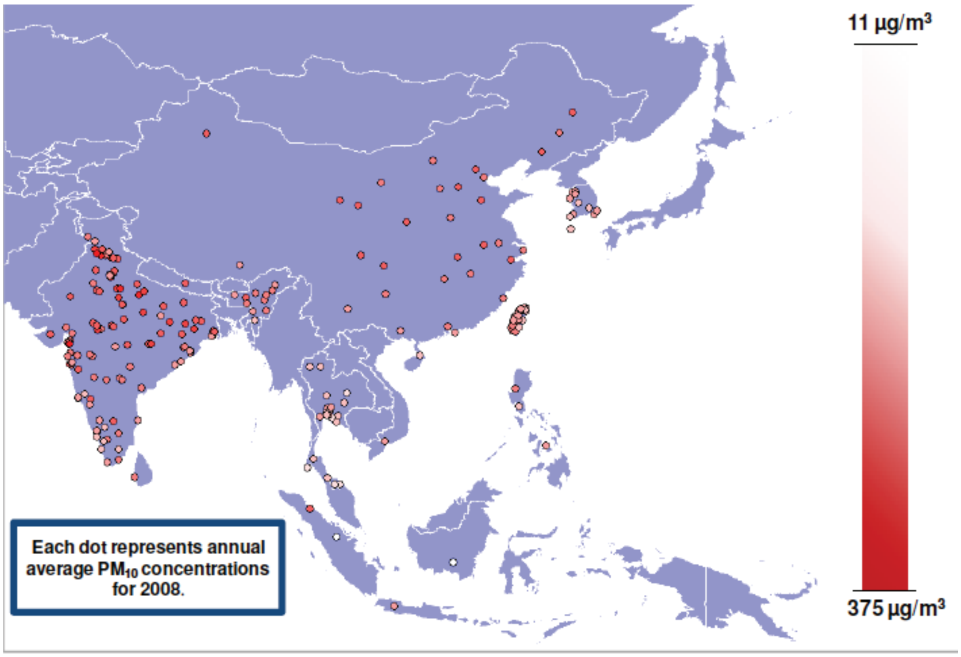
The figure shows data monitoring forest fires in Canada from about 1920 to 1999 in five year periods, in units of 10^5 km2 . The red line shows the five year mean observed May–August temperature anomalies weighted by area burned (temperature is in degrees Kelvin). The green line shows ensemble-mean simulate five-year-mean May–August area-burned-weighted temperature anomalies. Gray dashed lines indicate the 5–95% range of internal variability in area burned. All anomalies are calculated relative to the 1920–1999 mean.

There was an increasing trend in forest area burned that coincided with observed and simulated temperature trends since about 1960. This upward trend likely resulted from global climate change, as warmer temperatures resulted in decreased soil moisture and greater tendency for natural fires. Also, man-made fires may be harder to control as soil moisture decreases.

Source: *Gillett et al. Detecting the effect of climate change on Canadian forest fires. 2004. Geophysical Research Letters 31, L18211, doi:10.1029/2004GL020876*

17

Annual PM10 concentrations in Asian cities



Source: Clean Air Initiative for Asian Cities (2010)

The map shows annual PM10 concentrations range from 11 (minimum) to 375 (maximum) micrograms per cubic meter ($\mu g/m^3$). PM10 = Particles with aerodynamic particle diameters of 10 micrometers or less.

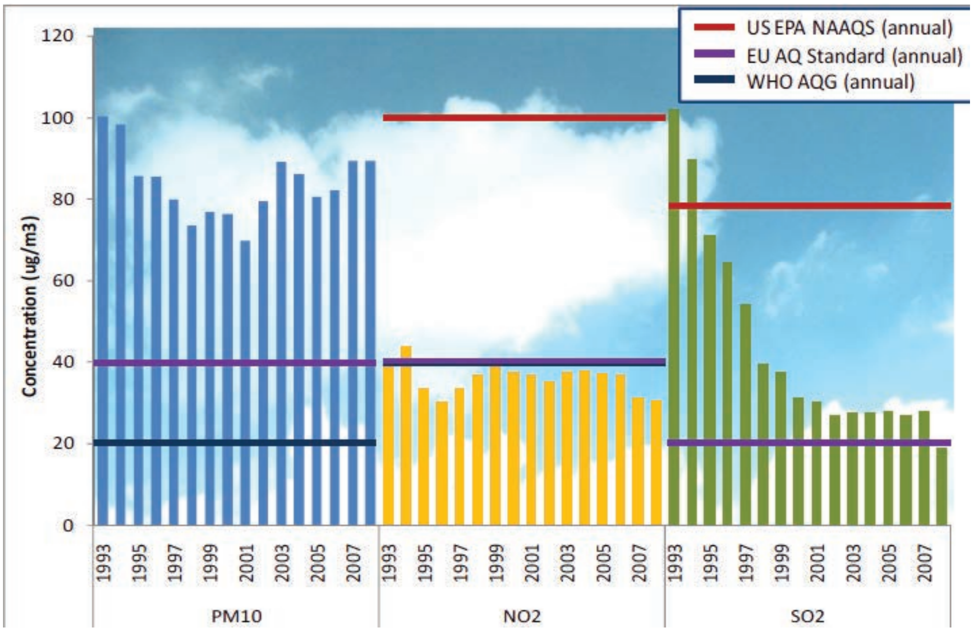
In 2008, CAI-Asia was able to collect annual average PM10 concentrations for 230 Asian cities. Monitoring results reflects PM10 as a critical pollutant for most Asian cities. From these 230 cities, only two had annual average PM10 concentrations within the WHO AQG (20 $\mu g/m^3$) while about 58% of these cities had annual PM10 levels exceeding even WHO Interim Target-1 of 70 $\mu g/m^3$. The average of annual average PM10 concentrations of 230 cities is 89.5 $\mu g/m^3$—about 4.5 times higher than WHO AQG.

Source: *Clean Air Initiative for Asian Cities (CAI-Asia) Center. 2010. Air Quality in Asia: Status and Trends – 2010 Edition. Pasig City, Philippines*

18

Average of annual average ambient air quality in 243 selected Asian cities

Source: Clean Air Initiative for Asian Cities (2010)

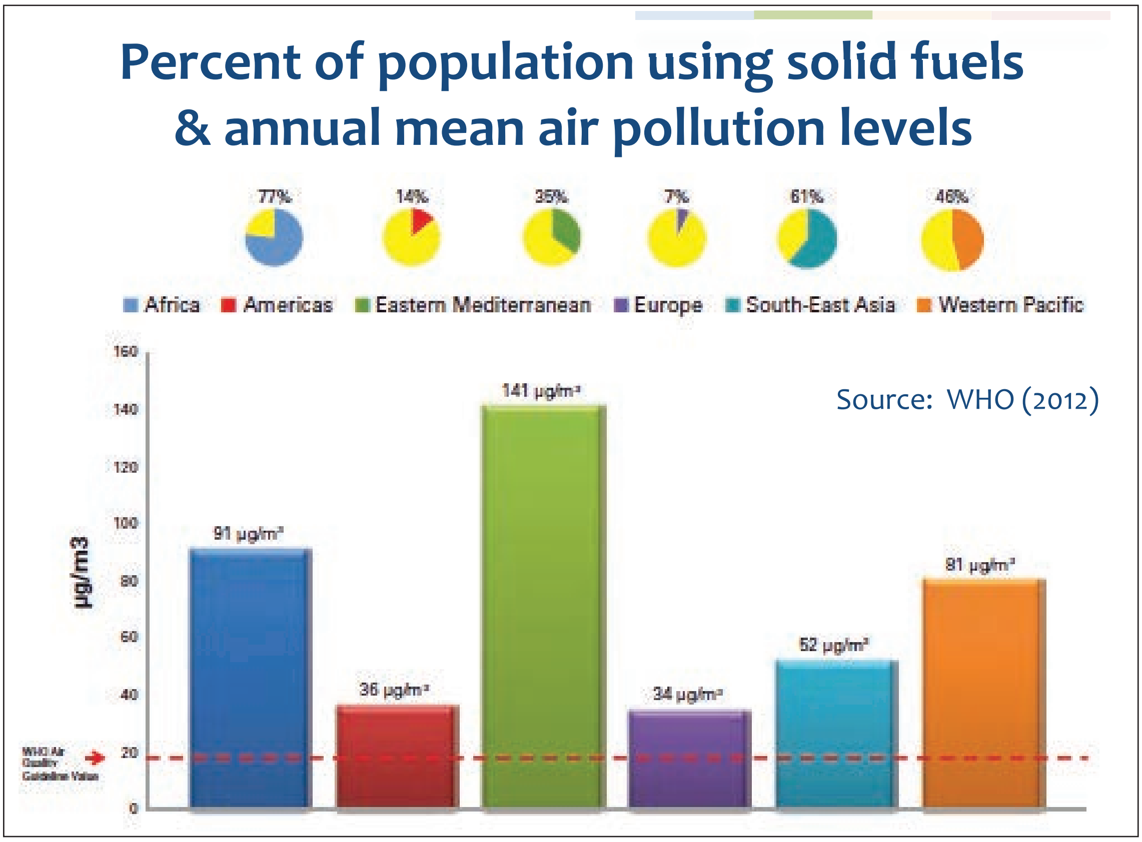


The data here are for 243 Asian cities for the time period 1993–2008. AQ = air quality; $\mu g/m^3$ = micrograms per cubic meter; US EPA = United Stated Environmental Protection Agency; NAAQS = National Ambient Air Quality Standards; EU = European Union; WHO = World Health Organization; AQG = air quality guidelines; PM10 = Particles with aerodynamic particle diameters of 10 micrometers or less; NO_2 = Nitrogen dioxide; SO_2 = Sulfur dioxide.

PM10 is still a major pollutant is Asian cities—with the average of annual average PM10 concentrations over three times above the WHO guidelines since 1993.

Source: *Clean Air Initiative for Asian Cities (CAI-Asia) Center. 2010. Air Quality in Asia: Status and Trends – 2010 Edition. Pasig City, Philippines*

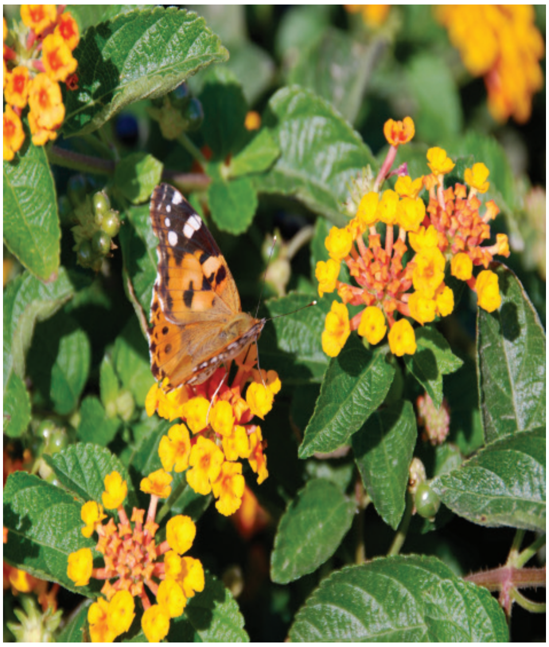
19



The figure shows the regional means of the percent of the population using solid fuels (pie charts) and annual mean air pollution levels by WHO region, reported in 2012. All regions exceed the WHO air quality guidance, with the Americas and Europe closest to meeting the guidelines. This shows the importance of solid fuel use and air pollution concentrations.

Source: *WHO Climate Change and Human Health Atlas 2012 http://www.who.int/globalchange/publications/atlas/en/*

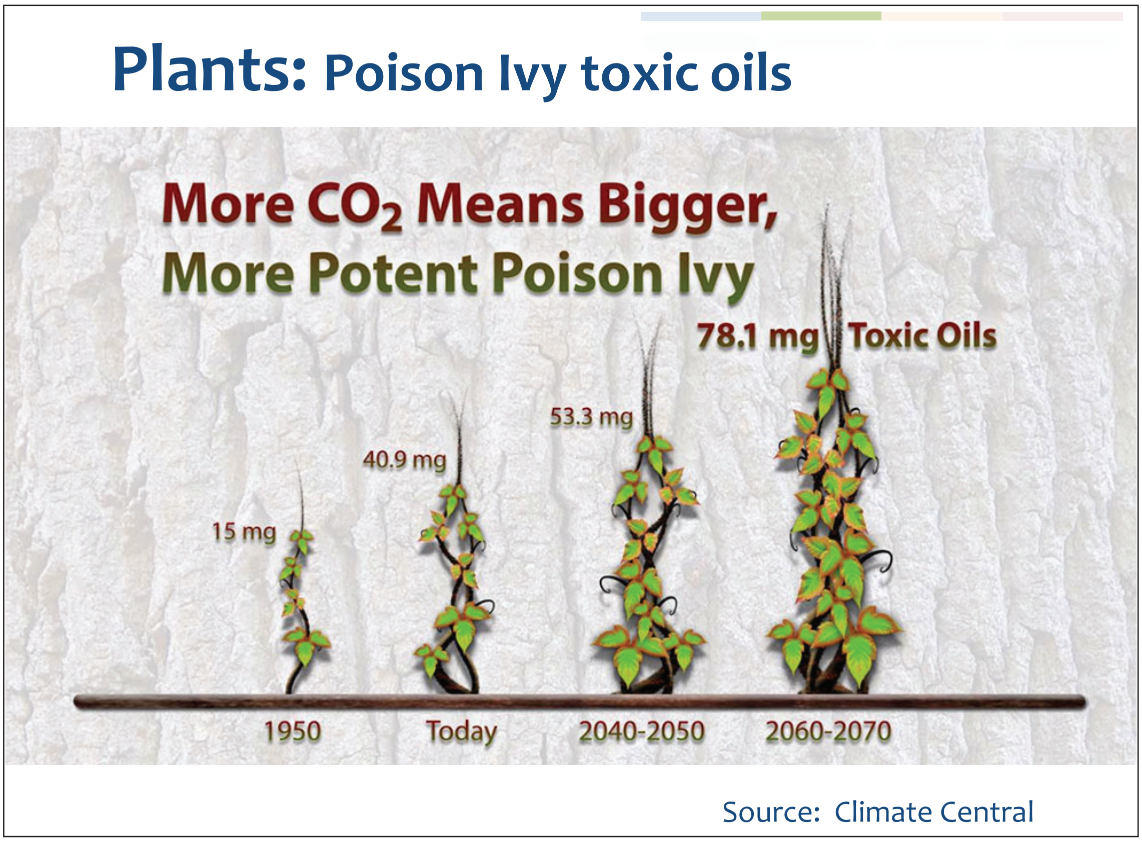
Pollen



Change in pollination seasons & migration of birds & insects including bees & butterflies may affect the seasonality of allergy & asthma

Increasing temperatures with climate change has changed the start of the pollen season in temperate countries, with earlier flowering of many plant species, early migration of birds and butterflies whose migration start time is temperature sensitive, and other effects. There is increasing interest in understanding whether these changes have affected allergies and asthma patterns and rates.

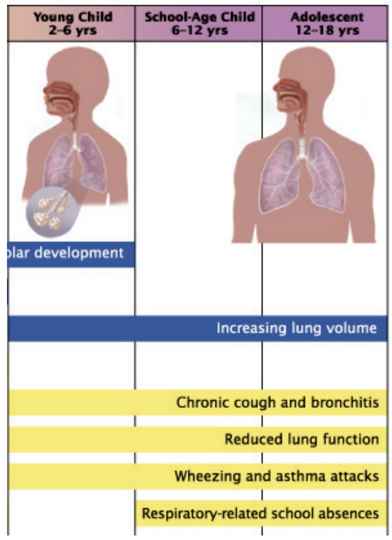
21



In addition to pollen, increasing atmospheric concentrations of carbon dioxide affect a variety of plant physiological processes that can have adverse health impacts. The example if for poison ivy, with the plants becoming larger and producing more toxic oils with increased CO_2 concentrations (note the measure increase between 1950 and today, and the projections to later in the century).

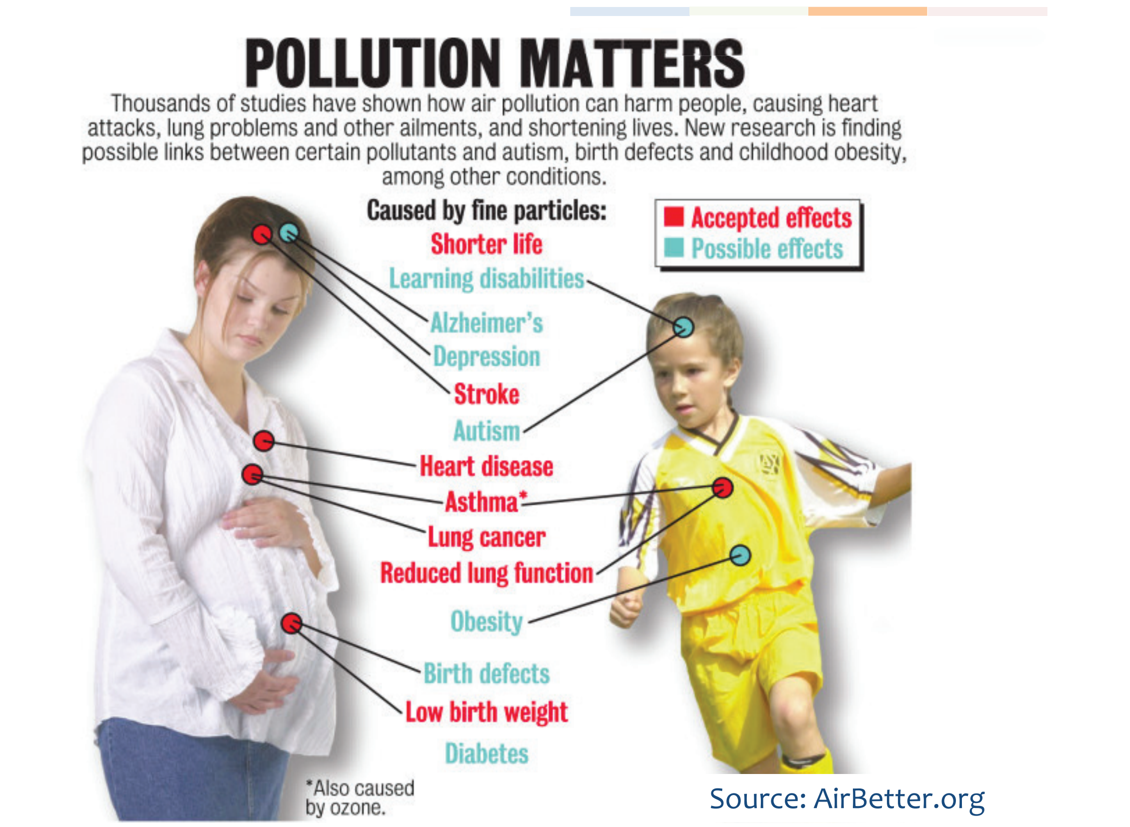
Source: *Climate Central<<http://www.climatecentral.org/>>*

Health impacts of PM & ozone



Let's look now at the health impacts of air pollutants. We'll focus specifically on Particulate Matter and ozone.

23



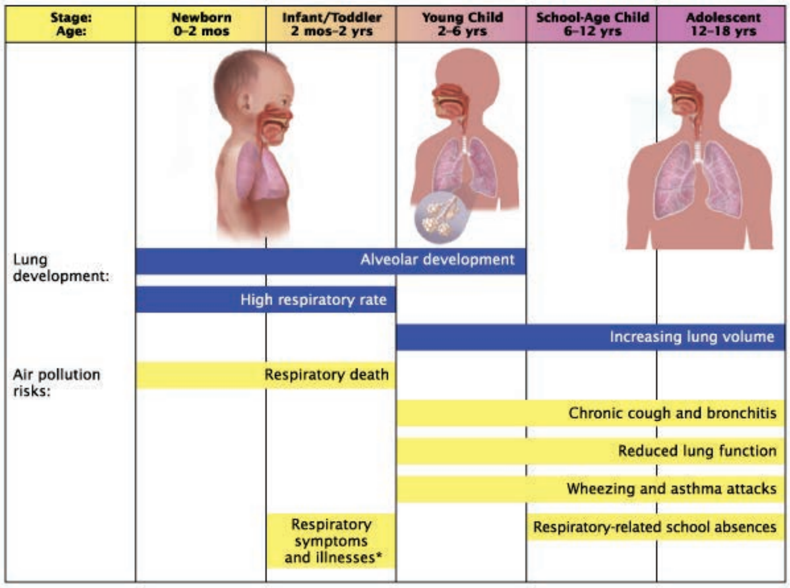
This figure illustrates the wide variety of health risks associated with ozone and particulate matter.

This slide can be used to ask participants about monitoring for air pollutants is in their countries.

Source: *http://www.airbetter.org/wp-content/uploads/2014/10/Pollution_effects-620x597.jpg*

24

Air pollution effects on the developing respiratory system



Source: UCLA Institute of the Environment & Sustainability

Children are particularly at risk from exposure to high ambient concentrations of air pollutants, as shown in this chart.

Source: *UCLA Institute of the Environment & Sustainability. 2008. http://www.environment.ucla.edu/reportcard/article1700.html*

25

Time series analyses

- Analyzes a series of daily observations of air pollution & health to determine short-term, acute effects
- Widely used & economical approach, often utilizing readily-available data
- Temporal studies avoid many of the confounding factors that can affect spatial studies
- Time-varying factors may confound the pollution associations
  - Seasonal cycles, weather variables, day of week

The slide summarizes important points on time series analyses, which can be used for air pollution epidemiology.

Q: Do any of you have experience with time series analyses?

26

Prospective cohort studies

- Address long-term, chronic effects
- Large populations in multiple cities enrolled & followed for many years to determine morbidity or mortality experience
- Must control for “spatial” confounders, e.g. smoking, income, race, diet, occupation
- Assessment of confounders at individual level is an advantage over cross-sectional, ecologic studies

The prospective cohort study design could be called the gold standard for air pollution epidemiology. The bullet points summarize the characteristics of such studies. These studies tend to be very expensive and require many years for completion. Retrospective exposure assessment can get around these constraints.

27

Review of evidence

- Review of evidence on health aspects of air pollution – REVIHAAP project (WHO EURO) available at: http://euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf?ua=1
- City level data available at: http://apps.who.int/gho/data/view.main.AMBIENTCITY2014?lang=en

You can also review evidence of air quality impacts to help in managing air pollution in your area.

The two websites are sources of evidence of the health impacts of air pollution and of city level data.

28

Ambient air pollution attributable deaths in 2012, by WHO region

Source: WHO

	Ambient air pollution attributable deaths	Deaths in children under 5 years	Deaths per 100 000 capita	Deaths in children under 5 years per 100 000
South-East Asia	**936 300** (761 500 – 1 257 500)	**40 800**	**51**	**23**
Western Pacific	**1 669 400** (1 289 400 – 1 955 700)	**14 100**	**102**	**12**
Global	**3 732 500** (3 187 700 – 4 290 900)	**126 800**	**53**	**19**

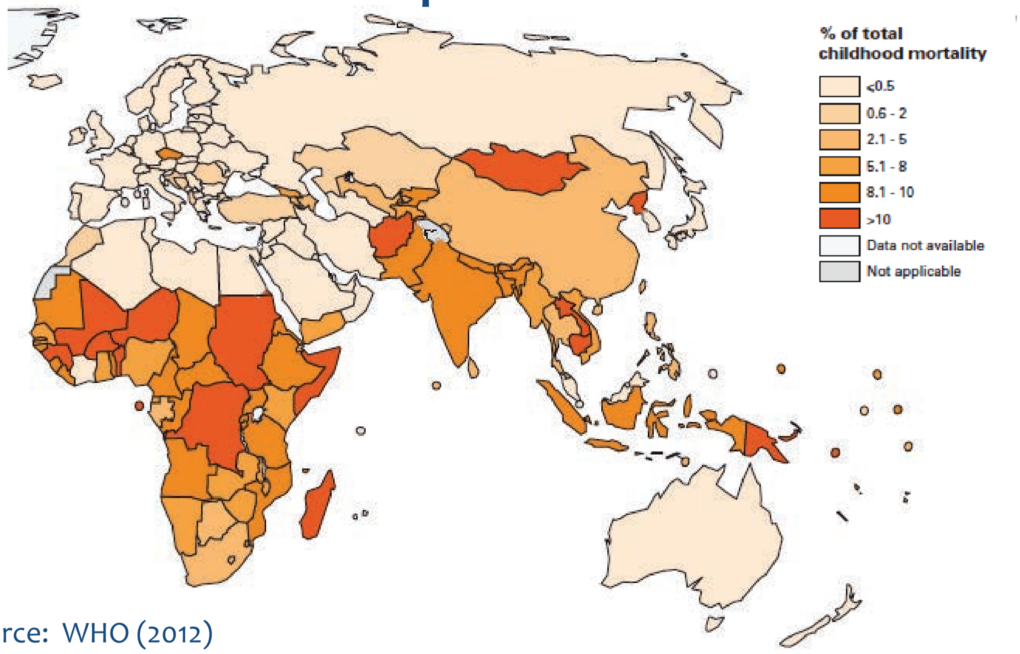
Worldwide deaths attributable to ambient particulate matter pollution in 2010 was 1 850 428 in males and 1 373 113 in women. Deaths due to ozone was 86 335 in males and 66 100 in females. 22% of years of life lost due to ischemic heart disease is from ambient particulate matter pollution. (***Source:*** *Lim et al. 2012.)*

Ambient (outdoor air pollution) in cities and rural areas caused an estimated 3.7 million premature deaths worldwide in 2012, as you can see in the table. 88% of those premature deaths occurred in low- and middle-income countries, with the greatest number in the WHO Western Pacific and South-East Asia regions (Source: WHO; http://www.who.int/phe/health_topics/outdoorair/databases/en/)

Source: *Lim et al. 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet; December 15:380(9859): 2224–2260. doi:10.1016/S0140-6736(12)61766-8.*

29

Percent of childhood mortality due to air pollution

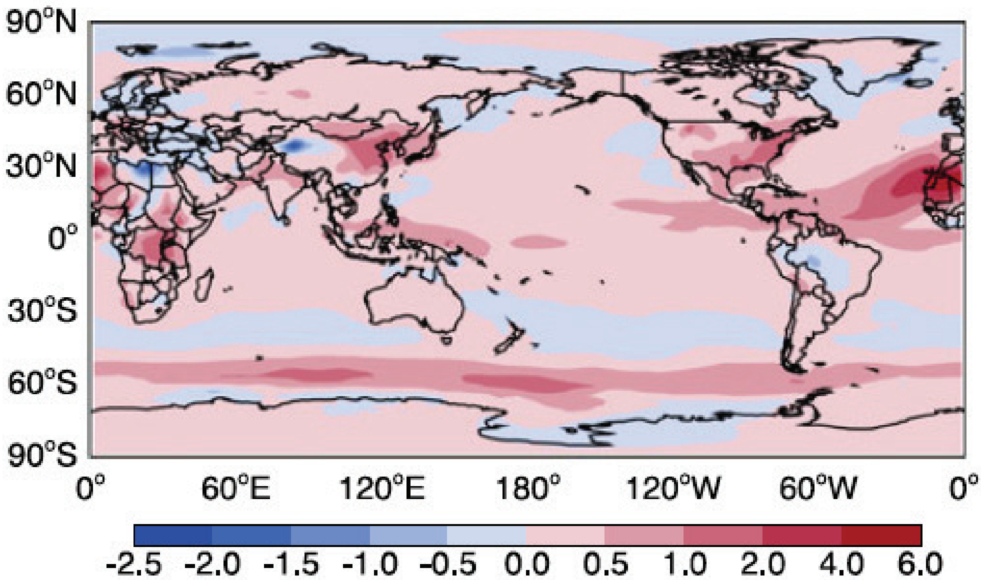


Source: WHO (2012)

The map summarizes the percent of childhood mortality on an annual basis due to air pollution, ranging from less than 0.5% to over 10% in countries colored in red. The worldwide burden of childhood mortality due to air pollution is significant.

Source: *WHO Climate Change and Human Health Atlas 2012 <<http://www.who.int/globalchange/publications/atlas/en/>>*

Climate change-induced changes in annual mean surface PM2.5 from 1981 - 2000 to 2081 - 2100



ug/m3 Source: Fang et al. (2013)

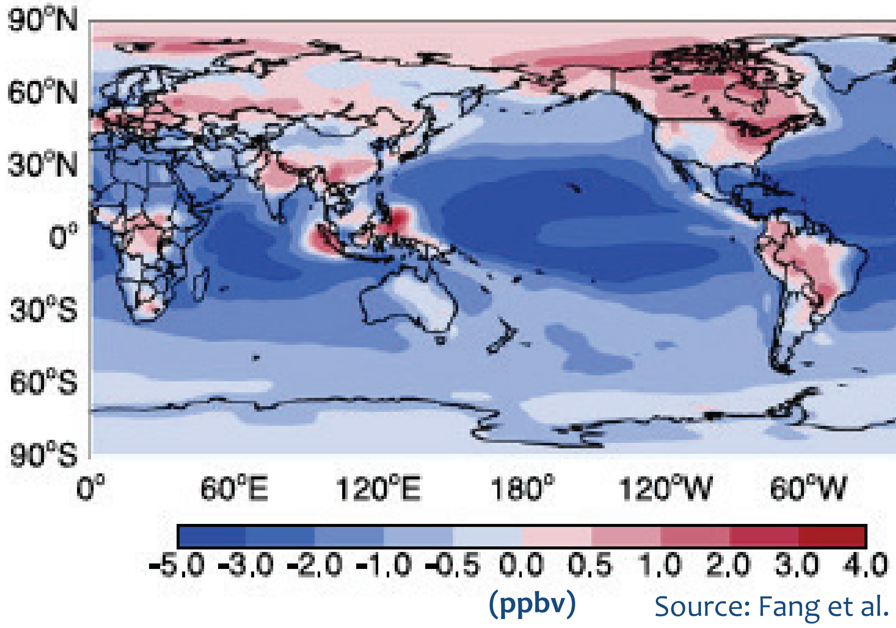
The map shows the simulated change in annual mean surface PM2.5 between now and the end of the century due to climate change. Some regions could see an increase by as much as 6 ug/m³. A few regions will likely see decreases. There is a global mean increase of 0.28 $\mu g/m^3$. The increase is 0.48 μg/m3 when weighted by population, greater than the global average, indicating a greater increase over more populated areas. Among all PM2.5 components, the largest increases are in sulfate, smaller dust particles, and organic matter.

In the northern hemisphere, surface PM2.5 increases substantially near source regions (e.g., over East Asia, eastern United States, northern India, and Africa). These source regions are usually highly populated, therefore increases in PM2.5 are likely to adversely impact human health. With climate change, surface PM2.5 concentrations decrease over western Brazil, parts of northern Europe, the Middle East, and parts of North Africa, suggesting a potential "climate benefit" for air quality there.

Source: *Fang et al. Impacts of 21st century climate change on global air pollution-related premature mortality. 2013. Climatic Change 121:239–253. DOI 10.1007/s10584-013-0847-82013*

31

Climate change-induced changes in annual mean surface O3 from 1981-2000 to 2081-2100



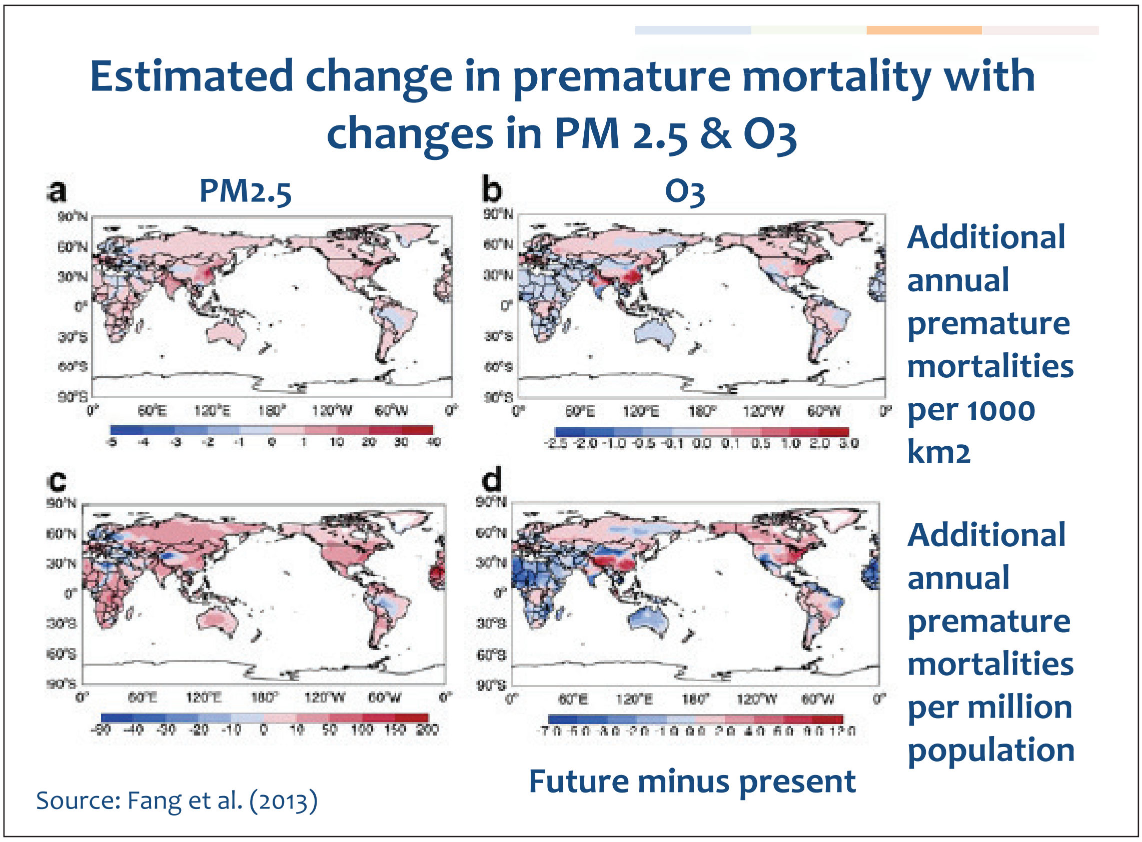
Source: Fang et al. (2013)

Surface ozone concentrations respond differently than PM2.5 to projected 21st century climate change. The global annual mean O_3 concentration changes by −1.3 ppbv (−0.2 ppbv when weighted by population) with largest reductions occurring over remote oceanic regions and increases occurring over many polluted continental regions. The decrease in O_3 concentrations over remote oceanic regions and in the global mean is largely driven by an increase in water vapor in the warmer future atmosphere.

However, over regions with large NOx emissions such as south China, north India, northeast United States, and central Africa, the study projected surface O_3 would increase.

Source: *Fang et al. Impacts of 21st century climate change on global air pollution-related premature mortality. 2013. Climatic Change 121:239–253. DOI 10.1007/s10584-013-0847-82013*

32



Estimated change in premature mortalities associated with changes in surface PM2.5 (left column) and O_3 (right column) resulting from 21st century climate change (i.e., "future" minus "present" simulations). A and C show changes due to PM2.5 and B and D show changes due to O_3.

The units are: (A, B) additional annual premature deaths per 1000 km^2, and (C, D) additional annual premature deaths per million population.

In North America, Europe, South and East Asia, 21st century climate change induced changes in both PM2.5 and O_3 surface concentrations are projected to increase premature mortality under the scenario of a constant population, baseline mortality rate, and emissions of short-lived air pollutants. Climate change generates an air quality "climate penalty" by increasing surface concentrations of air pollutants and associated human health risks. As a result, stronger emission controls will be needed in many regions to maintain current air quality and public health.

Source: *Fang et al. Impacts of 21st century climate change on global air pollution-related premature mortality. 2013. Climatic Change 121:239–253. DOI 10.1007/s10584-013-0847-82013*

33

Atmospheric brown cloud

Increases in concentrations of PM 2.5 of 20 µg/m^3 could lead to about 340 000 excess deaths per year in China & India

Atmospheric brown haze is also altering regional weather, creating acid rain, & (perhaps) affecting forest & crop yields

The atmospheric brown cloud affects millions of people across multiple countries, primarily in Asia. Brown clouds contain a variety of toxic aerosols, carcinogens, and particles including PM2.5. Increases in concentrations of PM 2.5 of 20 μg/m^3 could lead to about 340 000 excess deaths per year in China and India.

ABC also alters regional weather patterns, creates acid rain, can increase snow melt as black carbon increases heat absorption, and may be affecting forest and crop yields.

Five regional hotspots for ABCs were identified, including

- East Asia, covering eastern China;
- The Indo-Gangetic plains in South Asia from the northwest and northeast regions of eastern Pakistan across India to Bangladesh and Myanmar; and
- South-East Asia, covering Cambodia, Indonesia, Thailand, and Vietnam

Source: *UNEP Atmospheric Brown Clouds: Regional Assessment Report with Focus on Asia. 2008. <<http://www.unep.org/pdf/ABCSummaryFinal.pdf>>*

34

4

Benefits of air quality policies

Finally, we'll look at the benefits that come from working to air quality policies.

This image is of an air quality monitoring sign, displaying real time data on current levels of pollutants compared to the guidelines for the city.

35

WHO ambient air quality guidelines

- **PM2.5**
  - 10 $\mu g/m^3$ annual mean
  - 25 $\mu g/m^3$ 24-hour mean
- **PM10**
  - 20 $\mu g/m^3$ annual mean
  - 50 $\mu g/m^3$ 24-hour mean
- **Ozone**
  - 100 $\mu g/m^3$ 8-hour mean

Source: WHO (2008)

The World Health Organization sets air quality guidelines. These are the latest guidelines for PM and ozone.

This slide can be used to ask participants if they know the air quality guidelines in their country.

Source: *WHO 2008 <<http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/>>*

36

WHO key facts on air pollution

- Key sources of urban outdoor air pollution can be reduced by policies & investments supporting cleaner transport, energy-efficient housing, power generation, industry & better municipal waste management
- Key rural & peri-urban air pollution sources can be reduced by decreasing outdoor emissions from household coal & biomass energy systems, agricultural waste incineration, forest fires & certain agro-forestry activities (e.g. charcoal production)

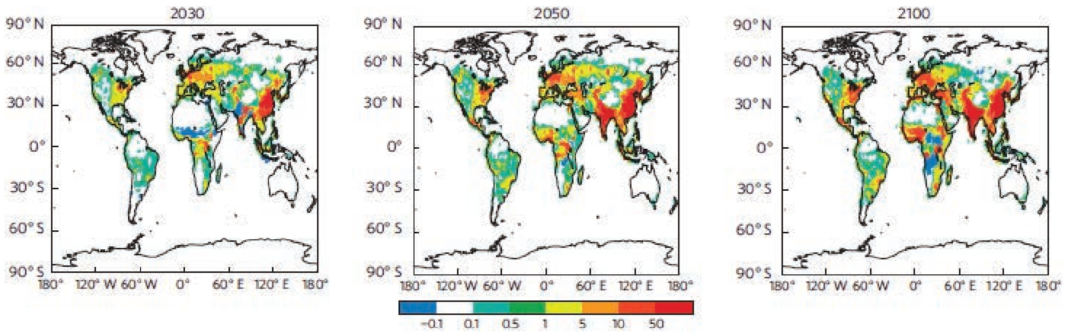
The points summarize some key facts related to air pollution policies.

Source: *WHO. 2014. http://www.who.int/mediacentre/factsheets/fs313/en/*

37

Co-benefits of avoided premature mortality from PM2.5 & O3 in 2030, 2050, & 2100

Deaths per year per 1000 km ²



Deaths PM2.5 - cardiopulmonary disease plus lung cancer
Ozone (O3) – respiratory disease

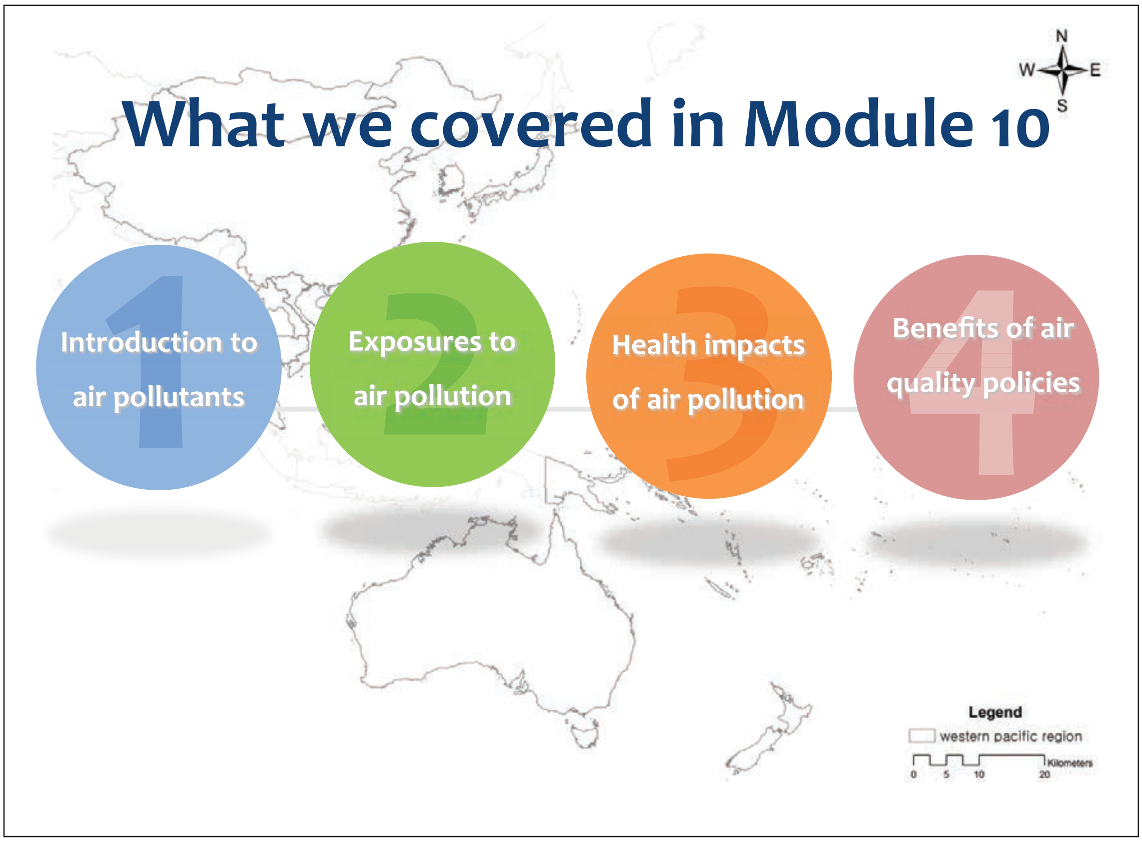
Source: West et al. (2013)

This study simulated the co-benefits of global greenhouse gas reductions on air quality and human health using a global atmospheric model and consistent future emission scenarios, via two mechanisms: reducing co-emitted air pollutants, and slowing climate change and its effect on air quality. They used relationships between chronic mortality and exposure to fine particulate matter and ozone, global modeling methods, and new future scenarios. Relative to a reference scenario, global GHG mitigation avoids 0.5±0.2, 1.3±0.5 and 2.2±0.8 million premature deaths in 2030, 2050, and 2100. Air quality and health co-benefits, especially as they are mainly local and near-term, provide strong additional motivation for transitioning to a low-carbon future.

The large numbers of potentially avoided premature mortality in Asia is evident.

Source: *West et al. Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health. 2013. Nature Climate Change;3; DOI: 10.1038/NCLIMATE2009*

38



So here's what we covered in Module 10:

1. Introduction to air pollutants and their characteristics
2. Exposures to air pollution
3. Health impacts of air pollution
4. Benefits of air quality policies

39

Learning from Module 10

- The mixtures of air pollutants produced by burning of fuels & by wildfires, can adversely affect human health directly & indirectly
  - Elevated concentrations of articulate matter & ozone cause significant mortality
- Climate variability can influence air quality, resulting in adverse health consequences
  - Includes affects on aero-allergens like pollen
- Reducing the sources of air pollutions would prevent avoidable premature mortality

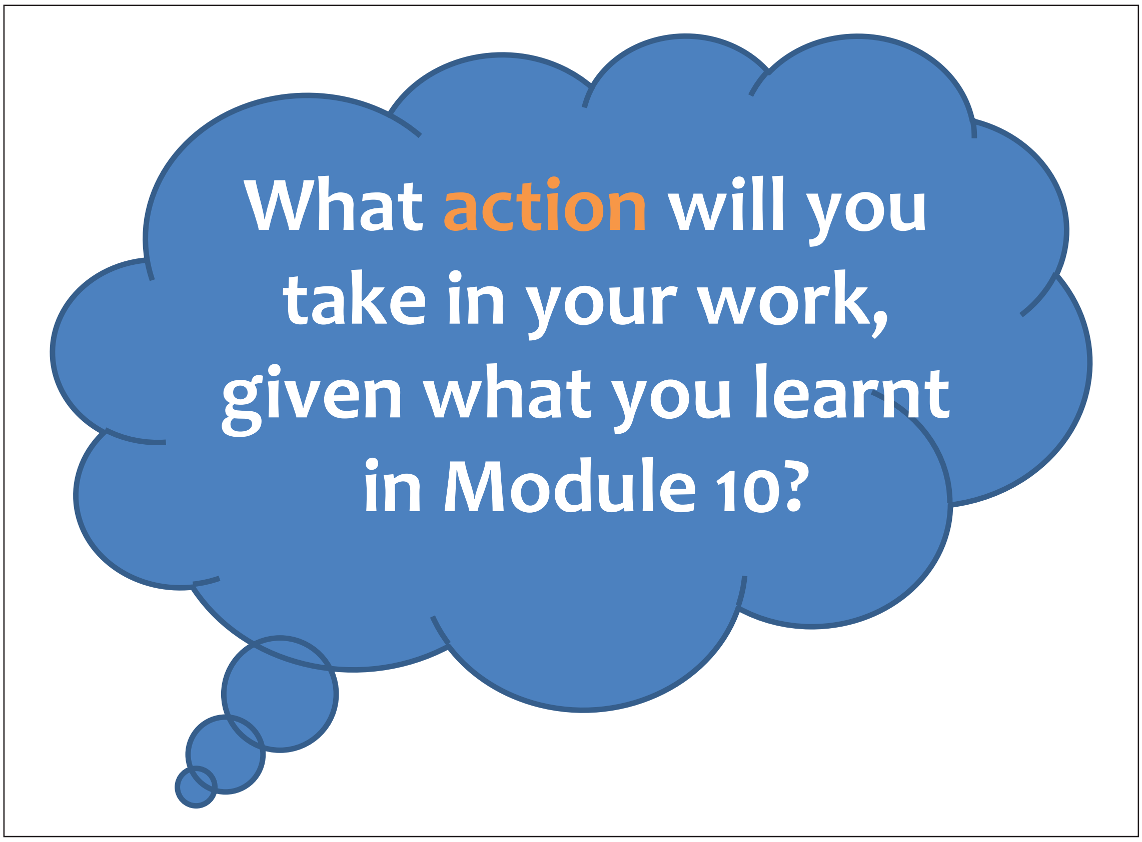
Here's the key learnings we covered in Module 10, around the many intersections of air quality, climate, and health.

Fuel combustion is responsible for most of the air pollutants that adversely affect human health. This fuel combustion is also responsible for most of anthropogenic climate change. Therefore, human health and climate change are inextricably linked at the concentrations of emissions of air pollution. The interactions are complex in that there are benefits to health to the energy generated by much fossil fuel combustion, such as through energy used to produce safe water and improved sanitation, refrigeration, and other technologies that continue to improve human health and well-being, At the same time, air pollutants are known to cause a variety of adverse health impacts, as will be discussed in this module. The module on mitigation will provide a more in-depth discussion of how reducing greenhouse gas emissions can benefit human health.

Climate variability can influence air quality in a variety of ways. For example, horizontal and vertical air motions in the atmosphere transport and dilute air pollutants emitted by human activities. Temperature, humidity, rainfall, and winds also may influence the generation of some unwanted air contaminants, including smoke from wildfires and allergenic pollens.

Q: Are there any questions on the learnings from Module 11?

40



To finish off Module 10, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around air quality and climate change.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes**: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 11

Assessing health vulnerability

Key learning messages in Module 11

- The health impacts of climate change will be inequitably distributed within and between countries
- Vulnerability is the propensity to be adversely affected
- Causes of vulnerability include biological characteristics, the physical environment, social circumstances and national and international politics
- Vulnerability can be assessed using Health Impact Assessment (or HIA) and Health National Action Plan (or HNAP)
- Many facets of vulnerability means many opportunities for intervention.

Estimated length: 60 minutes or less

Structure of Module 11

Section	Slides	**Activity** (if any)
Key learning messages	2–3	
Module outline	4	
1. Defining key terms around health vulnerability	5–8	
2. The main causes of vulnerability to disease and injury resulting from climate change	9–14	
3. The Health National Action Plan (or HNAP) and Health Impact Assessment (or HIA) approaches to assessing vulnerability	15–23	EXERCISE on slide 20: ● Individual reflection on your own country's vulnerability to climate change. 4 minutes individual initial assessment on spider diagram in slide notes. 2 minutes pair share. Hand raise on most vulnerable areas in the group.
Module outline	24	
Learning from Module 11	25–26	
Learning reflection, action generation	27	

Required resources

- Data projector and slide changer
- Module 11 slides
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 11

HNAP and HIA assessments could potentially come across as overly policy heavy to some participants. Stress that these can be practically orientated and very useful as operational documents to not only assess health vulnerability to climate change, but to then design and implement programs to reduce risk. Ideally all countries will start to use these assessments, if they are not currently, to assess and manage the health risks of climate change.

Key terms introduced in Module 11

- Vulnerability/health vulnerability
- Risk
- Exposure
- Climate Risk Index
- Sea level rise
- Typhoons
- El Niño
- Modern agriculture
- Traditional agriculture
- Health National Action Plan (or HNAP)
- Health Impact Assessment (or HIA)
- Vulnerability and adaptation assessment
- Climate resilience.

References (in order of presentation)

- IPCC. 2013. Fifth Assessment Report, Chapter 11.
- Germanwatch 2014. Global Climate Risk Index 2014**.** Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012
- IPCC. 2013. Fifth Assessment Report.
- Woodward, A.J., S. Hales, and P. Weinstein. 1998. Climate change and human health in the Asia-Pacific region: Who will be most vulnerable? *Climate Research* 11:31-38.
- Fukuma, Y. 1993. Objective evaluation of preparedness against typhoon, by typhoon classification. *Journal of Meteorological Research* 45:159–196.
- KNMI. 2009. Effects of El Nino on world weather. Available: http://www.knmi.nl/research/global_climate/enso/effects/
- WHO. 2014. *WHO guidance to protect health from climate change through health adaptation planning*.
- http://www.who.int/globalchange/publications/guidance-health-adaptation-planning/en/.
- WHO. 2014. *Operational framework for building climate-resilient health systems*.

Module 11: Assessing health vulnerability

In Module 11 we'll look at how as health professionals we can assess the health vulnerability of our country or region to climate change.

2

Key messages in Module 11

- The health impacts of climate change will be inequitably distributed within & between countries

"The rich will find their world to be more expensive, inconvenient, uncomfortable, disrupted & colorless — in general, more unpleasant & unpredictable, perhaps greatly so. The poor will die."

- Kirk R. Smith (2008)

University of California, Berkeley

The key message shown here is the health impacts of climate change will be inequitably distributed within and between countries. Given this message, it is thus important to improve our understanding of communities' differential levels of vulnerability, in order to prioritise limited resources. Unless we have this understanding of different types and levels of vulnerability, then it is virtually impossible to design responses that meet the needs of communities.

Source: *Smith, K. (2008).Mitigating, adapting and suffering. How much of each? Annual Review of Public Health (29) (doi:10.1146/annurev.pu.29.031708.100011)*

3

Key messages in Module 11

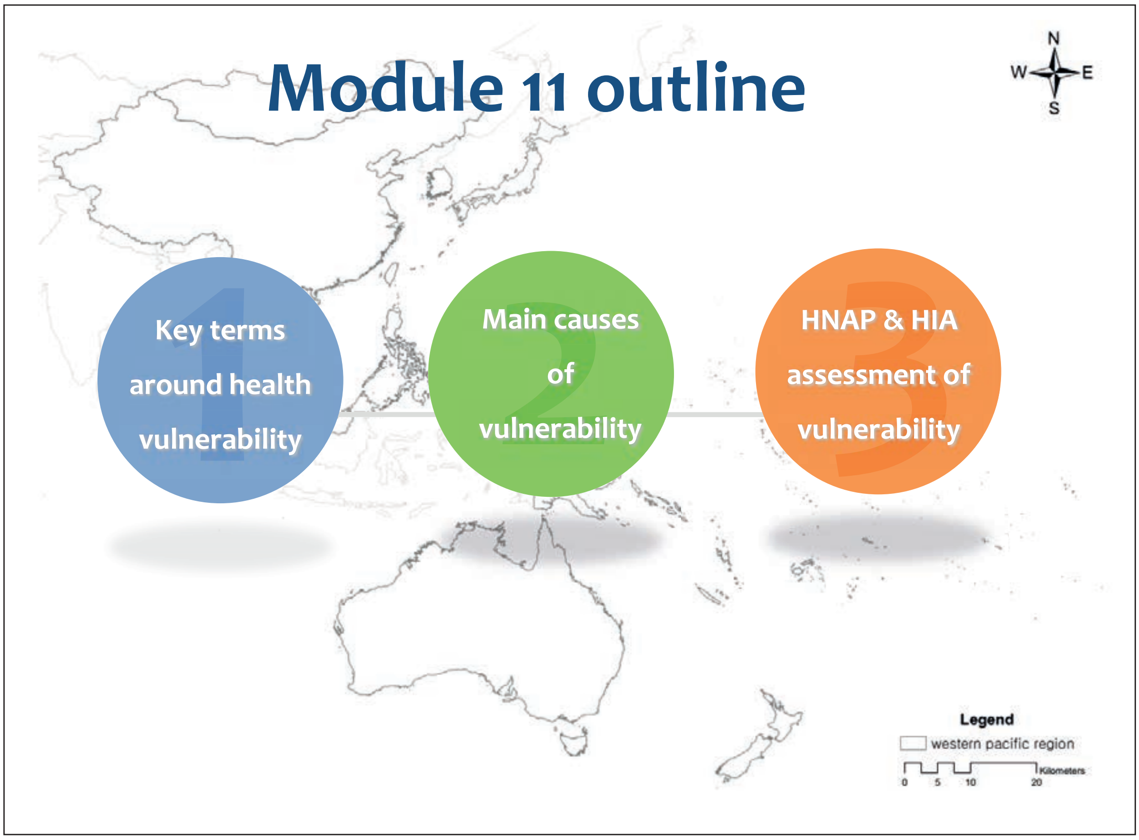
- Vulnerability is the propensity to be adversely affected
- Causes of vulnerability include biological characteristics, the physical environment, social circumstances & national & international politics
- Vulnerability can be assessed using HIA & HNAP
- Many facets of vulnerability means many opportunities for intervention

Key messages around assessing health vulnerability to climate change that we'll cover are: (CLICK to animate four points)

1. Vulnerability is the propensity to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
2. The causes of vulnerability fall across a spectrum, ranging from biological characteristics of organisms to the terms of international trade.
3. Framing vulnerability in this way is not to suggest the phenomenon is too big and wide to grasp. To the contrary, the many facets of vulnerability mean there is a correspondingly wide range of opportunities for intervention at the various levels.
4. And finally, an important point: many of the causes of vulnerability to climate change make individuals and populations susceptible to other environmental threats as well. As a result, intervention to reduce vulnerability to climate change will bring other benefits, and these will very likely be evident before the full impact of climate change is apparent.

(Note that these four 'key messages' were taken from the conclusion slide at the end of the draft module. I'm not sure if they are the key messages drafted at the first meeting re the training. They can be shifted to the end and the slide title changed to 'Summary' if it was only intended to have the one key message re unequally distributed health impacts. – KT)

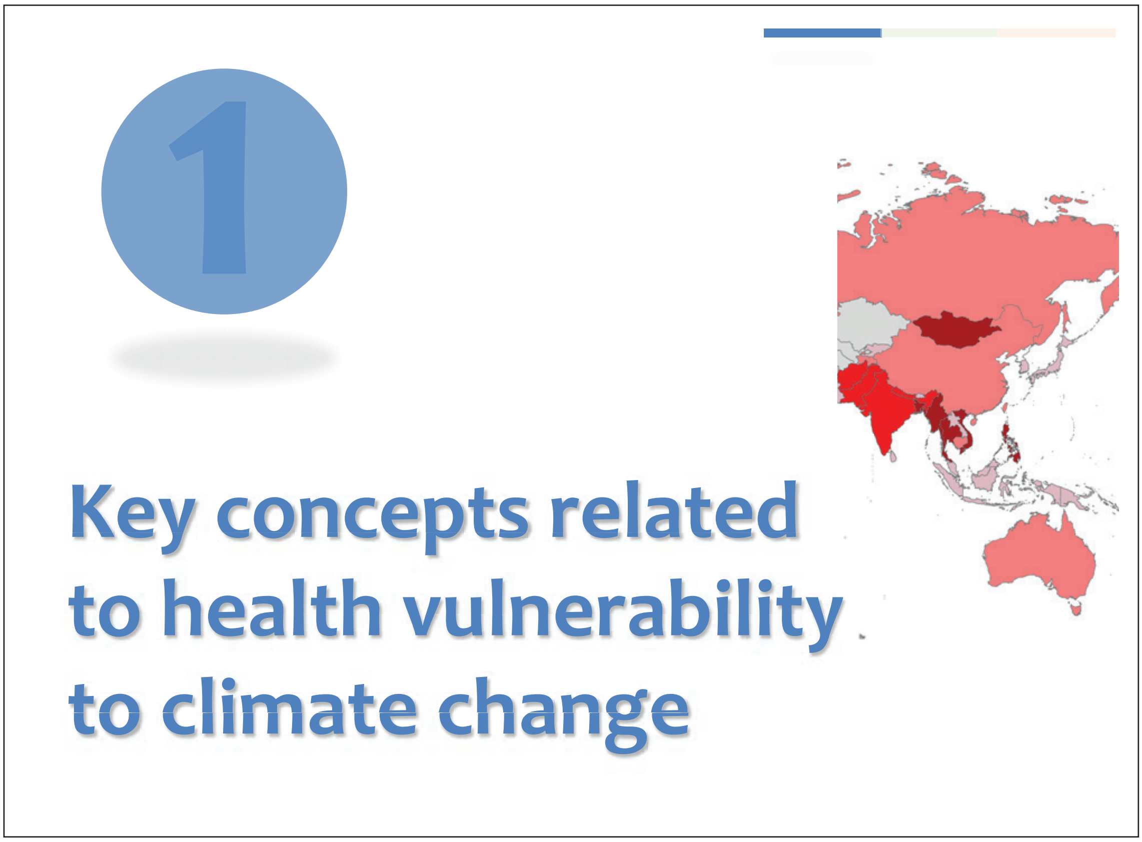
4



The structure of Module 11 is:

1. A definition of key terms around health vulnerability
2. The main causes of vulnerability to disease and injury resulting from climate change, and
3. Looking at the Health National Action Plan (or HNAP) and Health Impact Assessment (or HIA) approaches to assessing vulnerability.

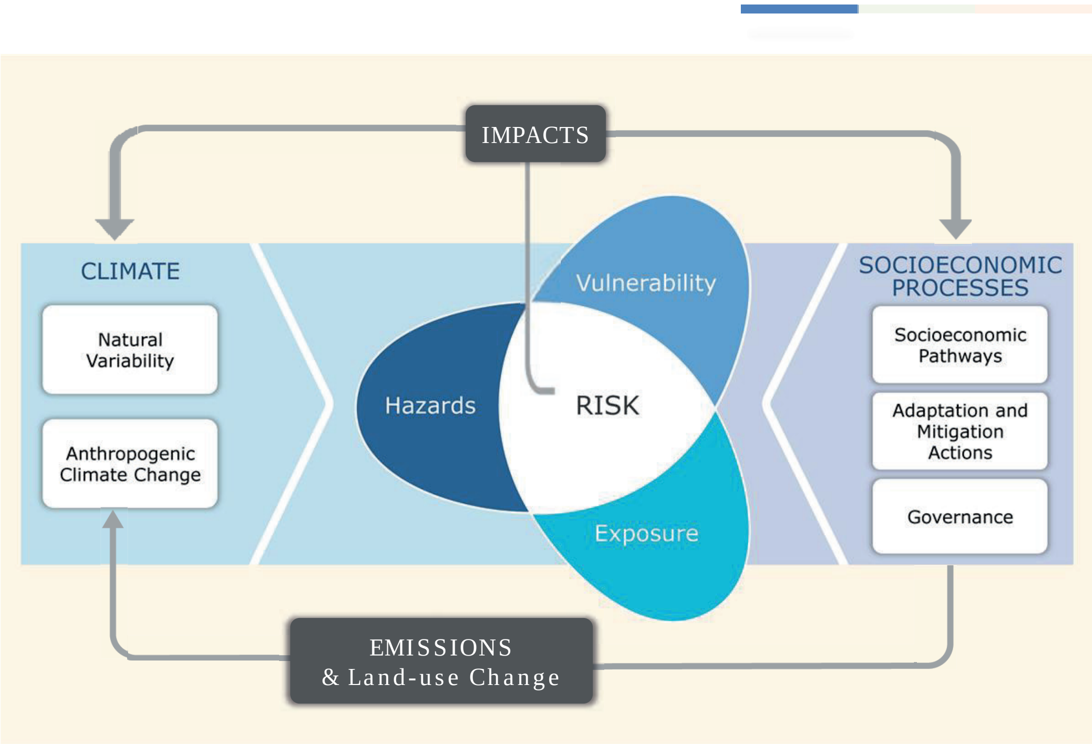
5



We'll start by looking at some of the key concepts related to health vulnerability to climate change.

First off, what do we mean by the term 'vulnerability'?

Vulnerability is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm, and a lack of capacity to cope and adapt.

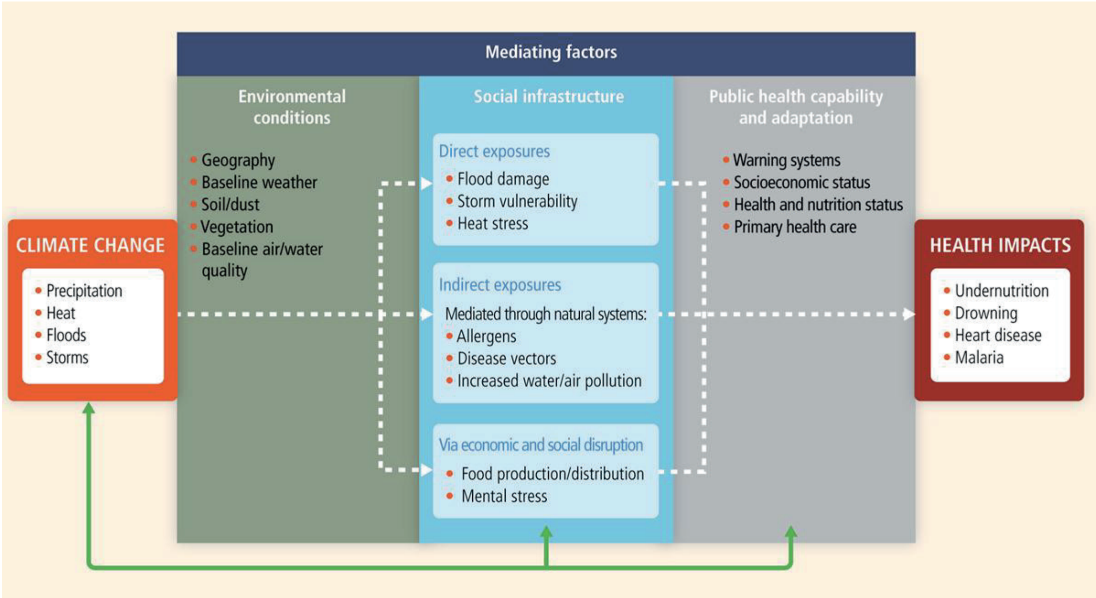


Source: IPCC (2013)

This diagram is from the latest IPCC report (AR5). In it, we can see that risk is at the centre of the framework, and arises from the combination of vulnerability, exposure and hazards. The pressures indicated on the left and the right of the diagram influence these factors. Climate (natural variability and anthropogenic climate change) is of course one of the key determinants of hazards, and influences exposure and vulnerability. Socioeconomic processes on the right include socioeconomic pathways (e.g. development trajectories), action taken on adaptation and mitigation, and governance (e.g. types of decision-making that is occurring to respond to climate change, such as regulation of GHG emissions through a carbon tax); these strongly influence vulnerability and hazard. Future risks that individuals and communities face arise from the interactions of exposure, vulnerability and hazards, and are influenced by climate and development. This in turn determines the level of impacts from changes in the climate. This diagram highlights that we need to look at the system as a whole to understand risks and impacts. Although we can assess (e.g.) mitigation actions and exposure to weather events separately, it is the combination of all of these components shown in the diagram that gives us a holistic picture of the overall risks.

Source: *IPCC. 2013. 5th Assessment Report.*

7



Source: IPCC (2013)

In terms of understanding how exactly climate change affects health, and increases vulnerability, it is helpful to look at this diagram, which we saw in an earlier module (Module 2 – Pop. Health and Climate).

This diagram from the IPCC AR5 report shows three primary exposure pathways by which climate change affects health:

- directly through weather variables such as heat and storms;
- indirectly through changes in natural systems that in turn affect disease vectors; and
- pathways heavily mediated through human systems such as undernutrition.

The green box indicates the moderating influences of local environmental conditions on how climate change exposure pathways occur in a particular population.

The grey box indicates that the extent to which the three categories of exposure translate to actual health burden is moderated by such factors as background public health systems and socioeconomic conditions, and adaptation measures.

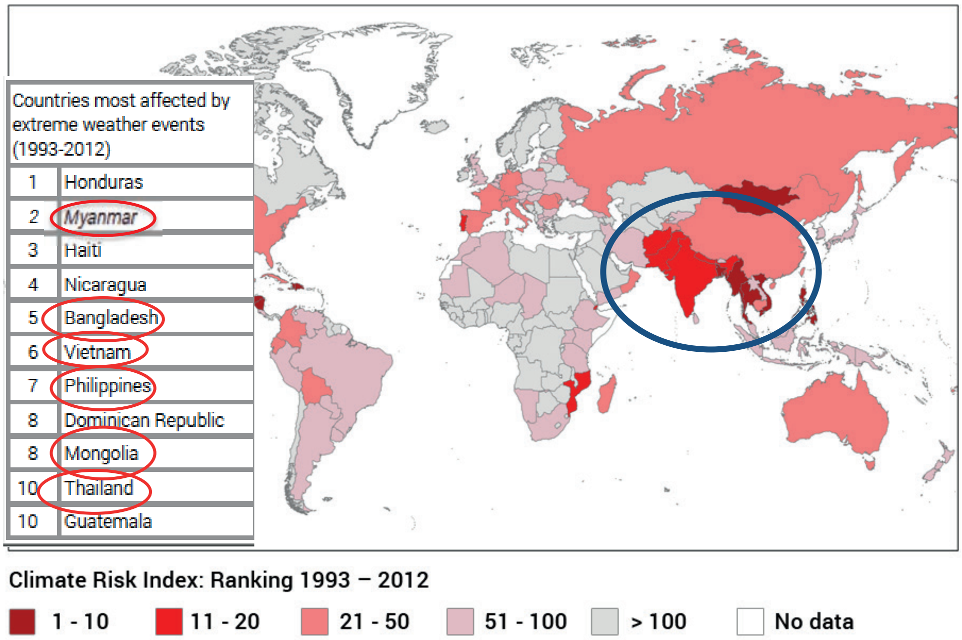
The green arrows at the bottom indicate that there may be feedback mechanisms, positive or negative, between societal infrastructure, public health, and adaptation measures and climate change itself.

Source: *IPCC AR5 Chapter 11*

8

Global Climate Risk Index 2012

Source: Germanwatch (2014)



This is an example of a vulnerability or risk map and was developed by Germanwatch (a German NGO). This index is a way to analyse the quantified impacts of extreme weather events — Meteorological events such as tropical storms, winter storms, severe weather, hail, tornado, local storms; hydrological events such as storm surges, river floods, flash floods, mass movement (landslide); climatological events such as freeze, wildland fires, droughts) both in terms of fatalities as well as economic losses that occurred—based on data from the Munich Re NatCatSERVICE, which is worldwide one of the most reliable and complete data bases on this matter.

CLICK - We can see that 6 of the top ten countries most affected by extreme weather events are in the Asia Pacific region. These countries ranking the highest are the ones most impacted and should see the Climate Risk Index as a warning sign that they are at risk from extreme weather events.

The Climate Risk Index does not provide an all-encompassing analysis of the risks from anthropogenic climate change, but should be seen as one analysis informing countries' exposure and vulnerability to climate-related risks along with other analyses, based on the most reliable quantified data.

Source: *Germanwatch 2014. Global Climate Risk Index 2014. Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012*

Other references for vulnerability maps include the document 'Climate Change Vulnerability Mapping for Southeast Asia' by Yusuf and Francisco from the Economy and Environment Program for Southeast Asia (EEPSEA), based in Singapore.

9

2

Climate change vulnerability & some of its causes

Let's now look at some the main causes of vulnerability linked to climate.

10

Vulnerability

The propensity or predisposition to be adversely affected.

Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm & lack of capacity to cope & adapt.

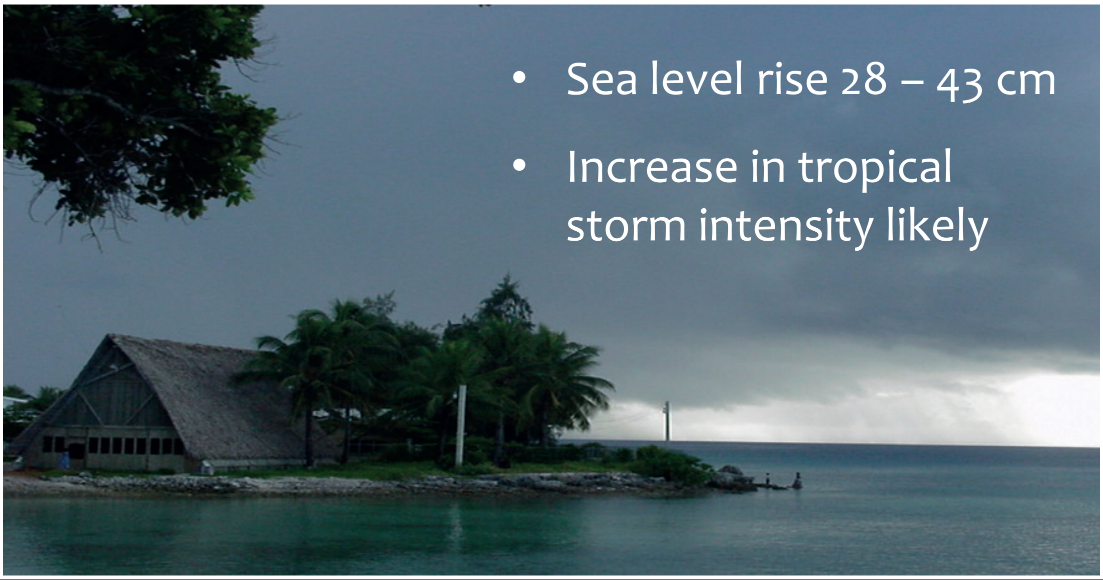
IPCC (2013)

Vulnerability, as defined by the IPCC in the Fifth Assessment Report, is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Source: *IPCC. 2013. Fifth Assessment Report.*

11

Climate change & Pacific Ocean sea level rise



Many vulnerable countries will be exposed to climate extremes such as storms, as well as sea level rise.

Some parts of the world are at increased risk of storms simply because of their location. An example shown in this slide is the Pacific islands that lie in the tropical storm belt, and hence will be exposed to any increase in the intensity of tropical storms, as may occur with climate change.

There are other physical attributes of these islands that make them vulnerable – at particular risk are the densely populated, low lying coral atolls.

The next slide includes a list of the Pacific islands, ranked in terms of their vulnerability to sea level rise. The major discriminator is island type – however, national GDP is included also as a measure of the islands' capacity to respond to the threat and to adapt.

12

Vulnerability of Pacific Islands to sea level rise

Nation	Major island type	GNP per capita 1994 (US $)	Population (1995)	Maximum altitude (m)	Susceptibility to sea level rise
Tokelau	Atoll	4000	1500	4	Extreme
Marshall Islands	Atoll	2500	54700	4	
Tuvalu	Atoll, raised coral	–	9500	4	
Line Islands	Raised coral	–		8	
Kiribati	coral, atoll	730	78400	81	
Micronesia	Various	1890	105700	791	Severe
Palau	Coral	3250	16500	207	
Pitcairn	Coral, atoll	–	50	304	
Nauru		12000	10500	71	
French Polynesia	Volcanic, atoll	7000	218000	2237	
Cook Islands	Volcanic, varied	2750	19100	652	
Niue	Coral	2250	2500	67	
Tonga	Various	1640	98200	1125	
American Samoa	Volcanic	8000	54800	931	Moderate
Fiji	Mixed	2220	774800	1323	
New Caledonia	Mixed	11000	182200	1628	
N Marianas	Volcanic	–	56700	965	
Solomon Islands	Mixed, volcanic	1200	367800	2446	
Vanuatu	Mixed	1300	164100	1979	Modest
Wallis and Fatuna	Volcanic	3000	14400	769	
Easter Island	Volcanic	–	2811	600	
Papua New Guinea	Mixed	1120	4302000	4694	
Guam	Mixed	11800	149300	393	
Western Samoa	Volcanic	900	163400	1857	

Source: Woodward et al. (1998)

This table shows vulnerability of Pacific island to sea level rise in categories (extreme, severe, moderate etc.). Note these labels apply to all islands based on the previous filled in value in the table.

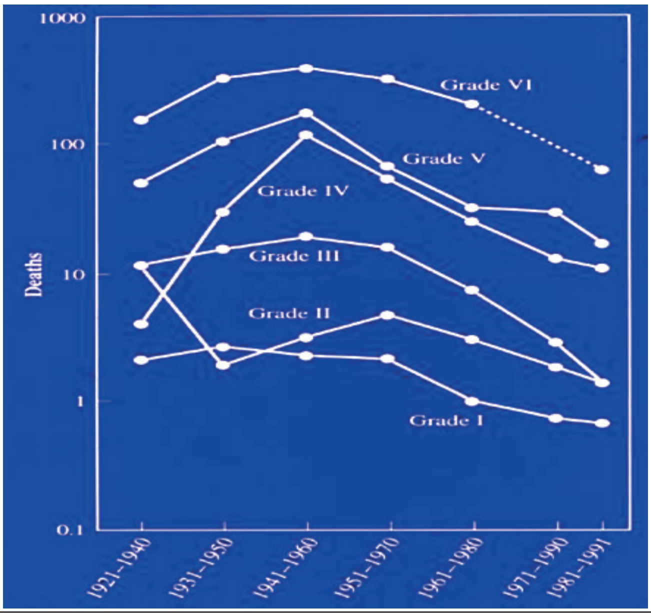
The low lying coral atolls, especially Tokelau, the Marshalls, and Tuvalu, have the greatest susceptibility to sea level rise. None of these islands are wealthy, as measured by GDP per capita. There are important cultural sources of resilience – traditional methods of weather forecasting, for example, and food storage, have helped many generations to cope with tropical storms. But without significant economic resources, these countries will find it difficult to make the structural adaptations that are required in the face of long-term climate change.

This is an important point – the most severe effects of climate change are likely to be experienced by those populations with the least resources. Poverty is a powerful driver of vulnerability.

However, poverty is not the only cause of vulnerability, and sometimes populations that are poor are very good at coping with climate extremes.

Source: Woodward, A.J., S. Hales, and P. Weinstein. 1998. Climate change and human health in the Asia-Pacific region: Who will be most vulnerable? Climate Research 11:31-38.

Typhoon impacts by classification: a preparedness evaluation



Loss of life due to typhoons is decreasing owing to better preparedness

Source: Fukuma (1993)

Moving to another example of a weather event – typhoons.

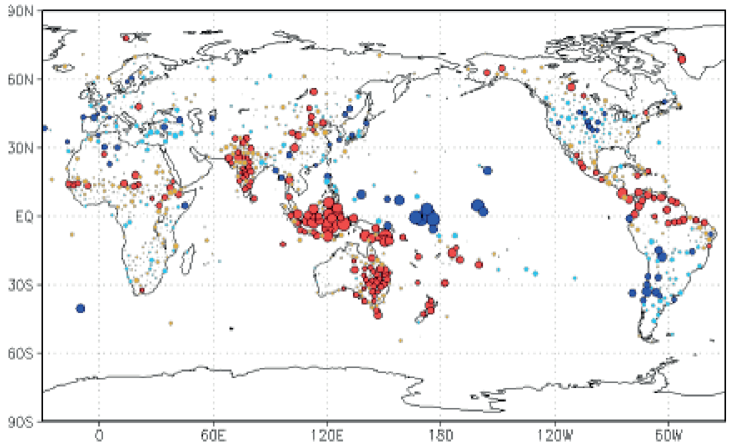
Typhoons frequently pass across Japan, and mortality per typhoon has varied markedly over the last 70 years.

The impact of these storms was greatest in the period 1941 to 1960, and since then has declined steeply. The recent improvement has been most marked for typhoons of intermediate severity (not surprising since this is where adaptive strategies are likely to make the greatest difference). Possible explanations include better land management, coastal protection, communications, and early warning systems and housing.

Source: *Fukuma, Y. 1993. Objective evaluation of preparedness against typhoon, by typhoon classification. Journal of Meteorological Research 45:159–196.*

14

Effect of El Niño on rainfall



Data:

June – August over 40 years, to 2000

Red dots: drier than usual during El Niño

Blue dots: more rainfall

Size of circle: size of effect

Source: KNMI (2009)

El Niño events associated with weakening easterlies, warming of the western Pacific, & shift in rainfall patterns

In terms of the weather events we've touched on, it is useful to understand a little bit about climate patterns, such as El Nino.

First, a brief explanation of what is meant by an 'El Niño event'.

These events are part of a cyclical climate pattern known as the El Niño Southern Oscillation, in which there are periodic shifts in ocean currents and prevailing winds, centered in the western Pacific. The El Niño part of this cycle involves weakening easterlies, warming of the Pacific on the western side, and a tendency for rainfall patterns to shift eastwards.

This map shows how El Niño events typically bring warmer and drier conditions to much of South-East Asia, including the Indian sub-continent.

***Source:** KNMI. 2009. Effects of El Nino on world weather. Available: http://www.knmi.nl/research/global_climate/enso/effects/*

15

Pacific: Does modern agriculture reduce vulnerability to climate variability?

Traditional agriculture

- Crop diversity
- Drought-resistant staples (e.g. taro, yam)
- Robust methods of food preservation
- Strong social networks
- Inter-island trade systems

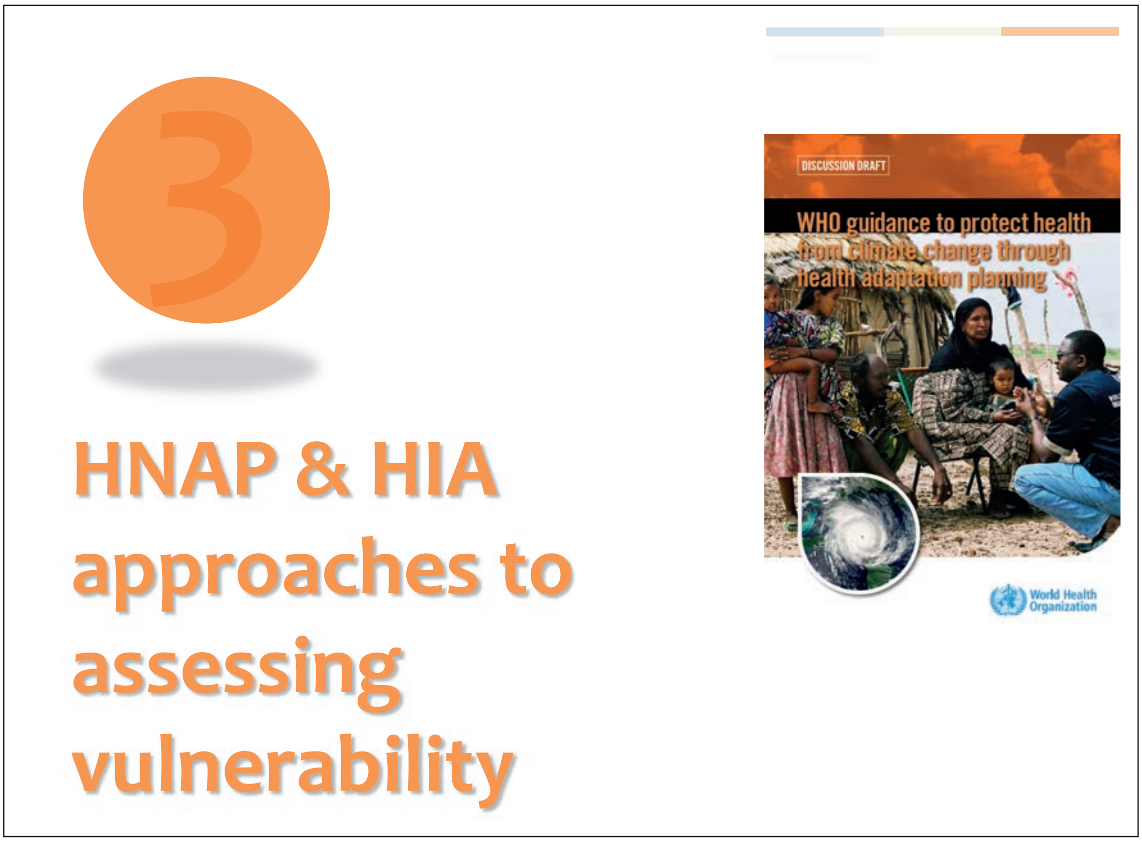
Modern agriculture

- Cash cropping
- Reliance on imported staples (e.g. rice)
- Unreliable methods of food preservation (e.g. refrigerators)
- Attenuated social networks
- Trade systems global, not local

Modernity does not necessarily bring greater protection against climate extremes and other natural hazards, and traditional social systems. Although cash-poor, the Pacific's agricultural methods often included very important adaptive components.

Here are some examples from the Pacific, continuing the theme of food security and vulnerability to hunger.

16

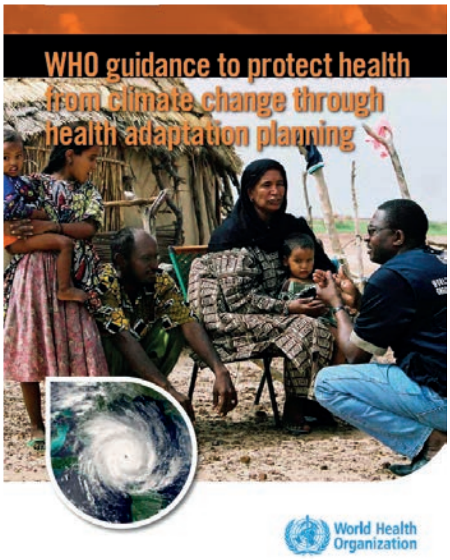


In this third and last section of Module 12 we'll move on to a closer look at the process of conducting a vulnerability and adaptation assessment using a Health National Adaptation Plan (or HNAP) and Health Impact Assessment (or HIA) approaches.

17

HNAP – a systematic process to:

- Engage in the overall NAP process at the national level
- Identify national strategic goals for building health resilience to climate change (if countries have not done so through, for e.g., a National Health Adaptation Strategy)
- Develop a national plan with prioritized activities to achieve these goals, within a specific time period & given available resources



http://who.int/globalchange/publications/guidance-health-adaptation-planning/en/

This particular example showcases the current WHO guidance on developing a Health National Adaptation Plan (or HNAP). This 'WHO guidance to protect health from climate change through health adaptation planning' was published in 2014 and can be found online at the web address listed:

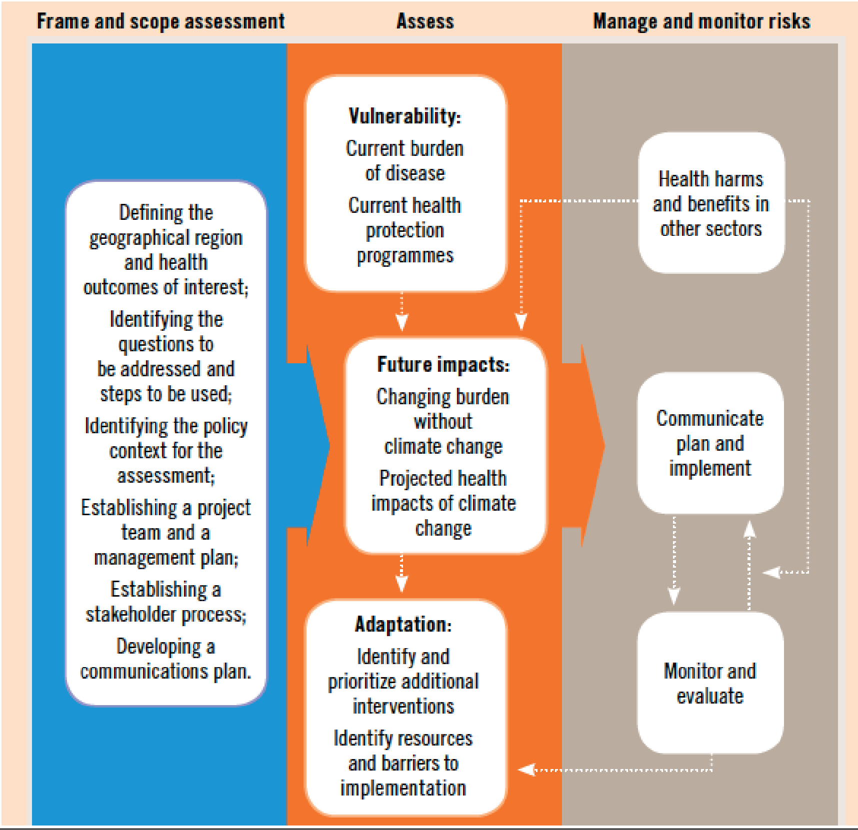
http://www.who.int/globalchange/publications/guidance-health-adaptation-planning/en/

Under the United Nations Framework Convention on Climate Change, all countries are conducting National Adaptation Plans (NAPs).

Guidance on conducting NAPs was developed by the Least Developed Country Expert Group (LEG) << *http://unfccc.int/adaptation/groups_committees/ldc_expert_group/items/4727.php*>>. WHO developed guidance for Ministries of Health to develop the health components of the NAPs. The guidance is designed to fit within the national health process.

Source: *WHO. 2014. WHO guidance to protect health from climate change through health adaptation planning. http://www.who.int/globalchange/publications/guidance-health-adaptation-planning/en/*

18



Source: WHO (2014)

A core component of a HNAP is conducting a vulnerability and adaptation assessment. The process for doing so is outlined in the figure. CLICK to animate the figure to fill the screen.

WHO has a guidance document on conducting such an assessment << *http://www.who.int/globalchange/publications/Final_Climate_Change.pdf*>>.

The three categories of activities are:

1. Framing and scoping the assessment
2. Conducting the assessment, and
3. Managing and monitoring risks.

This guidance document is being used to conduct vulnerability and adaptation assessments in Asia and the Pacific.

Source: *WHO. 2014. Operational framework for building climate-resilient health systems.*

19

Box 5: Conducting a health V&A in Mongolia

Mongolia conducted a health V&A in 2009 with the goal of determining the associations between weather and climate and health, and to use that information to make recommendations for further action.[15] The specific objectives were to analyse associations between weather and climate and the health impacts of air quality, water availability and quality, extreme weather events, and infectious diseases. Associations were analysed to understand morbidity and mortality trends in relation to weather patterns, to identify key vulnerabilities, and to develop recommendations for adaptation and mitigation strategies to manage the health risks of climate change.

Extensive data sets were collected from relevant ministries and analysed for each topic, quantifying exposure-response relationships, identifying vulnerable groups, and recommending policies and measures to increase resilience to climate change. For example, the recommendations for air quality were as follows.

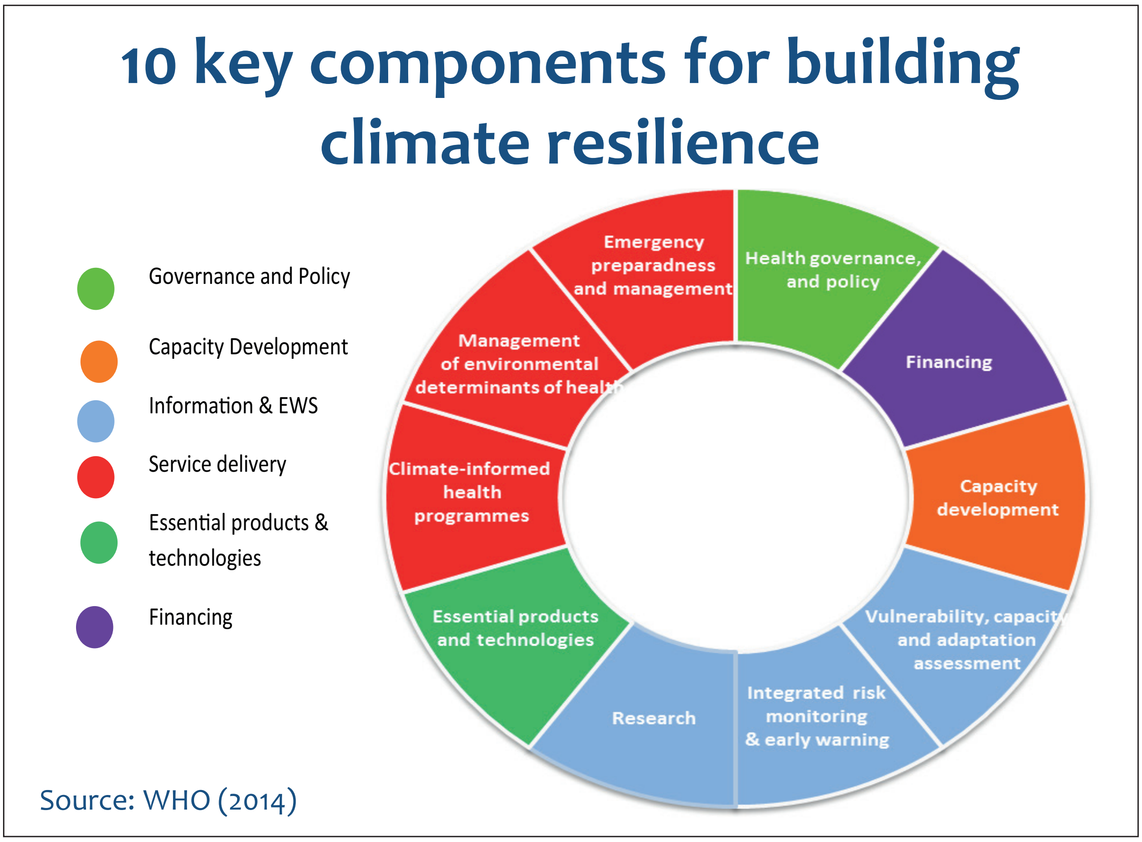
1. Revision and improvement of legislative environment:
   a. review and change relevant laws;
   b. add the issue of climate change and health to the national security concept;
   c. develop and implement strategy and programme.
2. Improvement of air quality monitoring to:
   a. measure O3, PM10, PM2.5, CO;
   b. increase number of monitoring stations.
3. Expansion of cooperation to improve research capacity.
4. Health sector strengthening on health data reporting system (to provide daily morbidity and mortality data).
5. Early warning system on climate change and air pollution.
6. Training and education on climate change and air pollution.

Source: WHO (2014)

The box provides an example of conducting a comprehensive health vulnerability and adaptation assessment in Mongolia. The box summarizes the goal and objectives of the assessment are stated, the approaches for conducting the assessment, and example recommendations for air quality. This is one of many examples in the guidance document, to help countries as they conduct their vulnerability and adaptation assessments.

Source: *WHO. 2014. Operational framework for building climate-resilient health systems.*

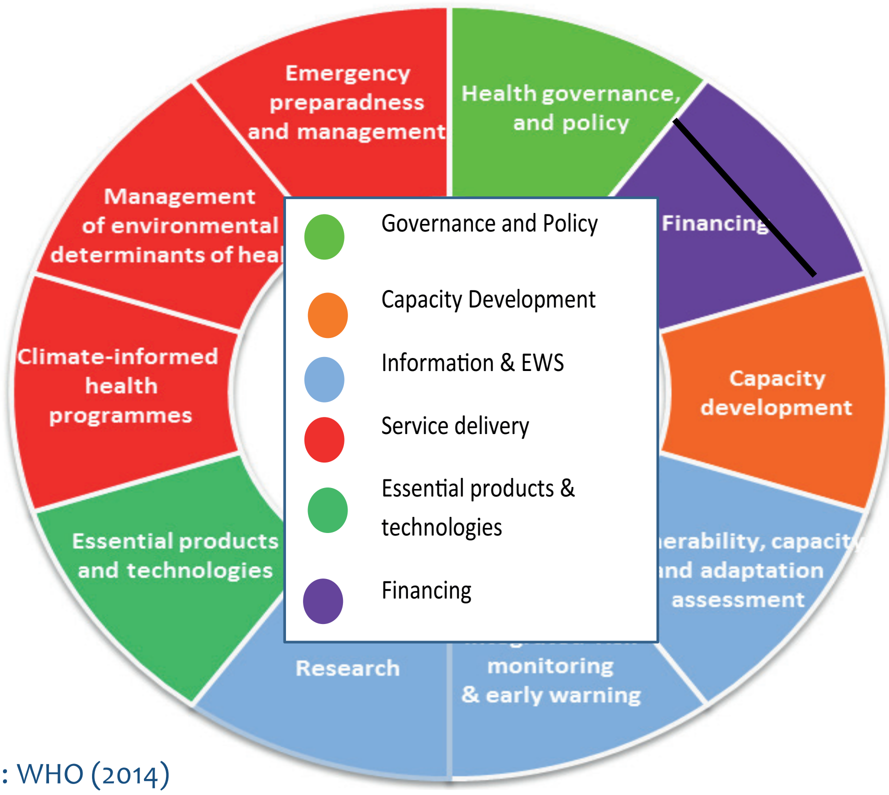
20



The figure shows the ten key components for building climate resilience from the WHO operational framework for building climate-resilience health systems. The components are categorized into those whose primary focus is risk management, information, or foundational activities. The HNAP should identify priority adaptation policies and programmes to promote resilience within those components where the country needs are the largest to effectively manage the health risks of climate change.

Source: *WHO. 2014. Operational framework for building climate-resilient health systems.*

21



Source: WHO (2014)

Reflection exercise:

I'd like to give you a chance to reflect on your own country's vulnerability now. Next we're going to look at the HNAP and HIA as a comprehensive way to assess your country's vulnerability to health impacts from climate change – these will be key tools for you to take away in your ongoing work to reduce vulnerability.

But within the space of this session, I'm going to give you some time – about **4 minutes** – to do a very initial and informal assessment of roughly how your country is performing in each of these 10 areas that contribute to climate resilience.

In your slide notes, please take your pen and draw a line across each section of this pie at the level – out of 10 – that you think your country is performing at. For example, if your country generally has good financing available for programmes targeting climate change and the health impacts of climate change, you might draw a line like this, towards the outer edge of the pie section – **CLICK** to show curved line. The closer to the outside of the pie your lines are, the more resilient you think your country is in this particular area. If sections have lines closer to the inside of the circle, this would be an area you think your country is much less climate resilient in.

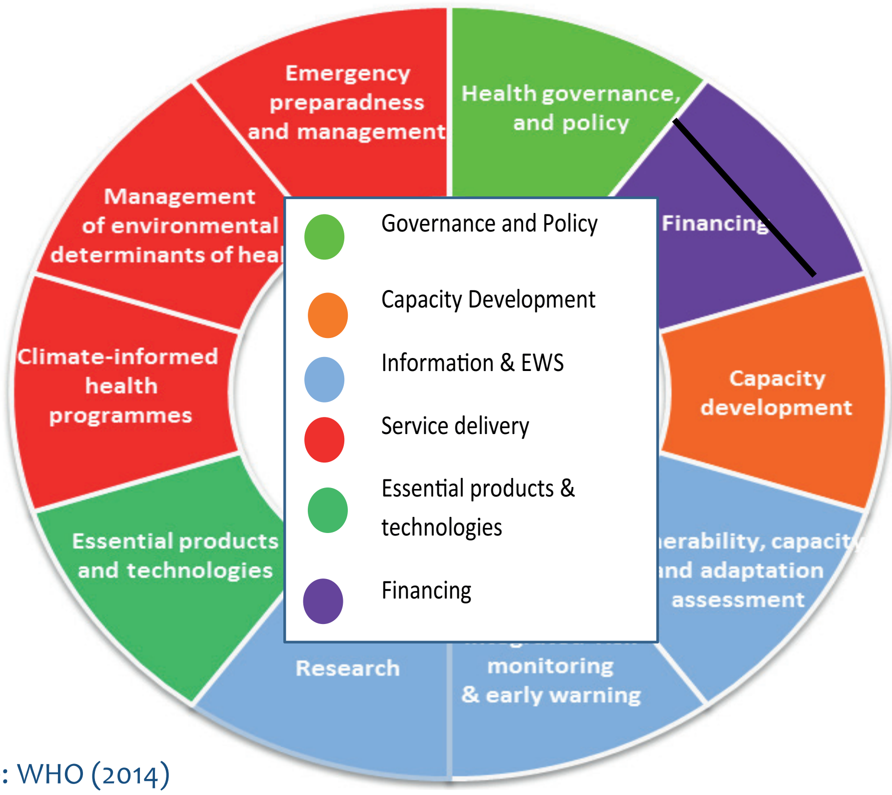
So over the next 4 minutes consider each pie section and draw a line somewhere across each section, with 0 – not resilient - on the inner ring and 10 – very resilient - on the outer ring.

Are there any questions? No? Ok, please do your rough spider diagram."

Give time countdown: **3 mins** "You have another minute to finish off.

4 mins: "Ok, now that you have a rough spider diagram of the resilience of your country in these 10 areas, I'd like you to pair up with a person near you and share the key areas where you think your country is most resilient, and those where you think you are least resilient to climate change.

21



Source: WHO (2014)

You'll have 45 seconds each to share, so these will be only the 2 – 3 most resilient and least resilient areas you'll be sharing.

Give swap over instruction at **1 minute**.

At **2 minutes**: "Ok, thank you for sharing."

To finish off, I'm curious about which categories of these 10 components you think your country is *least* resilient in. Have a look again at the category titles for the section colours – **CLICK twice** to show – Government & policy, capacity development, information & early warning systems, essential products & technologies, and financing, and where your lowest lines where, closest to the inner ring.

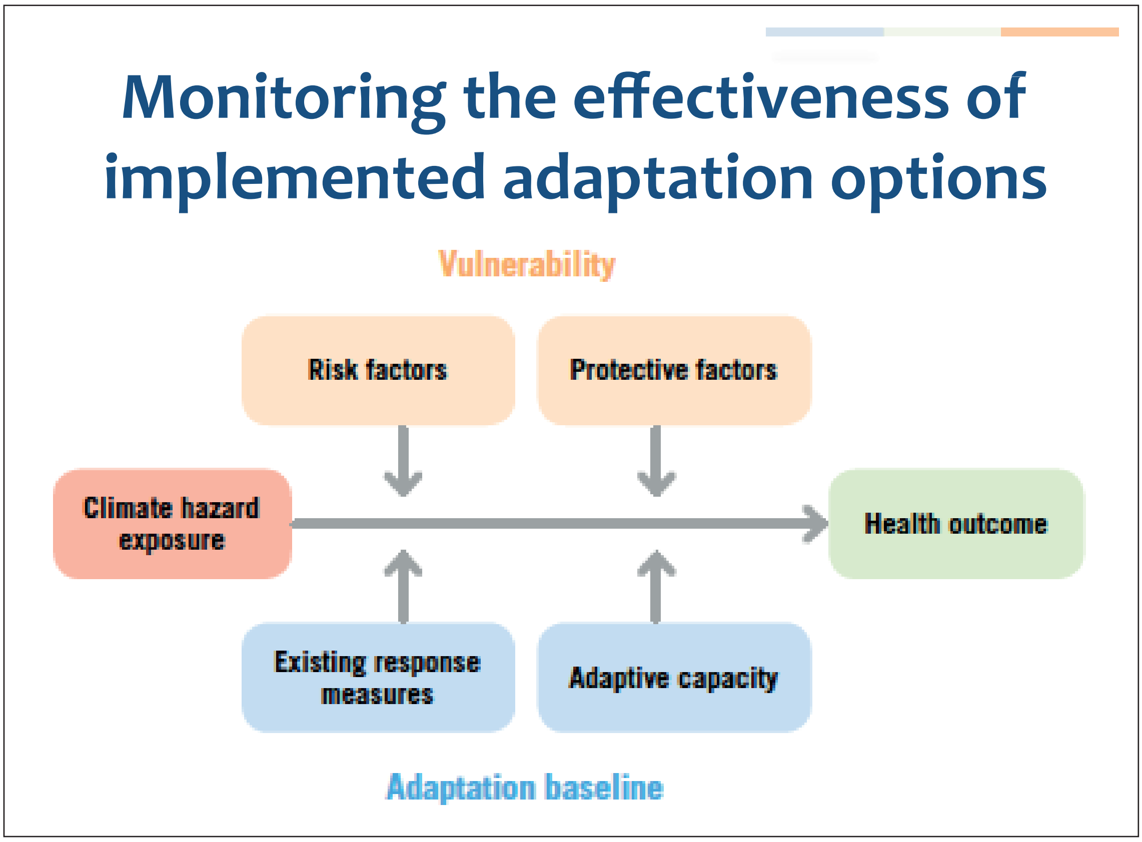
Can I get you to raise your hand as I name each category if that was an area where your lowest lines occurred?"

Read each, slowly, raising your own hand as you say the category title to model the behaviour you're seeking. Allow enough time between each category that people can look around the room to get a sense of areas that other countries may also be less resilient in.

- Government & policy
- Capacity development
- Information & early warning systems
- Essential products & technologies; and
- Financing

"Thank you, that's an interesting indicative exercise that might give us a sense of some of the key areas that will feature in the HNAP's developed by a range of countries."

22



When a HNAP is developed, an important component is indicators for monitoring the effectiveness of adaptation options that have been implemented.

From the perspective of vulnerability, indicators should be identified for monitoring changes in risk and protective factors. From the perspective of the level of adaptation before the HNAP was conducted, indicators should be identified for monitoring changes in the effectiveness of existing response measures and in the community/national capacity to prepare for, respond to, cope with, and recover from the health risks of climate change. These four factors are mediators of the extent to which exposure to the hazards of climate change are translated into health impacts.

Let's look next at a Health Impact Assessment and what that would be made up of.

Source: *WHO. 2014. WHO guidance to protect health from climate change through health adaptation planning*

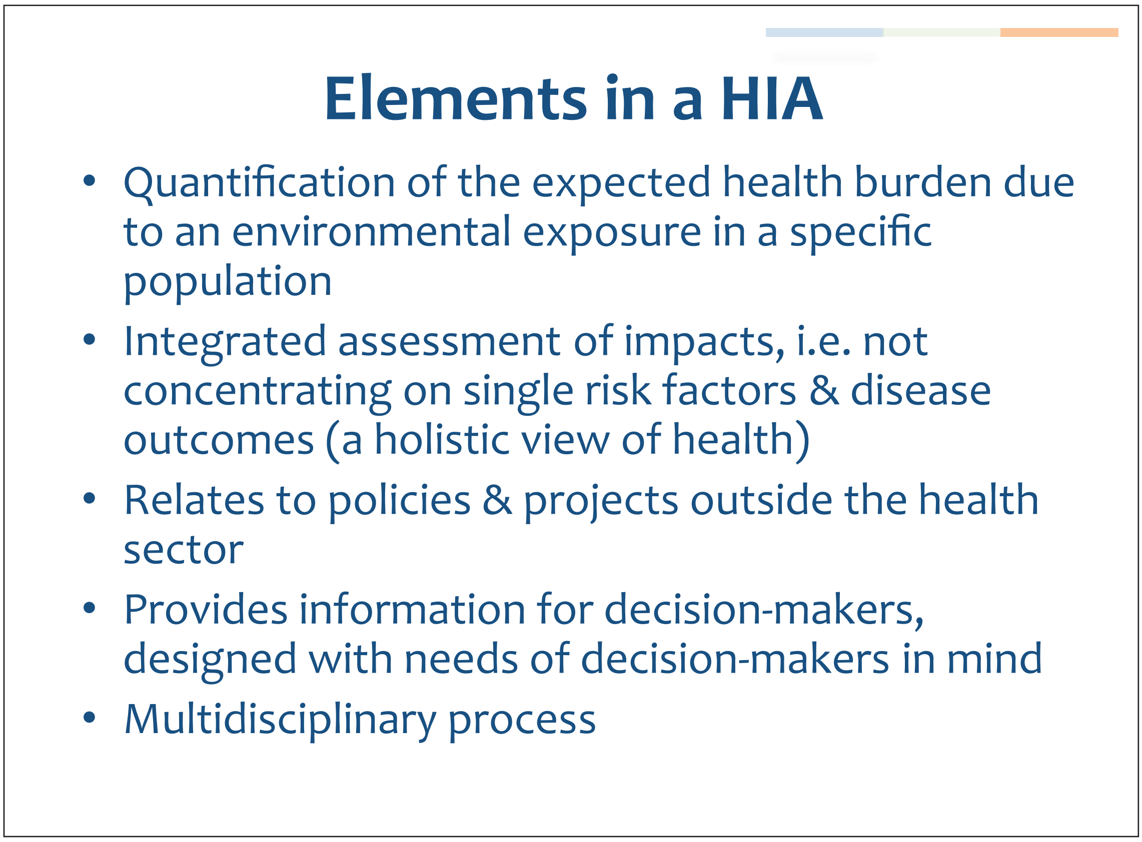
23

Health Impact Assessment (HIA)

A combination of procedures, methods & tools by which a policy, project or hazard may be judged as to its potential effects on the health of a population, & the distribution of those effects within the population

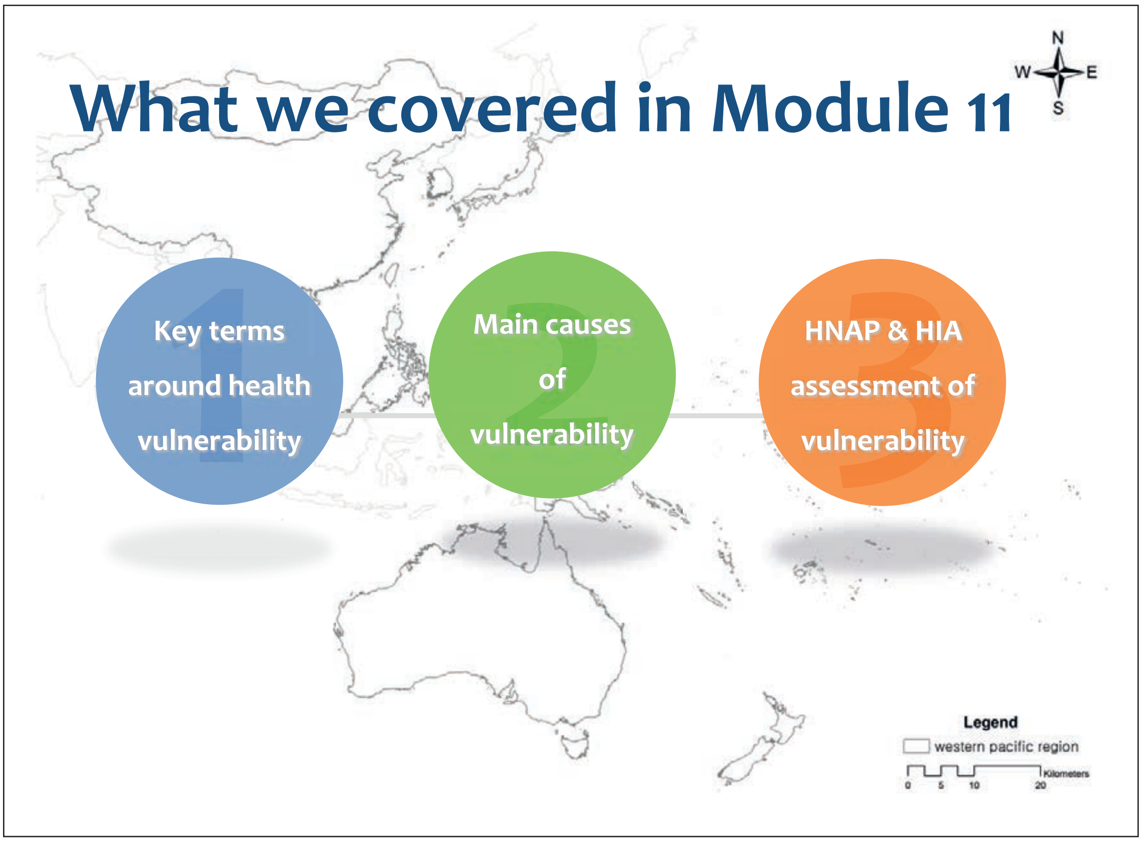
A Health Impact Assessment is a combination of procedures, methods & tools by which a policy, project or hazard may be judged as to its potential effects on the health of a population, & the distribution of those effects within the population

An adaptation assessment can be considered as part of a health impact assessment.



This lists the standard elements of a health impact assessment - **CLICK** to animate each one (5 in total)

25



In Module 11 we covered:

1. A definition of key terms around health vulnerability
2. The main causes of vulnerability to disease and injury resulting from climate change, and
3. Describing the HNAP and the Health Impact Assessment approaches to assessing vulnerability.

Learning from Module 11

The health impacts of climate change will be inequitably distributed within & between countries

"The rich will find their world to be more expensive, inconvenient, uncomfortable, disrupted & colorless — in general, more unpleasant & unpredictable, perhaps greatly so. The poor will die."

- Kirk R. Smith (2008)

University of California, Berkeley

One of the key take aways from this module is that the health impacts of climate change will be inequitably distributed within and between countries. Given this message, it is important to improve our understanding of communities' differential levels of vulnerability, in order to prioritise limited resources. Unless we have this understanding of different types and levels of vulnerability, then it is virtually impossible to design responses that meet the needs of communities.

Source: *Smith, K. (2008).Mitigating, adapting and suffering. How much of each? Annual Review of Public Health (29) (doi:10.1146/annurev.pu.29.031708.100011)*

27

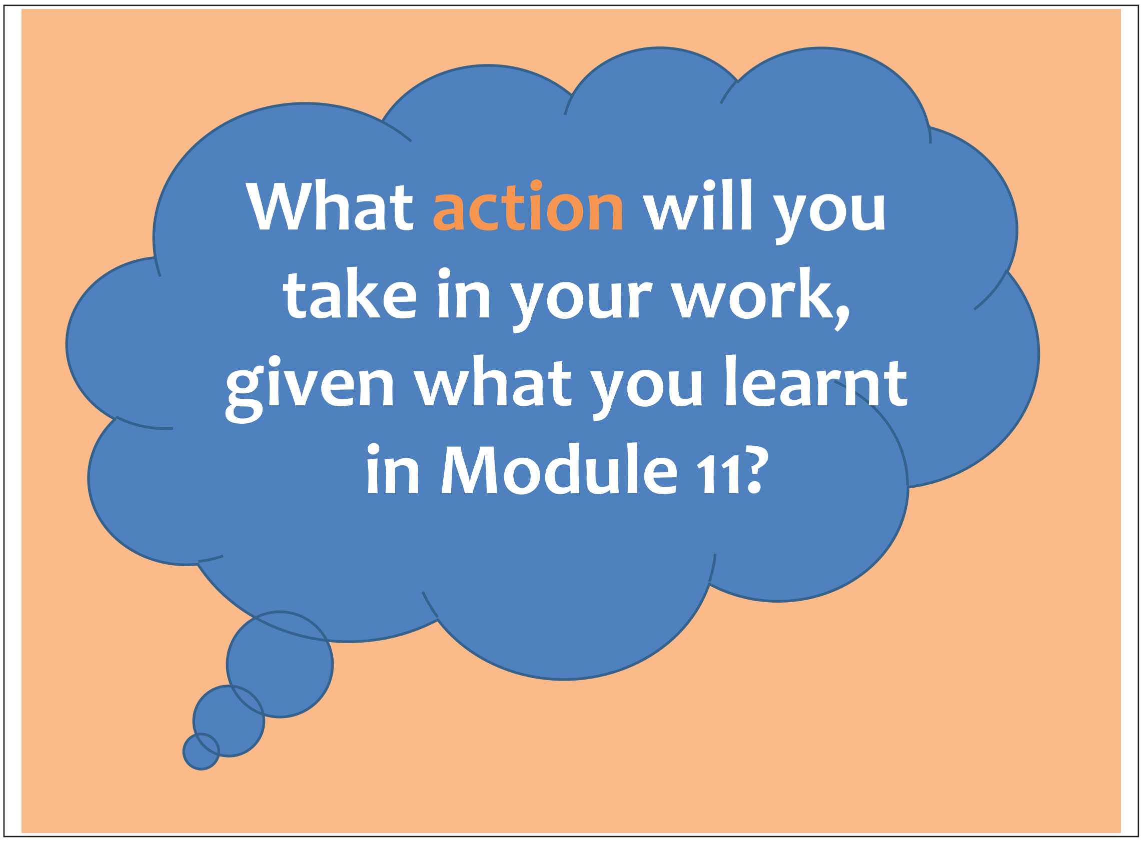
Learning from Module 11

- Vulnerability is the propensity to be adversely affected
- Causes of vulnerability include biological characteristics, the physical environment, social circumstances & national & international politics
- Vulnerability can be assessed using HIA & HNAP
- Many facets of vulnerability means many opportunities for intervention

Key learnings around assessing health vulnerability to climate change are: (CLICK to animate four points)

1. Vulnerability is the propensity to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
2. The causes of vulnerability fall across a spectrum, ranging from biological characteristics of organisms to the terms of international trade.
3. Framing vulnerability in this way is not to suggest the phenomenon is too big and wide to grasp. To the contrary, the many facets of vulnerability mean there is a correspondingly wide range of opportunities for intervention at the various levels.
4. And finally, an important point: many of the causes of vulnerability to climate change make individuals and populations susceptible to other environmental threats as well. As a result, intervention to reduce vulnerability to climate change will bring other benefits, and these will very likely be evident before the full impact of climate change is apparent.

28



To finish off Module 11, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around assessing health vulnerability.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes**: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 12

Adaptation to climate change

Key learning messages in Module 12

- Strong health systems are essential for adaptation
- Importance of developing climate-resilient health systems.

Estimated length: 60 minutes

Structure of Module 12

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. The theory and practice of adaptation	4–14	
2. The process of conducting an adaptation assessment	15–30	EXERCISE on slide 23: Has your country conducted a vulnerability and adaptation assessment? What was the process & outcome? Ask for volunteer input and gather 3 – 5 quick responses. Likely 5 minutes.
3. Examples of adaptation activities in the WP and SEA region	31–39	
Module outline	40	
Learning from Module 12	41	
Learning reflection, action generation	42	

Required resources

- Data projector and slide changer
- Module 12 slides.

Instructions for delivery of Module 12

The adaptation assessment process and slides 15 – 30 may seem technical to some participants. Ensure that you're familiar with the process of conducting an adaptation assessment before delivering the module. It's also valuable to emphasise the practical benefits of carrying out an adaptation assessment to participants, helping prepare countries to implement programs that will make them more ready to face the impacts of climate change, and therefore reduce the burden on health.

Key terms introduced in Module 12

- Adaptation
- Health National Action Plan
- National Action Plan
- Adaptation assessment
- Framework for Adaptation
- Vulnerability and adaptation assessment
- Adaptation policies and measures
- Adaptation baseline
- Surveillance system

References (in order of presentation)

- WHO. 2013. *Protecting Health from Climate Change: Vulnerability and Adaptation Assessments*.
- IPCC. 2013. *Fifth Assessment Report, Chapter 11*.
- UK Climate Impacts Programme. 2006. UKCIP Experience: NCSP Workshop on Vulnerability and Adaptation Assessment under the Second NatioNational Communications Meeting.
- WHO. 2013. Protecting Health from Climate Change: Vulnerability and Adaptation Assessments. http://www.who.int/globalchange/publications/Final_Climate_Change.pdf. Slide 17
- McMichael A.J., D. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga, and A. Woodward (eds.). 2003a. Climate change and human health: Risks and responses. WHO/WMO/UNEP.
- WHO. 2015. *Case Study: Climate Resilient Health Facilities. A Public Tertiary Health Facility in Surat, Western India responds to the Challenge of Floods. Slide 34*
- WHO. 2015. *Case Study: Climate Based Early Warning System. Sea Surface Temperature in the South Atlantic helps predict Malaria Outbreaks in distant India. Slide 35*
- United Nations Environment Program. 2014. *Adaptation Technologies Mongolia, Disaster Warning Systems*. http://www.unep.org/roap/Portals/96/Compendium%20Report_Mongolia_Final.pdf.
- UK Climate Impacts Programme 2006. UKCIP Experience: NCSP Workshop on Vulnerability and Adaptation Assessment under the Second NatioNational Communications Meeting.

Module 12: Adaptation

In Module 12 we're going to look in more depth at adaptation to climate change, and how this can occur in your country.

2

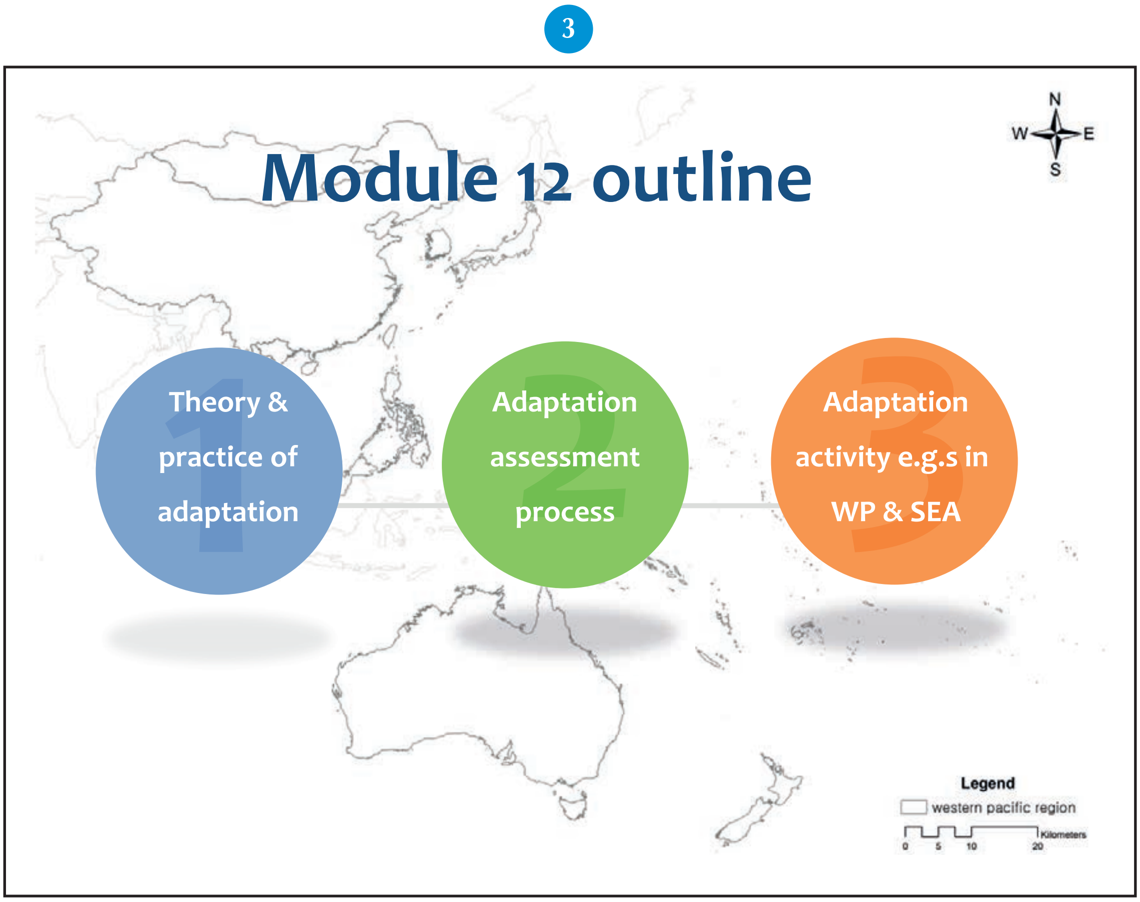
Key messages in Module 12

- Strong health systems are essential for adaptation
- Importance of developing climate-resilient health systems

There are two key messages in this module:

The first is that strong health systems are essential for adaptation. Indeed, strong health systems are essential for most effective responses, whether that is in relation to an infectious diseases outbreak, such as what we saw in 2014 with Ebola, or whether that is in relation to provision of effective health services to respond to a natural event like an earthquake or tornado. Here, again we can see the utility of the 'win-win' argument – i.e. if we invest in health systems, then this is effectively investing in a whole range of health-relevant responses, including risks from climate change.

This links in with the second key message here – the importance of developing climate-resilient health systems. These are health systems that can bounce back, and perhaps even transform, after a weather event such as a storm or flood. In the long-run, supporting climate-resilient health systems that can respond effectively to such threats, is a sustainable approach, as they save both money, time and lives.



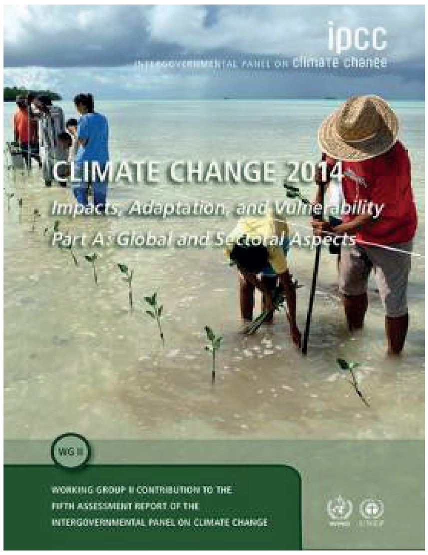
This module on adaptation has three key areas:

1. The theory and practice of adaptation
2. The process of conducting an adaptation assessment
3. Examples of adaptation activities in the WP and SEA region.

4

1

Theory & practice of adaptation



Let's begin by looking at the theory and practice of adaptation to climate change

5

Adaptation

Definition:

Actions taken by individuals, institutions, corporate sector & governments to address the risks of climate change directly or indirectly through addressing factors that increase vulnerability

Goal of adaptation: to prepare for, & effectively respond to, the health risk of climate change

- Adaptation can be:
  - Anticipatory
  - Responsive

As discussed in an earlier module, adaptation includes the strategies, policies, and measures undertaken now and in the future in all sectors to reduce potential adverse effects of climate change. These strategies, policies, and measures can address the risks of climate change directly (i.e., developing early warning systems) or indirectly (i.e., improving the public health infrastructure).

A primary goal of building adaptive capacity is to avoid, prepare for, and effectively respond to the health risks of climate change. Adaptation actions will be taken at all levels, including our individual actions as well as programmes and activities implemented by the corporate sector, national agencies and institutions. These actions can be proactive, anticipating adverse health outcomes, or in response to observed climate change.

6

Adaptation

The process of adaptation can be:

– **Incremental** - actions where the central aim is to maintain the essence & integrity of a system or process at a given scale

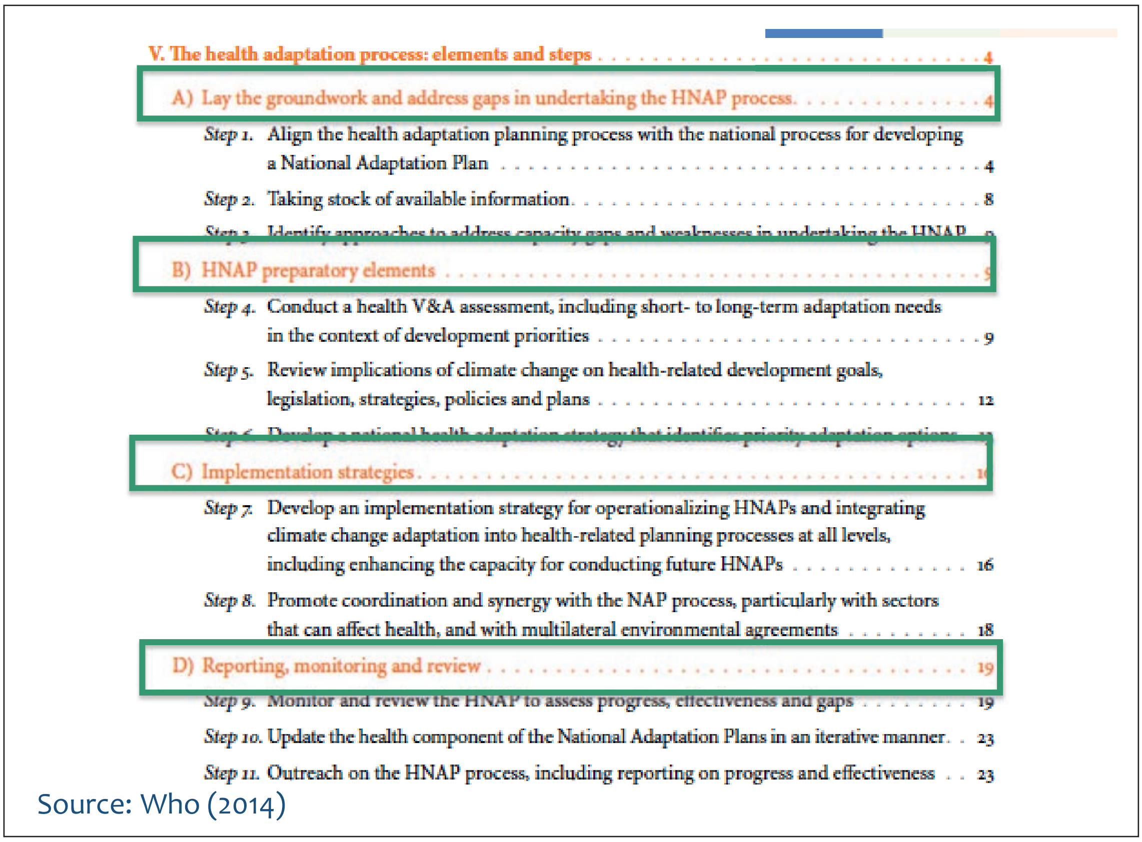
OR

– **Transformational** - changes the fundamental attributes of a system in response to climate & its effects

The process of adaptation can be incremental or transformational.

Adaptation measures can modify current programmes, such as changing the location and/or intensity of vector control programmes to prepare for projected changes in the geographic range or incidence of vector-borne diseases. Or, adaptation measures can be designed to address new risks, such as those due to glacier lake overflows.

7



Source: Who (2014)

This slide lists the steps in a HNAP process. The categories are the same as those in the guidance from the LEG, but the steps were slightly modified to be consistent with the approaches and methods typically used in health assessments. The guidance document provides details on each step.

CLICK to highlight each of the four steps.

Step 1 is: Laying the groundwork and addressing gaps in undertaking the HNAP process

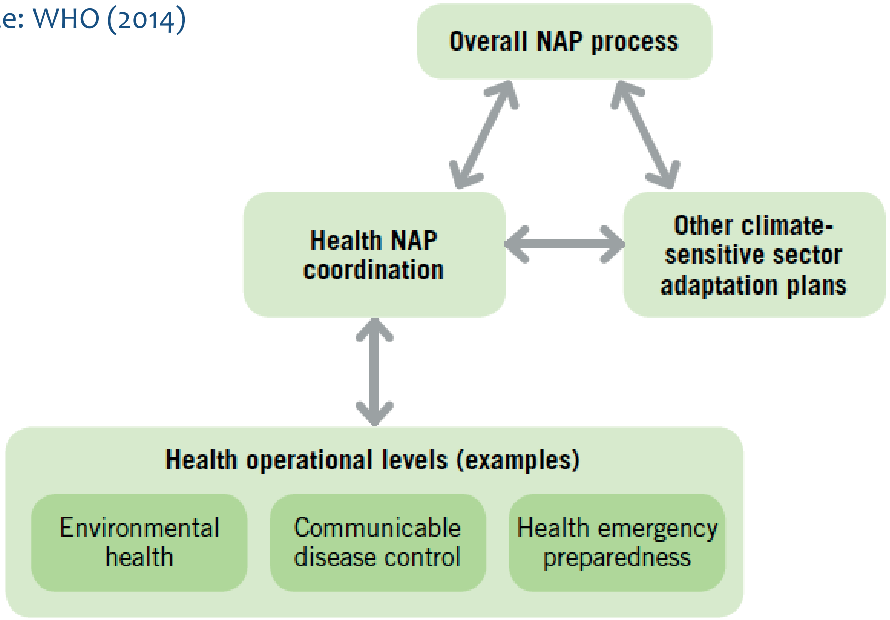
1. HNAP preparation
2. Developing a strategy for implementation; and finally
3. Reporting, monitoring and reviewing on the HNAP

Source: *WHO "Protecting Health from Climate Change: Vulnerability and Adaptation Assessments" 2014*

8

Integrating an HNAP within the NAP process & existing national health planning

Source: WHO (2014)



The figure summarizes the components necessary for integrating the HNAP within the overall NAP process. It highlights that the HNAP needs to work directly with operational levels within health systems.

Source: *WHO "Protecting Health from Climate Change: Vulnerability and Adaptation Assessments" 2014*

9

E.g.: Baseline measures for monitoring the effects of climate change on malnutrition

	Vitamin and mineral deficiencies	% or number (x1000) of children with anaemia younger than the age of 5 years % of clinical vitamin A deficiency in women % of households consuming adequately iodized salt - 15 parts per million or more	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/) (http://www.who.int/hia/green_economy/indicators_food.pdf)
	Nutritional status	Proportion of undernourished (as a percentage of the total population)	IFPRI Global Hunger Index (http://www.ifpri.org/book-8018/ourwork/researcharea/global-hunger-index)
	Food-borne illnesses	Prevalence of foodborne diseases Incidence of foodborne disease outbreaks Proportion of foods marketed that comply with international trade standards for hormone, pesticide, antibiotic residues as well as other chemical, microbiological food safety parameters.	WHO GEMS Food Contamination Monitoring and Assessment Programme (http://apps.who.int/nutrition/landscape_analysis/nlis_gem_food/en/index.html) (http://www.who.int/hia/green_economy/indicators_food.pdf)
	Infant and young child feeding	% of infants under 6 months of age who are exclusively breastfed % of infants aged 6–8 months who receive solid, semi-solid or soft food % of children aged 6–23 months who receive a minimum acceptable diet	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/)
	Health interventions and adaptation responses	% of women receiving daily iron (60mg) and folate (400µg) supplements during pregnancy % of children with diarrhoea receiving oral rehydration therapy and continued feeding Number of occupational trainings conducted to facilitate search for new livelihood opportunities	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/) (http://www.fao.org/forestry/15538-079b31d45081fe9c3dbc6ff34de4807e4.pdf)
Environment	Climate	Annual freshwater withdrawals, total (billion cubic metres) Agricultural irrigated land (% of total agricultural land) Early warning systems on reduced rainfall and emerging food safety crisis situations (e.g. FEWS)	UNDP Country Climate Change Profiles (http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/) World Bank Climate Change Knowledge Portal (http://sdwebx.worldbank.org/climateportal/index.cfm) (http://data.worldbank.org/indicator) (http://www.epa.gov/climatechange/pdfs/climateindicators-full-2012.pdf)

Source: WHO (2014)

The table I'm about to show provides examples of essential baselines for monitoring the effects of climate change on undernutrition. (**CLICK** to go to next slide to show table in full.)

Source: *WHO "Protecting Health from Climate Change: Vulnerability and Adaptation Assessments" 2014*

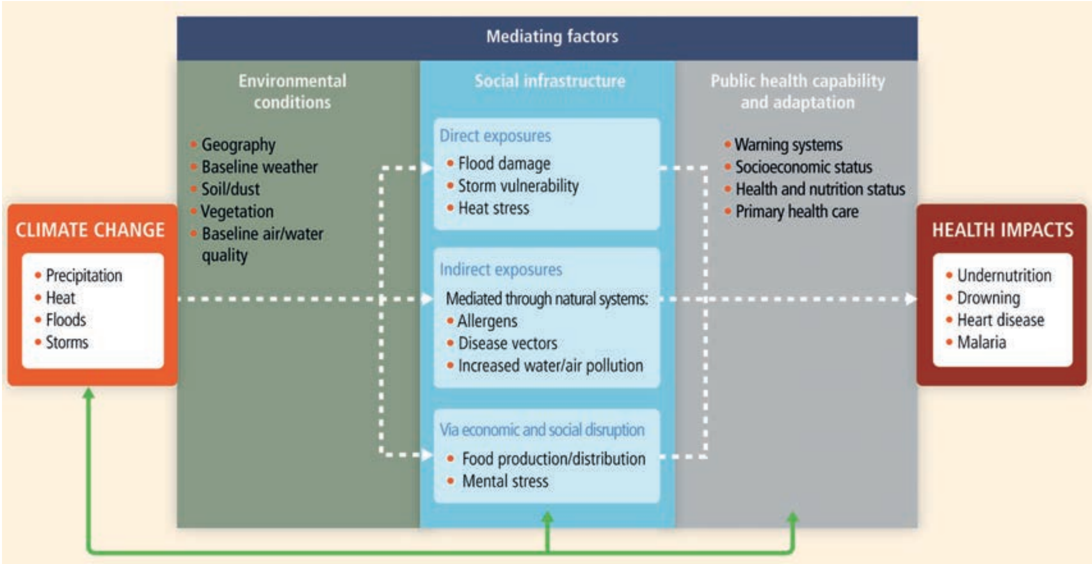
10

Sector	Factor	Measure	Existing resource
Health	Health effect of malnutrition in children[21]	% of children underweight (weight for age below 2 SD of WHO Child Growth Standards median)[22] % of stunted children (height for age below 2 SD of WHO Child Growth Standard median) % or number of newborns (x 1000) with low birth weight (<2500 grams)	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/)
	Vitamin and mineral deficiencies	% or number (x1000) of children with anaemia younger than the age of 5 years % of clinical vitamin A deficiency in women % of households consuming adequately iodized salt - 15 parts per million or more	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/) (http://www.who.int/hia/green_economy/indicators_food.pdf)
	Nutritional status	Proportion of undernourished (as a percentage of the total population)	IFPRI Global Hunger Index (http://www.ifpri.org/book-8018/ourwork/researcharea/global-hunger-index)
	Food-borne illnesses	Prevalence of foodborne diseases Incidence of foodborne disease outbreaks Proportion of foods marketed that comply with international trade standards for hormone, pesticide, antibiotic residues as well as other chemical, microbiological food safety parameters.	WHO GEMS Food Contamination Monitoring and Assessment Programme (http://apps.who.int/nutrition/landscape_analysis/nlis_gem_food/en/index.html) (http://www.who.int/hia/green_economy/indicators_food.pdf)
	Infant and young child feeding	% of infants under 6 months of age who are exclusively breastfed % of infants aged 6–8 months who receive solid, semi-solid or soft food % of children aged 6–23 months who receive a minimum acceptable diet	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/)
	Health interventions and adaptation responses	% of women receiving daily iron (60mg) and folate (400μg) supplements during pregnancy % of children with diarrhoea receiving oral rehydration therapy and continued feeding Number of occupational trainings conducted to facilitate search for new livelihood opportunities	WHO Nutrition Landscape Information System (NLiS) (http://www.who.int/nutrition/nlis/en/) (http://www.fao.org/forestry/15538-079b31d45081fe9c3dbc6ff34de4807e4.pdf)
Environment	Climate	Annual freshwater withdrawals, total (billion cubic metres) Agricultural irrigated land (% of total agricultural land) Early warning systems on reduced rainfall and emerging food safety crisis situations (e.g. FEWS)	UNDP Country Climate Change Profiles (http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/) World Bank Climate Change Knowledge Portal (http://sdwebx.worldbank.org/climateportal/index.cfm) (http://data.worldbank.org/indicator) (http://www.epa.gov/climatechange/pdfs/climateindicators-full-2012.pdf)

You can see that the table gives examples for the health and environment sectors. Various measures are listed as well as the source of data.

11

Ways climate change affects health



Source: IPCC (2013)

The next two slides are familiar diagrams from earlier modules, but important to reacquaint ourselves with.

In terms of understanding how exactly climate change affects health, and increases vulnerability, it is helpful to look at this diagram, which we saw in Module 2 – Pop. Health and Climate).

This diagram from the IPCC AR5 report shows three primary exposure pathways by which climate change affects health:

- directly through weather variables such as heat and storms;
- indirectly through changes in natural systems that in turn affect disease vectors; and
- pathways heavily mediated through human systems such as undernutrition.

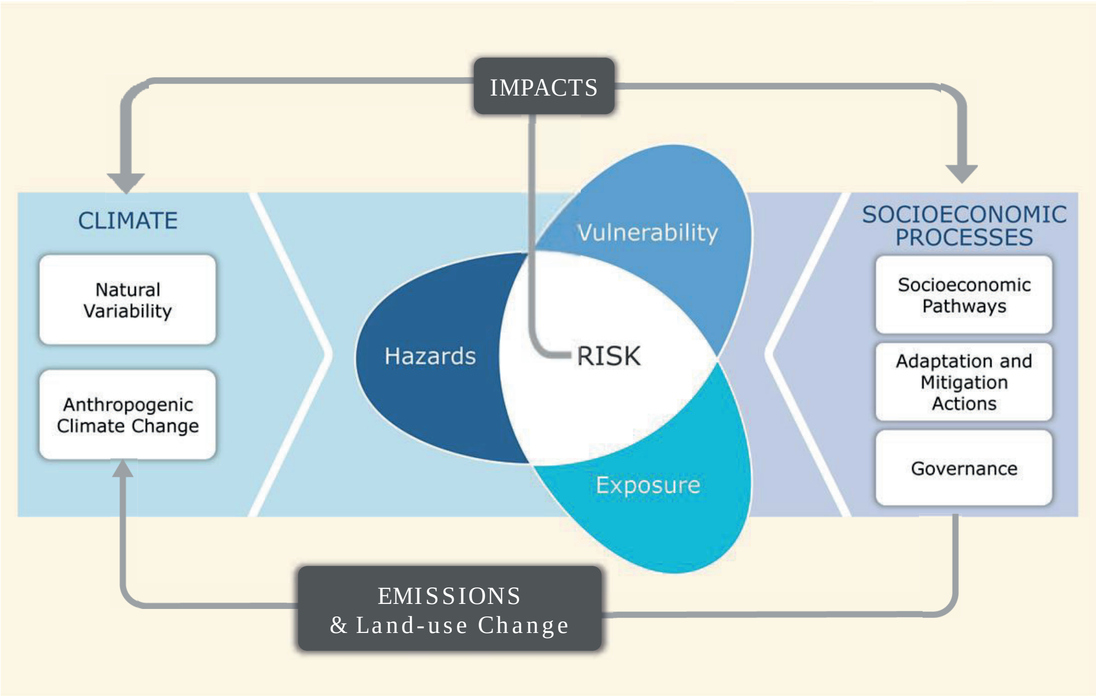
The yellow box indicates the moderating influences of local environmental conditions on how climate change exposure pathways occur in a particular population.

The orange box indicates that the extent to which the three categories of exposure translate to actual health burden is moderated by such factors as background public health systems and socioeconomic conditions, and adaptation measures.

The green arrows at the bottom indicate that there may be feedback mechanisms, positive or negative, between societal infrastructure, public health, and adaptation measures and climate change itself.

Source: *IPCC. 2013. AR5 Chapter 11*

12



Source: IPCC (2013)

This diagram is from the latest IPCC report (AR5). In it, we can see that risk is at the centre of the framework, and arises from the combination of vulnerability, exposure and hazards. The pressures indicated on the left and the right of the diagram influence these factors. Climate (natural variability and anthropogenic climate change) is of course one of the key determinants of hazards, and influences exposure and vulnerability. Socioeconomic processes on the right include socioeconomic pathways (e.g. development trajectories), action taken on adaptation and mitigation, and governance (e.g. types of decision-making that is occurring to respond to climate change, such as regulation of GHG emissions through a carbon tax); these strongly influence vulnerability and hazard. Future risks that individuals and communities face arise from the interactions of exposure, vulnerability and hazards, and are influenced by climate and development. This in turn determines the level of impacts from changes in the climate. This diagram highlights that we need to look at the system as a whole to understand risks and impacts. Although we can assess (e.g.) mitigation actions and exposure to weather events separately, it is the combination of all of these components shown in the diagram that gives us a holistic picture of the overall risks.

Source: *IPCC. 2013. Fifth Assessment Report.*

13

Context for adaptation

- Climate change is one of many factors influencing human health & social well-being
  - In most cases, it multiplies the threats of current drivers of climate-sensitive health outcomes
- Public health challenges presented by climate change need to be addressed within the context of issues such as access to clean water & sanitation, inadequate nutrition, & diseases such as HIV/AIDS
- Poverty is a major factor

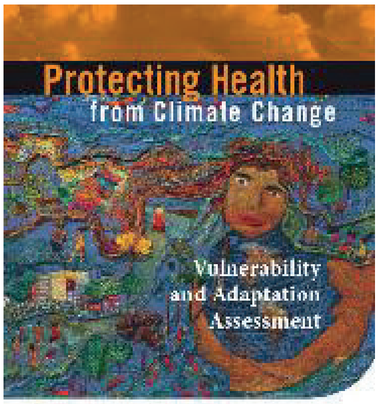
Also, as has been mentioned before, climate change is a stress multiplier for most climate-sensitive health outcomes. Therefore, effectively reducing the health risks of climate change means improving current health protection through addressing the key drivers of these health outcomes, within the context of other major health concerns.

A recurring theme throughout this training has been the importance of understanding the local context when conducting vulnerability and adaptation assessments. As noted on the slide, there are a wide range of factors that will influence the extent of risk and the options available for implementation. These range from political, social, economic, through to technological and human factors, which all determine whether adaptation activities are relevant and effective. Thus, we need to have a good understanding of the context we are working within, in order to account for differences in culture, education, knowledge and other factors to really design adaptation activities that are going to be effective, appropriate, and 'owned' by the community.

15

2

The process of conducting an adaptation assessment

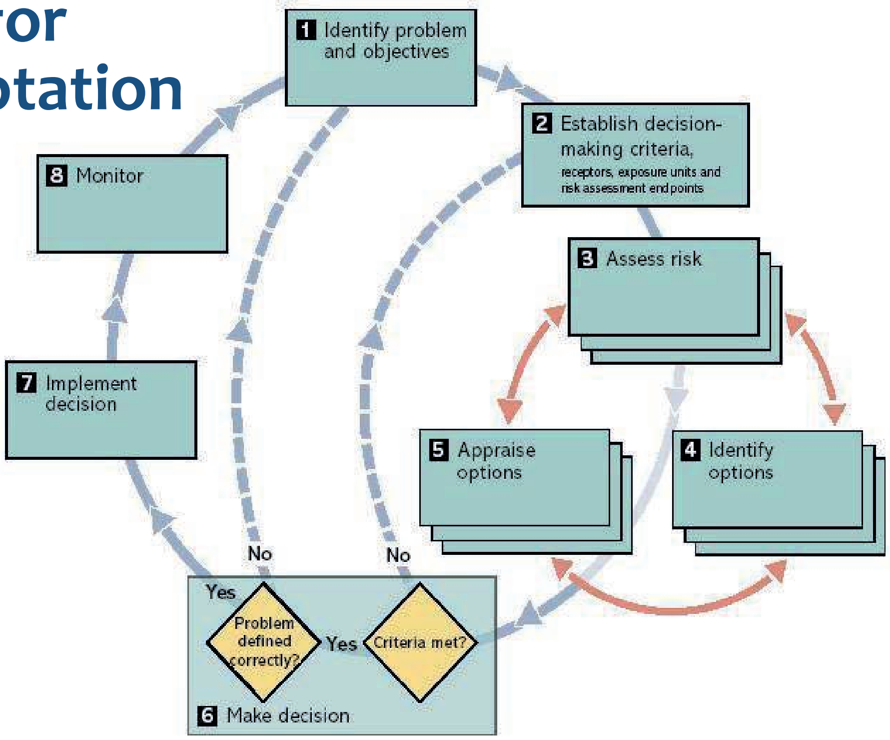


Now that we've covered some of the basics on climate change adaptation, let's look at the process of conducting an adaptation assessment.

16

Framework for Adaptation

Source: UK Climate Impacts Programme (2006)



This slide was shown in an earlier module. Conducting an adaptation assessment within a risk management framework facilitates understanding that adaptation is a process; that options implemented will need to be evaluated as the climate changes to determine their effectiveness under new conditions and to determine if modifications need to be made.

When considering adaptation, the process often is as important as the outcome. Adaptation will be an ongoing process, thus ensuring that the process is appropriate will form an important basis for future efforts. As noted on the slide, adaptation is an expression of values, not just an analytic exercise. Constraints and barriers to implementation need to be explicitly addressed. The process needs to take into consideration that adaptation will affect and be affected by development pathways. Taking a risk management approach will likely be most effective.

Risk management should consider both adaptation and mitigation, as both are needed to effectively manage the immediate and longer-term risks of climate change.

Source: *UK Climate Impacts Programme. 2006. UKCIP Experience: NCSP Workshop on Vulnerability and Adaptation Assessment under the Second NatioNational Communications Meeting.*

17

WHO guidance document on conducting an assessment

Being used to conduct vulnerability & adaptation assessments in Asia & the Pacific

Includes 3 categories of assessment activities:

1. Framing & scoping the assessment
2. Conducting the assessment
3. Managing & monitoring risks

Available at:
http://who.int/globalchange/publications/Final_Climate_Change.pdf

WHO also has a guidance document on conducting such an assessment, called 'Protecting Health from Climate Change: Vulnerability and Adaptation Assessments' << http://www.who.int/globalchange/publications/Final_Climate_Change.pdf>>. The three categories of activities are

1. Framing & scoping the assessment
2. Conducting the assessment, &
3. Managing & monitoring risks.

Source: *WHO. 2013 Protecting Health from Climate Change: Vulnerability and Adaptation Assessments,*

18

First step in an assessment: What is the purpose?

- Who will the audience be?
- What questions would the audience like addressed?
- Information needed to answer the questions?
- How will the final results be most effectively presented?

So, before beginning an adaptation assessment, it is important to understand the reasons for the assessment, including who will be the audience (e.g., national communications, Ministry of Health); the questions they would like addressed; the information needed to answer the questions; and how the final results could be most effectively presented. Taking the time to work through these questions will result in a more effective and efficient process.

19

Steps in an adaptation assessment

1. **Determine the scope of the assessment**
   - Region
   - Health outcome(s)
2. **Identify & convene stakeholders**
3. **Identify & evaluate current strategies, policies & measures to reduce that burden** (adaptation baseline)

These are the basic steps for conducting an adaptation assessment.

The scope of the assessment (in terms of geographic extent, temporal time scale, health outcomes of interest, and other factors) should be written up at the beginning of the process. Ideally, the scoping of the assessment will include stakeholders to make sure the assessment includes their key issues of concern. In any case, stakeholders should be involved throughout the process.

As discussed previously, the team working on the assessment should evaluate the effectiveness of current activities to reduce the burden of climate-sensitive health outcomes, and to determine what additional measures would increase their effectiveness.

20

Steps in an adaptation assessment

4. **Estimate future potential health impacts** using socioeconomic & climate change scenarios
   – Can be qualitative or quantitative

5. **Identify additional adaptation measures** to reduce potential negative health effects

Using qualitative or quantitative methods, estimation of the potential future health impacts will provide the basis for deciding what additional adaptation measures will be needed. Specification of the additional measures should include the geographic area where the measures are to be implemented, the time period for implementation, the mechanisms for implementation, who should be involved, etc.

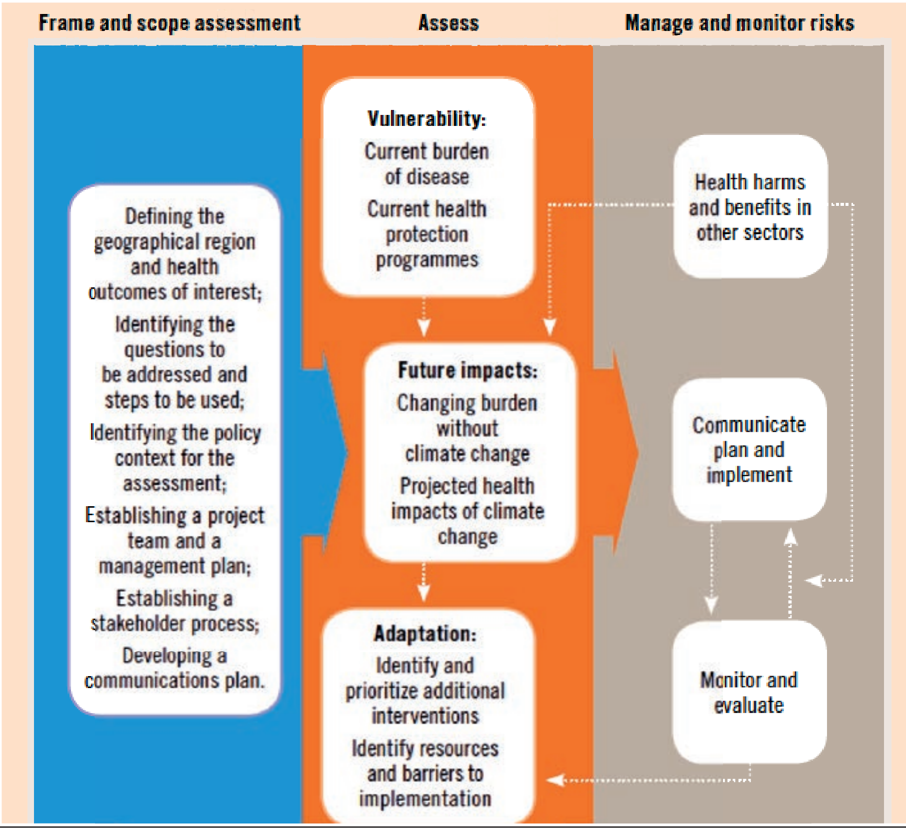
21

Public health adaptation to climate change

- Existing risks
  - Modifying existing prevention strategies
  - Reinstitute effective prevention programs that have been neglected or abandoned
  - Apply win-win or no-regrets strategies
- New risks

Most adaptation options will be implemented to address the existing adaptation deficit (that is, address current vulnerability to climate variability). Existing prevention strategies, such as programmes to address food security, may need to be implemented in new regions. Particularly for the risks of vector-borne diseases changing their incidence or geographic range, a key adaptation may be to reinstitute effective programmes that have been neglected or abandoned. Because of the uncertainties around future projections, whatever options are implemented should be robust to whatever changes occur. New risks also will arise, such as when outbreaks of infectious diseases appear in places where they are unexpected, or through new pathways. Improving the public health infrastructure is needed in many areas to increase the capacity to effectively prepare for and respond to current and new risks.

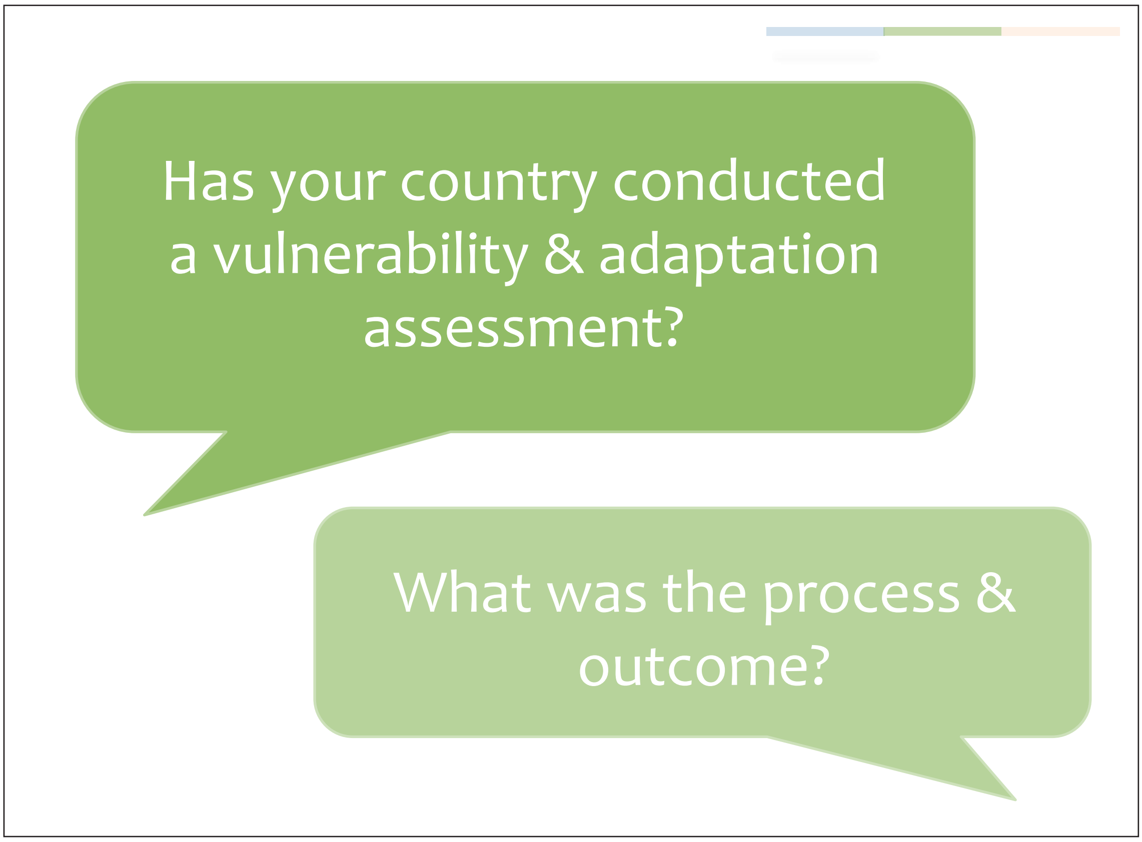
22



Conducting a vulnerability and adaptation assessment is a core component of a Health National Adaptation Plan HNAP. The process for doing so is outlined in the figure. CLICK to animate the diagram to a larger size.

Source: *WHO, 2014. Operational frame work for building climate-resilient health systems.*

23



Ask the group: "Have any of your countries conducted a vulnerability & adaptation assessment? Raise your hand if you have".

"For those of you who have done a vulnerability & adaptation assessment, would you be willing to briefly share what the process was like, and the outcome the assessment created?"

Facilitate input, ideally getting 3 – 5 quick responses. (Likely 5 minutes)

24

Questions for identifying adaptation policies & measures

- Adaptation to what?
- What is the current burden of disease?
- Is additional intervention needed?
- What are the future projections for the climate-sensitive health outcome?
- Who is vulnerable?
- On scale relevant for adaptation?

No matter what process you're using to conduct an assessment, these are questions that can be helpful for identifying adaptation policies and measures.

Adaptation to what – is adaptation required to address the risk of flooding, the spread of vector-borne disease, etc.? The policies and measures implemented must be specific to the weather/climate hazard, the health outcome of concern, and the local context.

When determining whether additional interventions are needed, it is valuable to determine the effectiveness of current interventions before improving current programmes or implementing new ones. Are there additional interventions that could reduce the current burdens of climate-sensitive health outcomes? Would a heat event early warning system be useful? Additional surveillance? Etc.

What are the future projections for the health risks of climate change, taking into consideration changes in not only climate but also socioeconomic conditions?

Which population groups are likely to be at the highest risk? For example, aging of populations in developed countries is likely to increase population vulnerability to heat events.

What scale (local to regional to national) is relevant for the adaptation options under consideration?

The remaining questions are considered on the next slide.

25

Who will undertake the adaptations – individuals, communities, nations? Will the adaptation be reactive to climate change or proactive? How can the process be facilitated?

When should the interventions be implemented? For example, there is concern about malaria spreading to highland areas of Africa. Surveillance systems should be established at the edges of the current distribution where changes in temperature and/or precipitation could provide a suitable climate for malaria vectors. Once surveillance has identified the presence of the vectors, then programmes to distribute treated bed nets could be implemented.

Finally, the effectiveness of all interventions should be monitored and evaluated to ensure that public health funds are being used effectively and efficiently.

26

Adaptation baseline

- What is being done now to reduce the burden of climate-sensitive health outcomes? How effective are these policies & measures?
- What could be done now to reduce current vulnerability? What are the main barriers to implementation (such as technology or political will)?
- What measures should begin to be implemented to increase the range of possible future interventions?

Beginning the process of adaptation will require an understanding of what is currently being done to reduce the burden of climate-sensitive health outcomes, as well as how effective those activities are in addressing climate variability and other factors. Discussions with experts involved with these activities and/or independent evaluations will provide insights into what else could be done now to reduce current vulnerability and the barriers to implementing these activities. Qualitative or quantitative consideration of likely future climate change can identify additional measures to increase the ability of the institutions, agencies, communities, and individuals to increase the range of possible future interventions, such as increasing the geographic extent of integrated vector management programmes in anticipation of disease vectors changing their range.

Particularly vulnerable populations
(using a flood as an example)

- *Glacial lake floods:* Elderly, poor, nomadic, children, disabled or infirm, women, independently living ethnic groups in remote areas
- *Flash:* Everyone in the path of the floods
- *Riverine (plains):* Elderly, poor, nomadic, children, the disabled or sick, women, & people in poor housing, coastal areas, institutions, or on isolated islands

The assessment should focus on addressing particularly vulnerable populations; these are examples for those most at risk from flooding events.

28

Adaptation options to reduce the health impacts of climate change

Health Outcome	Legislative	Technical	Educational & advisory	Cultural & Behavioral
Thermal stress	Building guidelines	Housing, public buildings, urban planning, air conditioning	Early warning systems	Clothing, siesta
Extreme weather events	Planning laws, economic incentives for building	Urban planning, storm shelters	Early warning systems	Use of storm shelters

Source: McMichael et al. (2003)

These are examples of adaptation options categorized into legislative, technical, educational or advisory, and cultural and behavioral. Obviously these are just examples from a much longer list of possible options. The specific options chosen to address a particular risk in a particular location will depend on the local context.

Source: *McMichael A.J., D. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga, and A. Woodward (eds.). 2003a. Climate change and human health: Risks and responses. WHO/WMO/UNEP.*

Adaptation options to reduce the health impacts of climate change

Health Outcome	Legislative	Technical	Educational-advisory	Cultural & Behavioural
Vector-borne diseases		Vector control, vaccination, impregnated bed nets, sustainable surveillance, prevention & control programmes	Health education	Water storage practices
Water-borne diseases	Watershed protection laws, water quality regulation	Screening for pathogens, improved water treatment & sanitation	Boil water alerts	Washing hands and other behaviour, use of pit latrines

Source: McMichael et al. (2003)

These are examples of adaptation options categorized into legislative, technical, educational or advisory, and cultural and behavioural. Obviously these are just examples from a much longer list of possible options. The specific options chosen to address a particular risk in a particular location will depend on the local context.

Q: Are there any questions on the adaptation options I've just outlined?

Source: *McMichael A.J., D. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga, and A. Woodward (eds.). 2003a. Climate change and human health: Risks and responses. WHO/WMO/UNEP.*

30

Steps in an adaptation assessment

1. Determine the scope of the assessment
2. Identify & convene stakeholders
3. Identify & evaluate current strategies, policies & measures to reduce that burden
4. Estimate future potential health impacts
5. Identify additional adaptation measures

To finish off this section on the adaptation assessment process, let's just summarize the four steps in an adaptation assessment again:

1. Determine the scope of the assessment (in terms of geographic extent, temporal time scale, health outcomes of interest, and other factors).
2. Ideally, the scoping of the assessment will include stakeholders to make sure the assessment includes their key issues of concern. In any case, stakeholders should be involved throughout the process.
3. The team working on the assessment should evaluate the effectiveness of current activities to reduce the burden of climate-sensitive health outcomes, and to determine what additional measures would increase their effectiveness.
4. Estimate the potential future health impacts, which will provide the basis for deciding what additional adaptation measures will be needed.
5. Identify additional adaptation measures to reduce potential negative health effects.

Following these steps will set you up to carry out a climate change adaptation assessment for your country or region – a really valuable tool in reducing the health impacts of climate change.

3

Examples of adaptation activities in the WP & SEA region

In the last section of this module let's now look at some examples of adaptation activities in the WP and SEA region, which could be used in your own work. The first three examples relate specifically to adaptation in the health sector.

32

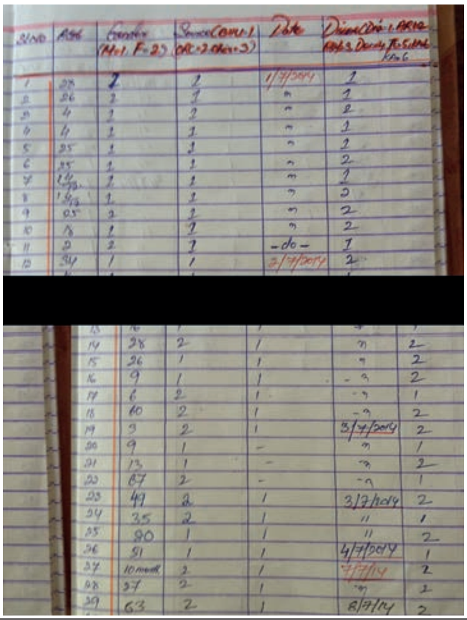
Surveillance system in Bhutan: Collecting weather data

This is an example of a health and climate change adaptation project in Bhutan – this is a surveillance project where climate-sensitive disease data is collected at a health centre, which is then correlated with weather data. This photo on the right shows the manual weather station where weather data is collected -– min/max temps, humidity and rainfall.

On the left is a local health worker in Bhutan collecting rainfall information.

33

Surveillance system in Bhutan: Collecting health data



The photo shows the form for collecting climate-sensitive disease data for the Bhutanese surveillance system. The columns from left to right are number; age; gender; which service they attended; date; type of disease (diarrhoea, acute respiratory infection, malaria, dengue, Japanese encephalitis, kala azar). This information is passed to central health officials who collate and analyse the data. The project is conducting climate sensitivity analyses, with a focus on temporal and spatial analyses and vulnerability mapping (risk mapping). Eventually, the project aims to develop predictive models, issue risk warnings, and develop a response plan.

In discussions, health care staff noted that measuring the meteorological data and collecting the health data in another form (alongside the standard health information system) did not add significantly to their workload. Staff also understood the potential to use the weather/health relationships to identify vulnerable groups to improve the effectiveness of the surveillance system.

New Civil Hospital, Surat, Gujarat, India

The Western Indian city of Surat in the State of Gujarat was devastated by floods in 2006. Approximately three-fourth of the city was inundated with severe losses to the municipal corporation and the economy running into billions of rupees. The death toll was officially estimated to be around 150 but unofficial estimates were to the tune of more than 500.

The New Civil Hospital that has been constructed in Surat, pictured in the top left, unlike the old hospital, has been built some distance away from the Tapti river. This location helped to obviate the impact of the floods.

During the floods one of the key factors that helped in the functioning of the hospital was a electric supply characterized by a backup. This ensured that emergency services remained operational in the critical response phase after the disaster. Three large underground water tanks – one of which is shown bottom right - ensured that there was adequate water supply.

The hospital administration have also put in place a number of measures to reduce the impacts of future floods. The drainage system has been enlarged to ensure greater outflow. The heights of medicine cabinets have been increased by about 1 metre. A number of new wards have also been built in such a way that they are more flood resistant. For example, while carrying out new construction the operation theatres, medical intensive care unit and the CT scan have been built on higher ground.

Source: *WHO. 2015. Case Study: Climate Resilient Health Facilities. A Public Tertiary Health Facility in Surat, Western India responds to the Challenge of Floods.*

Sea surface temperature monitoring in South Atlantic helps predict malaria outbreaks in India

Malaria transmission occurs in a large part of India. This includes the Kutch region of Gujarat in Western India. The high baseline of cases in this part of the world will magnify the impact of climate change on this critical health concern.

An Integrated Disease Surveillance Program (IDSP) which includes malaria has now been established across India. However surveillance doesn't include weather or environmental parameters which can predict disease outbreaks in advance, and help ensure adequate response time for health system preparedness - an essential component of adaptation in relation to climate change and health.

However a new multinational research collaboration between the University of Michigan in the United States and the National Institute of Malaria Research in India, as well as other partners, is providing a new and interesting adaptation response.

The group's research has shown that monitoring the sea surface temperature of the tropical South Atlantic sea is related to monsoon rainfall and malaria epidemics in the district of Kutch in arid north-west India. Sea surface temperature data can give a warning of outbreaks about four months in advance. This preparation time can be incredibly useful for health administrators to put in place appropriate prevention and curative measures which can effectively reduce the impact of the disease.

The fact that sea surface temperature in the south Atlantic is a driver of malaria outbreaks in arid India despite the considerable geographical separation between the climatic parameter – in America - and the disease outcome in India, shows that countries can collaborate well in their adaptation responses.

Source: *WHO. 2015.Case Study: Climate Based Early Warning System. Sea Surface Temperature in the South Atlantic helps predict Malaria Outbreaks in distant India.*

Disaster warning systems in Mongolia

Source: UNEP (2014)

With up to one third of Mongolia's population living as nomadic herders who rely upon grazing livestock, small changes in the climate and ecology can have profound effects on the country. Already, visible impacts have included an increase of 2.14 degrees in air temperature, landscape changes towards desertification, arid & semi-arid lands, and an increased frequency and intensity of natural disasters.

The main adaptation technology that Mongolia has focused on is developing is its own Disaster Warning System (DWS), with a pilot project launched in 2005 in the Dundgobi province. The objective of the project was to provide herders with advanced information and communication technologies to create an opportunity for them to be warned about coming risks so they can adequately prepare in advance.

The system itself has two operating modes: a day-to-day mode focusing on status updates, and an emergency mode to provide prior warning of impending disasters. The process for delivering disaster warnings to the population involves Mongolian national organizations and institutes collaborating to formulate disaster reports and delivering these to the Emergency Management and Report Centre. After this, the warnings will be disseminated by siren towers across Ulaanbaatar, one of the areas most vulnerable to natural hazards, operated by the Mongolian National Broadcaster, mobile phone networks, and radio stations.

Source: *UNEP. 2014. Adaptation Technologies Mongolia, Disaster Warning Systems. http://www.unep.org/roap/Portals/96/Compendium%20Report_Mongolia_Final.pdf*

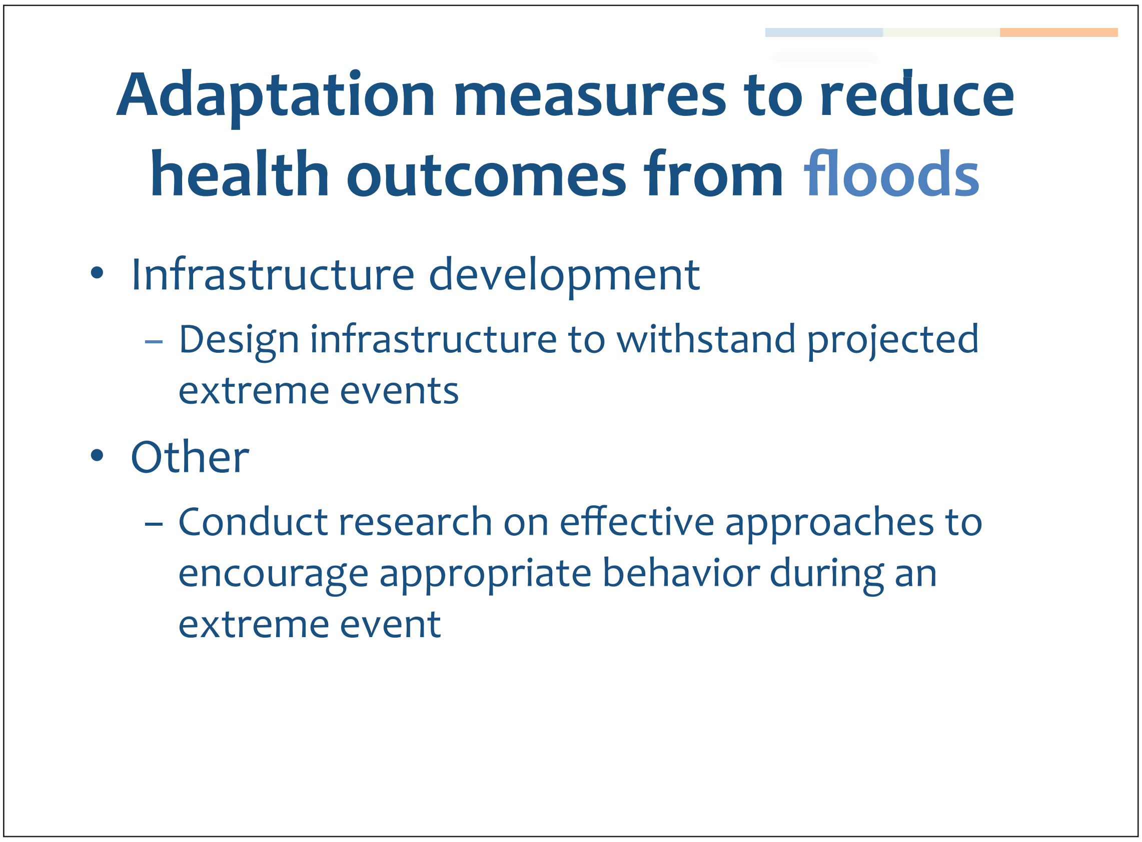
37

Adaptation measures to reduce health outcomes from floods

- Legislative policies
  - Improve land use planning
- Decision support tools
  - Early warning systems & emergency response plans
- Technology development
- Surveillance & monitoring
  - Alter health data collection systems to monitor for disease outbreaks during & after an extreme event

Here are some examples of adaptation measures to reduce the adverse health impacts of flooding. Similar lists can be created for other climate-sensitive health outcomes.

38



Here are some examples of adaptation measures to reduce the adverse health impacts of flooding. Similar lists can be created for other climate-sensitive health outcomes.

An adaptation assessment is likely to identify many more options for implementation than actually can be implemented. This will require prioritization of the options to identify those with the highest priority.

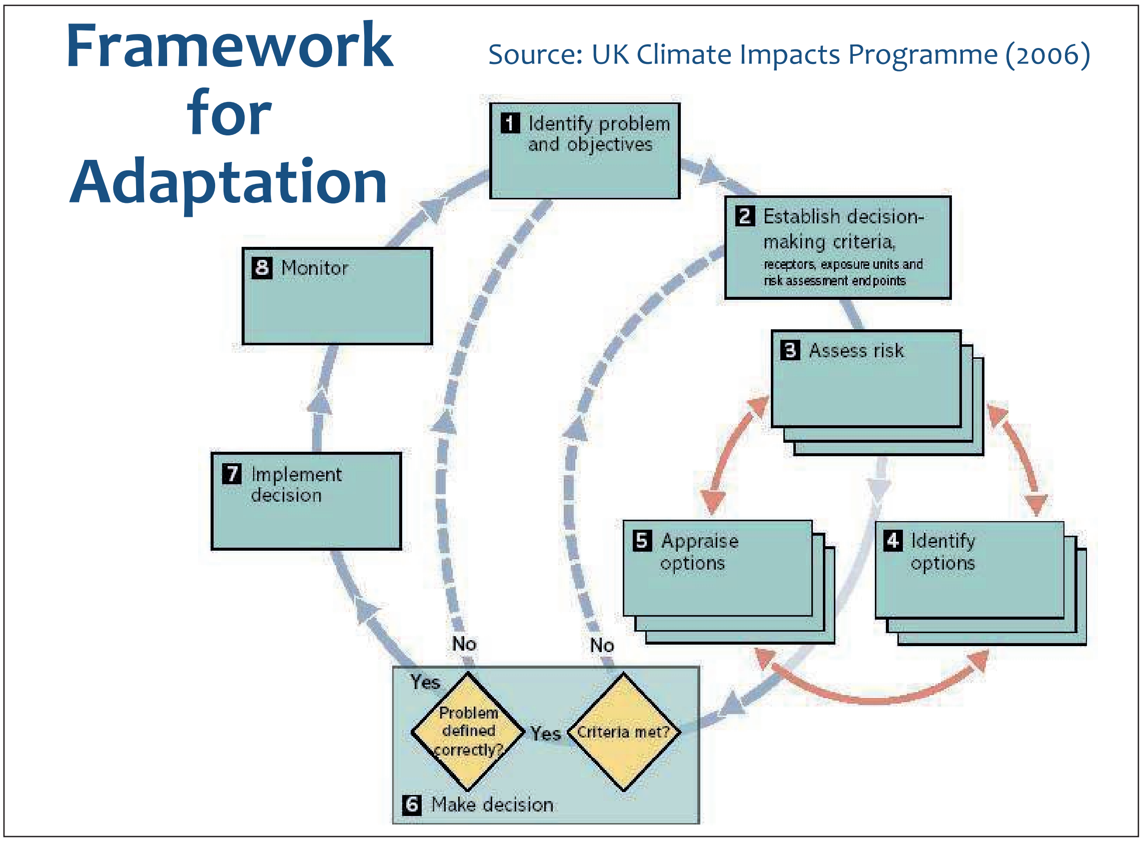
The priority options should address the current adaptation deficit (i.e., where there are increased burdens of climate-sensitive diseases); that is, they make sense anyway and become more urgent when considering climate change. In general, measures that reduce vulnerability to climate variability will generally reduce future risks to climate change.

Policy makers always look for options that have marginal adjustments and low cost than implementing new and expensive programmes, unless it can be demonstrated that the benefits of a new programme will greatly exceed its costs.

As mentioned previously, adaptation policies and measures should be robust to a range of future climates (i.e., low regrets).

Criteria for prioritization of adaptation activities

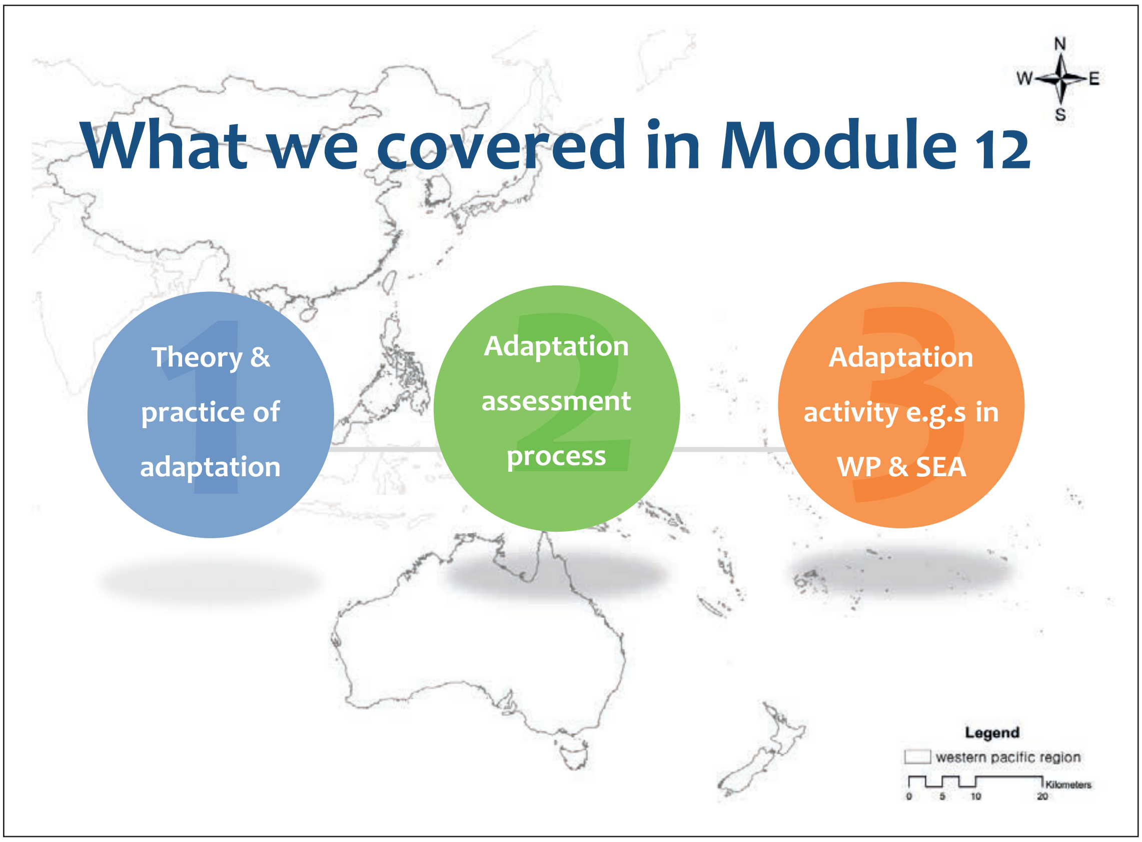
1. Benefits/effectiveness
2. Costs
3. Feasibility
4. Timing
5. Significance
6. Certainty
7. Adaptive capacity



We'll finish with this slide again, which emphasises the importance of assessing adaptation options that have been selected – then the iterative process continues to determine if modifications need to be made.

Source: *UK Climate Impacts Programme. 2006. UKCIP Experience: NCSP Workshop on Vulnerability and Adaptation Assessment under the Second NatioNational Communications Meeting.*

40



So, finishing off Module 12, a reminder that we've looked at:

1. The theory and practice of adaptation
2. The process of conducting an adaptation assessment
3. Some examples of adaptation activities in the WP and SEA region

41

Learning from Module 12

- Strong health systems are essential for adaptation
- Importance of developing climate-resilient health systems

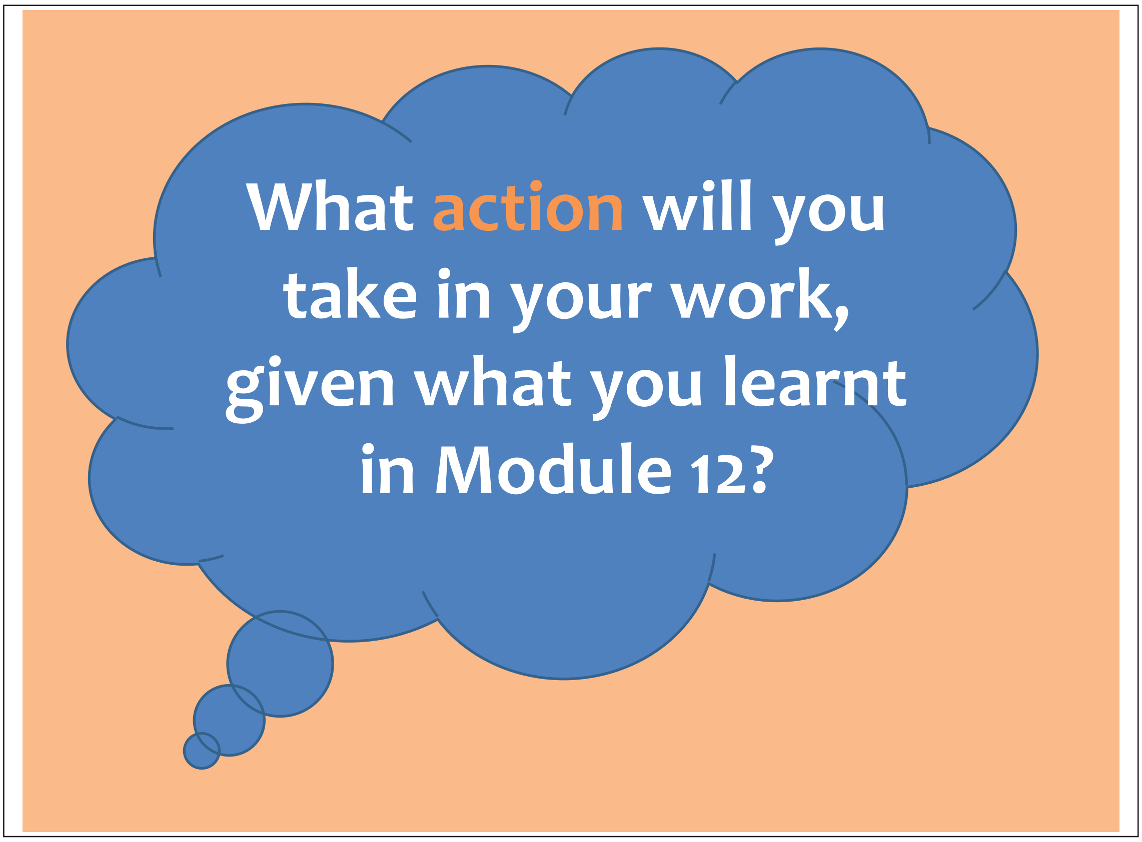
The two key messages to take away as learning from this module, in addition to the steps of undertaking an adaptation assessment, are:

That strong health systems are essential for adaptation. Indeed, strong health systems are essential for most effective responses, whether that is in relation to an infectious diseases outbreak, such as what we saw in 2014 with Ebola, or whether that is in relation to provision of effective health services to respond to a natural event like an earthquake or tornado. Here, again we can see the utility of the 'win-win' argument – i.e. if we invest in health systems, then this is effectively investing in a whole range of health-relevant responses, including risks from climate change.

This links in with the second key message here (CLICK) – the importance of developing climate-resilient health systems. These are health systems that can bounce back, and perhaps even transform, after a weather event such as a storm or flood. In the long-run, supporting climate-resilient health systems that can respond effectively to such threats, is a sustainable approach, as they save both money, time and lives.

Q: Are there any questions on the learning from Module 13, or the adaptation assessment process?

42



To finish off Module 12, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around adaptation to climate change.

Encourage quiet reflection (verbally if needed). At the end of ***2 minutes***: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 13

Mitigation and co-benefits

Key learning messages in Module 13

- Climate change mitigation is vital, and the health sector has an important role to play
- The framing of mitigation activities with relevance to health as 'cobenefits' or 'win-win' is strategic and useful
- Many cobenefits projects are underway, and need to be scaled up where possible.

Estimated length: 50 minutes or less

Structure of Module 13

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Introduction to mitigation	4–12	EXERCISE on slide 6: ● Brainstorm 4–5 types of mitigation activities your assigned sector could take to reduce greenhouse gas emissions. 4 minutes Assign each table one of the sectors listed on the previous slide: Energy supply, Industry, Waste, Transport, Agriculture, Buildings, Forestry. (double up if needed). Groups to use markers and blank A4 paper in the middle of the table.
2. Cobenefits of climate change mitigation for the environment and human health	13–21	EXERCISE on slide 21: ● What changes to public health practice could you implement in your country that also have mitigation benefits for the climate? 3 minutes, solo. Pair share some of the activities you came up with – 1 minute each.
Module outline	22	
Learning from Module 13	23	
Learning reflection, action generation	24	

Required resources

- Data projector and slide changer
- Module 13 slides
- Markers – two per table
- Blank A4 paper – one sheet per table
- Stopwatch
- Bell or noise maker.

Key terms introduced in Module 13

- Mitigation
- Mitigation activities
- Relationship between CO2 and temperature
- Cobenefits

References (in order of presentation)

- IPCC. 2013. Assessment Report Five, Working Group III.
- Patz J A, Gibbs H K, Foley J A, Rogers J V, Smith K R. 2007. *Climate change and global health: quantifying a growing ethical crisis*. EcoHealth 4 397.
- Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations, National Research Council. 2011. *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia*. http://www.nap.edu/catalog/12877/climate-stabilization-targets-emissions-concentrations-and-impacts-over-decades-to.

Module 13: Mitigation & co-benefits

In Module 13 we're going to look at climate change mitigation and the range of co-benefits mitigation can provide.

2

Key messages in Module 13

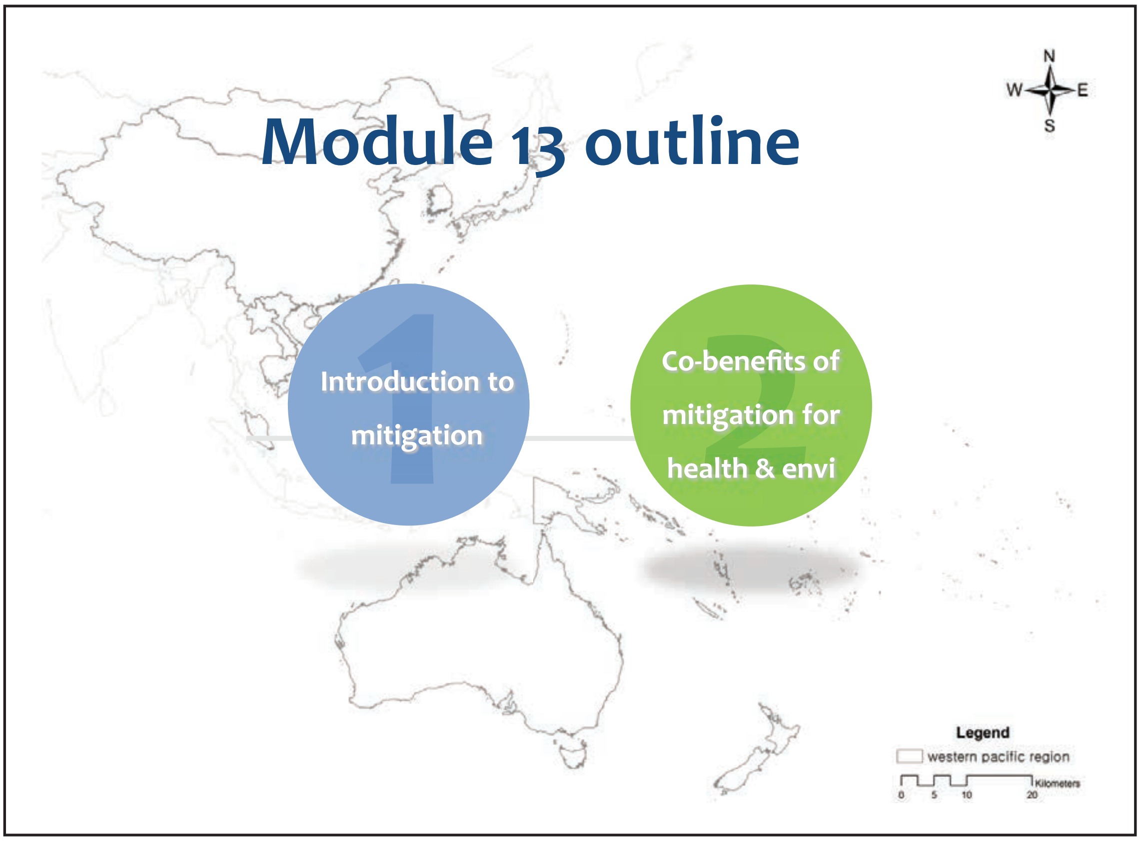
- Climate change mitigation is vital, & the health sector has an important role to play
- The framing of mitigation activities with relevance to health as 'co-benefits' or 'win-win' is strategic & useful
- Many co-benefits projects are underway, & need to be scaled up where possible

The three key messages that we'll discuss in this module on mitigation and co-benefits are:

CLICK to animate each message

1. Given our rapidly increasing GHG emissions, we need to focus on ways in which we can reduce (and in an ideal world, reverse) this trajectory.
2. The health sector can be more involved in this conversation, particularly via the framing of climate change mitigation and health activities as 'win-win' or projects with co-benefits. In addition it is important for the health sector to reduce its emissions, by greening hospitals and other health care facilities, for example.
3. It is useful to know the sort of co-benefits projects are currently occurring, to see to what extent we can incorporate these in our own contexts (and in particular, scale these up).

3



This module on mitigation and co-benefits has two key areas:

Firstly, we will look at the concept of mitigation, and provide an overview of different sectors' contributions to emissions, and why it is so important to reduce our emissions.

Secondly, we will discuss the co-benefits of climate change mitigation for the environment, and for human health. This framing of health and mitigation activities as 'co-benefits' (or 'win-win' strategies) has arisen in the last twenty years or so, and in the last ten years the health sector has started to focus more research on demonstrating co-benefits. Put simply, co-benefits refers to when GHG emissions can be reduced in ways that also generate health benefits. In this section we will discuss examples of win-win/co-benefit approaches to climate change and health relevant to the SE Asia and Western Pacific regions, and we will have a chance to discuss potential trade-offs that we need to consider when designing mitigation activities relevant to health.

4

1 Introduction to mitigation

Let's start into Module 13 by looking at some of the basic concepts around mitigation

5

Definition of mitigation

Mitigation: a human intervention to reduce the sources or enhance the sinks of greenhouse gases

Mitigation for the health sector: promoting & supporting initiatives that protect health by reducing GHG emissions

Mitigation options exist for all emission sectors:

Energy supply	Industry	Waste
Transport	Agriculture	
Buildings	Forestry/forests	

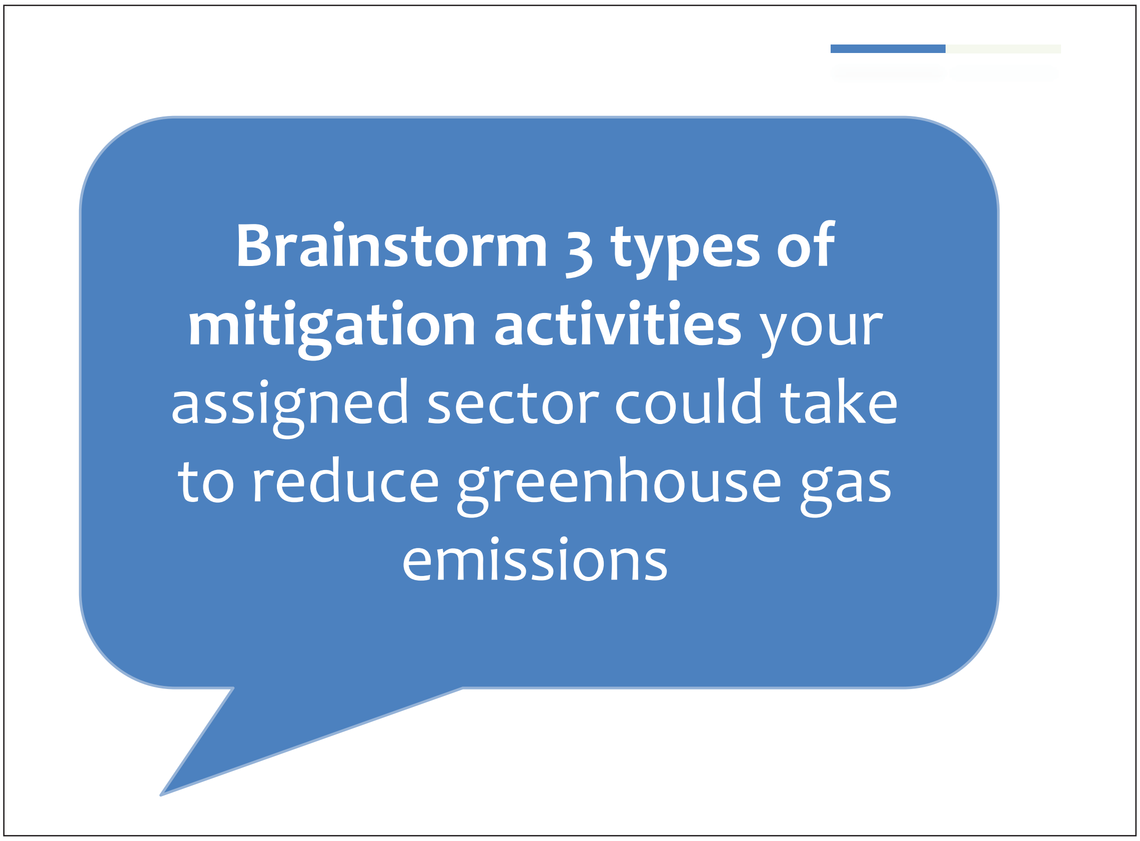
To begin with – some definitions:

Mitigation is the reduction of greenhouse gas emission sources, or the enhancement of greenhouse gas emission sinks. Examples of the reduction of GHGs would be sourcing electricity from renewable sources rather than from coal or oil, or switching off hospitable lighting in unused rooms to reduce electricity use from coal-fire powered electricity generators. An example of enhancing greenhouse gas emission sinks is planting forests, which take up carbon dioxide.

CLICK - Mitigation is very relevant for the health sector – as mentioned earlier, reducing GHG emissions can be done in ways that promote and protect health.

CLICK - All sectors are able to reduce their GHG emissions, whether in energy supply, forestry or agriculture.

6



GROUP EXERCISE:

Assign each table one of the sectors listed on the previous slide: Energy supply, Industry, Waste, Transport, Agriculture, Buildings, Forestry. (double up if needed) Get a helper to hand out markers and blank A4 paper to the middle of the table.

"For your assigned sector, please brainstorm 4 or 5 types of mitigation activities this sector could take to reduce greenhouse gas emissions. You'll have **4 minutes** as a group. If you have more than 4 or 5 ideas, go for it! Are there any questions? If not, "Ok, start brainstorming for this particular sector."

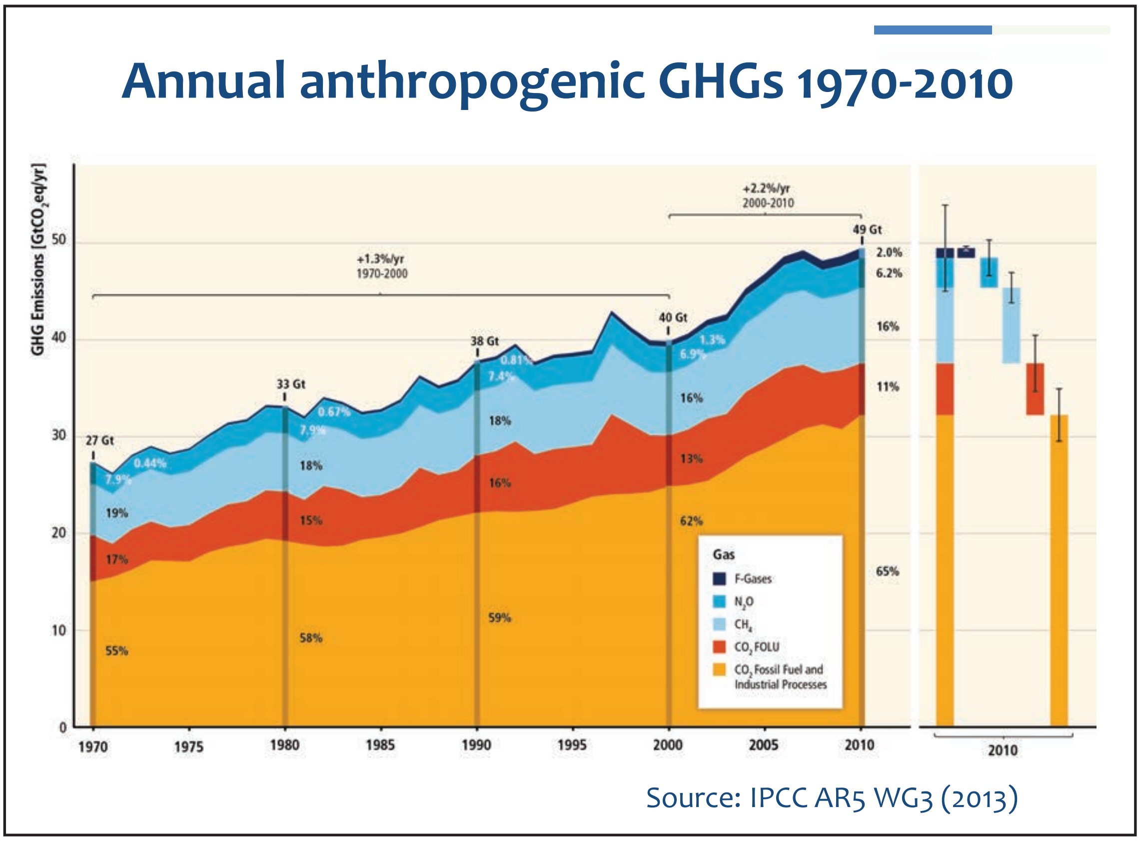
Give a time warning at **2 mins 30 secs:** "You have another 30 seconds to finish off your brainstorm. Please also decide on one representative for your group, who'll report back your three mitigation activities."

At **3 minutes** : "Ok, please finish your brainstorm. Could I please have the representative from this table tell us which sector you had, and the three activities you came up with that would reduce greenhouse gas emissions from this sector?"

Repeat for each table, writing up all mitigation activities on a flipchart page (or having someone – another trainer or a participant - you've asked to scribe for you write each one down). If an activity is repeated by another group, tick the activity where it was first written, to show that many activities are possible across a range of sectors.

"Thank you for all your great mitigation ideas. We'll put these up on the wall so you can go back to the ideas that other groups came up with. I'd encourage them to keep this wide range of mitigation activities in mind when you're back in your own countries working to mitigate climate change. We'll also look at mitigation options for the health sector in the next section of this module."

7



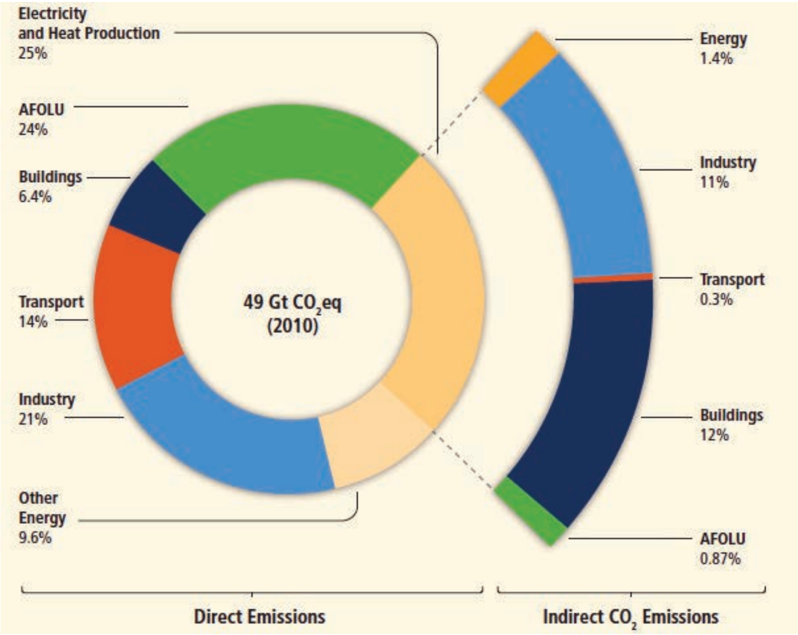
The main message to take from this graph is that emissions of air pollutants, including carbon dioxide and methane and other more 'conventional' air pollutants such as nitrogen dioxide are increasing, and these have negative impacts on health.

Many — but not all — mitigation measures reduce these air pollutants. A couple of mitigation examples include the reduction of cattle grazing (and other ruminant animals) – these animals produce methane; and the reduction of coal-fired power stations, which emit carbon dioxide.

Source: *IPCC. 2013. WGIII AR5*

8

Greenhouse gas emissions by economic sectors



Source: IPCC WG3 AR5 (2013)

Now turning to sectoral differences in relation to emissions. This image from the AR5 of the IPCC shows total anthropogenic GHG emissions (GtCO2eq / yr) by economic sectors.

Indirect emissions, shown on the right, are those that result from the generation of electricity and heat; direct emissions by sector are shown on the left.

We can see here that the agriculture, forestry and other land use sector emits the largest amount of direct emissions, closely followed by industry.

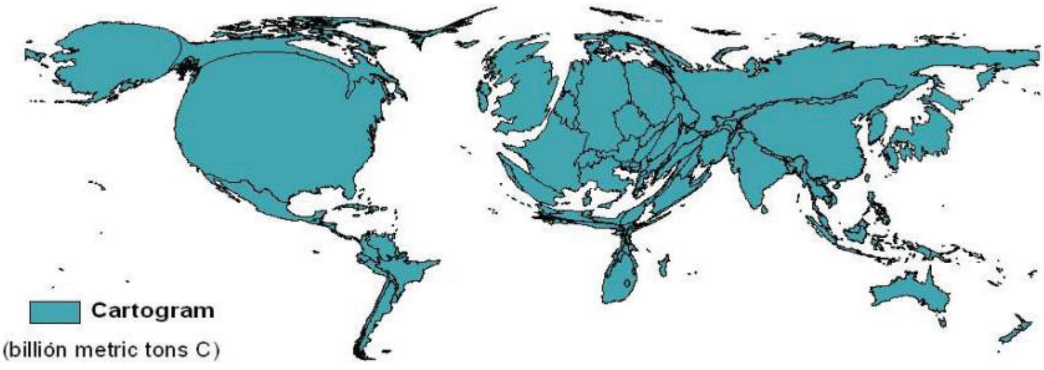
The IPCC presents many suggestions for reducing GHG – lets take one sector – transport:

The IPCC notes that "Integrated urban planning, transit-oriented development, more compact urban form that supports bicycling and walking, can all lead to modal shifts as can, in the longer term, urban redevelopment and investments in new infrastructure such as high-speed rail systems that reduce short-haul air travel demand." These changes have the potential to cut transport GHG emissions by 20% to 50% in 2050 compared to baseline. We also now recognise the public health benefits of active transport, which is also briefly reflected on in this chapter of the IPCC report.

Source: *IPCC. 2013. WGIII AR5*

9

Cartogram: Greenhouse gas emissions 2002



Source: Patz et al. (2007)

This slide, and the next one, make the point that the countries primarily responsible for greenhouse emissions are not the countries that so far are most affected by climate change.

This is a density-equaling cartogram with countries scaled according to cumulative emissions in billion tonnes carbon equivalent in 2002.

The total amount of greenhouse gases emitted by a country is closely correlated with national wealth, measured in conventional terms such as total GDP. This map illustrates how some countries, and some regions of the world, have been very modest contributors to total greenhouse emissions, and this is mostly a reflection of differentials in wealth. (Note that these figures are not expressed per capita, so population size is also a factor. New Zealand, for instance, escapes notice in this cartogram, but is the fifth heaviest emitter in the OECD when its small population is taken into account.)

Source: *Patz J A, Gibbs H K, Foley J A, Rogers J V, Smith K R, 2007, "Climate change and global health: quantifying a growing ethical crisis" EcoHealth 4 397*

10

Cartogram: Climate change health impacts

Estimated mortality (per million people) attributable to climate change in 2000

Source: Patz et al. (2007)

Note: Uses only data on deaths from malaria & dengue fever, diarrhoea, malnutrition, drowning (& heatstroke for OECD countries)

Here is another density-equaling cartogram, showing WHO regions scaled according to estimated mortality in the year 2000, attributable to the climate change that occurred from 1970s to 2000.

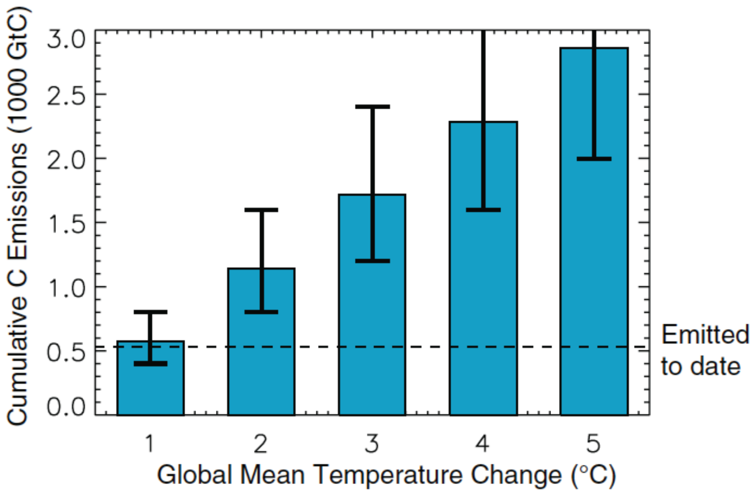
The map is quite different to the one we have just seen: the burden of disease falls mostly on the poorest regions, Africa in particular.

For obvious reasons, the impacts of storms and flooding and other climate-sensitive health problems, are greatest where material resources are in shortest supply.

Source: *Patz J A, Gibbs H K, Foley J A, Rogers J V, Smith K R, 2007, "Climate change and global health: quantifying a growing ethical crisis" EcoHealth 4 397*

11

Cumulative rising emissions, rising temperatures



Source – Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations, National Research Council (2011)

The main message from this graph is that recent studies show that cumulative carbon dioxide emission is a useful metric for linking emissions to impacts. We can see here that an increase in cumulative emissions is related to an increase in global mean temperature change.

Background note for trainer - [Error bars reflect uncertainty in carbon cycle and climate responses to carbon dioxide emissions due to observational constraints and the range of model results. Cumulative carbon emissions are in teratonnes of carbon (trillion metric tonnes or 1 000 gigatonnes).]

Source: *Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations, National Research Council. 2011. Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. http://www.nap.edu/catalog/12877/climate-stabilization-targets-emissions-concentrations-and-impacts-over-decades-to.*

Relationship between CO2 & temperature

Stabilization CO_2-Equivalent Concentration (ppmv): Range and Best Estimate	Equilibrium Global Average Warming (°C)
320 ⟵ **340** ⟶ 380	1
370 ⟵ **430** ⟶ 540	2
440 ⟵ **540** ⟶ 760	3
530 ⟵ **670** ⟶ 1060	4
620 ⟵ **840** ⟶ 1490	5

Note: Green and red numbers represent low and high ends of ranges, respectively; **black bolded** numbers represent best estimates.

Source – Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations, National Research Council (2011)

What we can see in this table is that global temperature change can be linked both to concentrations of atmospheric carbon dioxide and to accumulated carbon emissions. The green numbers represent the low end of the range, and the red represents the high end of the range. The black bolded numbers represent the best estimate of carbon dioxide concentration, which is then linked to the associated global average warming.

Because there are many factors that shape climate, uncertainty in the climate sensitivity is large; the possibility of greater warming, implying additional risk, cannot be ruled out, and smaller warmings are also possible. Choices about stabilization targets will depend upon value judgments regarding the degree of acceptable risk.

Source: *Committee on Stabilization Targets for Atmospheric Greenhouse Gas Concentrations, National Research Council. 2011. Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia. http://www.nap.edu/catalog/12877/climate-stabilization-targets-emissions-concentrations-and-impacts-over-decades-to.*

2

Co-benefits of mitigation for health & the environment

Let's now look at the co-benefits that exist for health and the environment from reducing greenhouse gas emissions.

Mitigation & co-benefits – IPCC AR5:

Co-benefits = climate mitigation +
health gains from well-chosen health policies

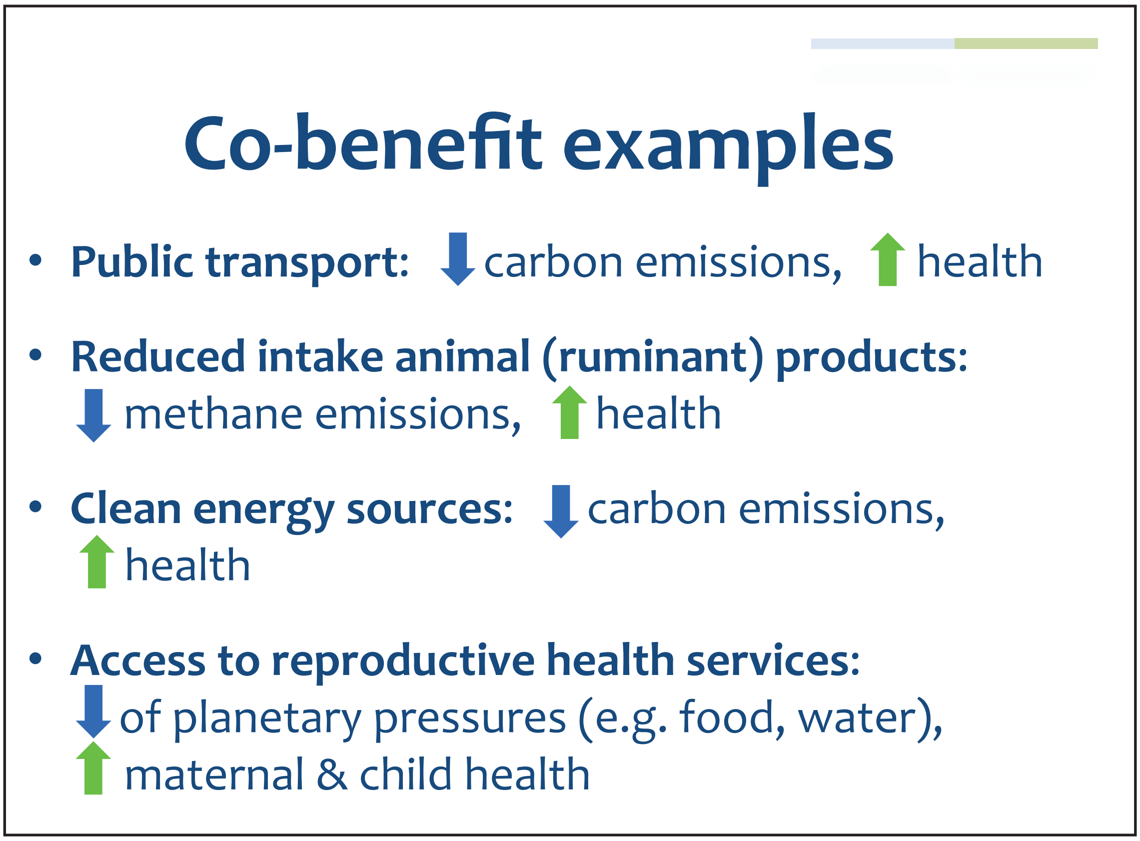
Meat Free Monday
Senin Tanpa Daging
Indonesia

Working Group II of the IPCC had its first major and serious focus on co-benefits in the Fifth Assessment Report.

By co-benefits we mean… (explain formula listed)

On the next slide I'll present some examples of mitigation strategies that have health co-benefits.

15



Here are some co-benefit examples:

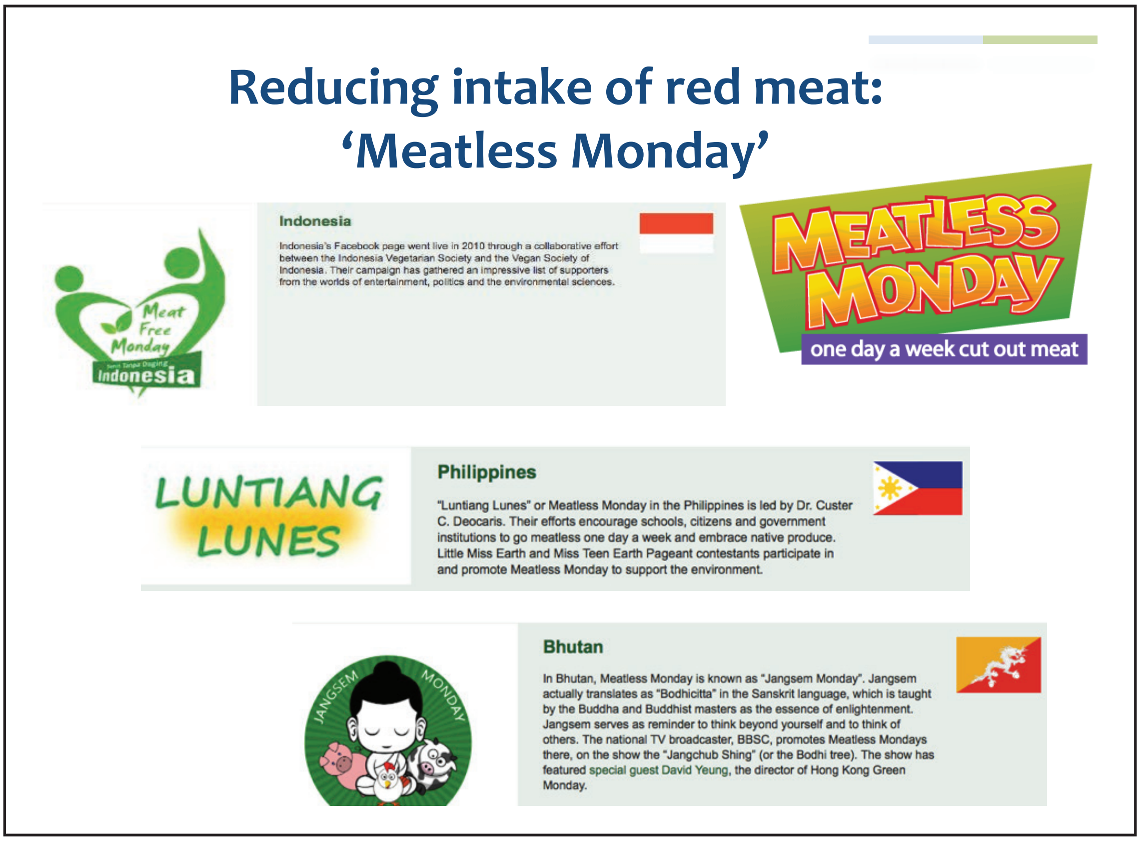
- Public transport – such as cycling rather than driving a car, results in reduction in carbon emissions as well as improved health.
- Reducing consumption of meat (ruminants that emit methane) results in fewer methane emissions as well as improved (mainly heart) health.
- Clean energy sources - such as windpower and solar power - reduce carbon emissions and have the benefit to health of reducing air pollution via less reliance on dirtier energy sources, such as coal-fired power plants.
- Population growth influences the consumption of resources and emissions of Climate-Altering Pollutants (such as methane, carbon dioxide etc.) (CAPs) (Cohen, 2010). Slowing population growth through lowering fertility, as might be achieved by increasing access to family planning, has been associated with improved maternal and child health – the co-benefit - in two main ways: increased birth spacing and reducing births by very young and old mothers.

16

Metropolitan Rapid Transit, Bangkok

The Metropolitan Rapid Transit or MRT is a rapid transit system serving the Bangkok Metropolitan population in Thailand. The first section of the metro opened in 2004 as Bangkok's second public transit system. It now services 240 000 daily users, or 80.6 million people annually, reducing exposure of a good proportion's of the city's population to smog and particulate pollution if they were to commute by tuk tuk, motorcycle, foot, bicycle or car on the streets.

17



'Meatless Monday' is an example of a successful social marketing approach. This started in Europe, and has since extended to parts of Asia and the Pacific, as you can see in these image logos for Meatless Monday in Indonesia, the Phillippines and Bhutan.

Solar at the Niue Foou Hospital

Nieu, a low-lying Pacific Island which will be severely impacted by climate change, has made significant steps in mitigating its own contribution to emissions. Supported by funding from The European Union European Development Fund, Nieu has replaced its electricity transmission network, increased its renewable energy generation capacity, and implemented energy efficiency initiatives.

This included the installation of solar Photovoltaic systems at the Niue Foou Hospital, as shown in these photos.

Niue plans in the long term to bring solar production to about 80 to 90 per cent of their electricity capacity, and eventually introduce electric vehicles on the island, reducing their fossil fuel dependency "very much to just the bare essentials" their Premier Toke Talagi was quoted as saying in 2012.

Source: *Delegation of the European Union for the Pacific. EU Ambassador Presents Credentials in Niue (26/06/2014). http://eeas.europa.eu/delegations/fiji/press_corner/all_news/news/2014/20140626_01_en.htm*
ABC. 2012. Japanese-funded solar project to revolutionise Niue's power generation. http://www.abc.net.au/news/2012-10-15/an-niue-premier-welcomes-japan-solar-project/4312978

Photo source: *http://climatepasifika.blogspot.com.au/2011/03/pacific-climate-change-roundtable-tour.html*

19

Solar cookers, Vietnam

Many people in Vietnam still depend on coal, straw, leaves or wood for cooking. These open fires contribute to air pollution and cause lung and eye diseases owing to people spending time in hot and smoky kitchens. This traditional cooking method also involves women and children walking to find wood for daily cooking.

Solar cookers are a great outcome for emissions reduction, using the renewable source of sunlight to concentrate heat for cooking, reducing use of wood, which captures carbon, and also reducing diseases from air pollution.

These images show solar cookers distributed by Vietnam Solar Serve, an NGO that promotes solar cooking in Vietnam.

Waste management at Bir Hospital, Kathmandu, Nepal

A Health Care Waste Management Center was established in 2011 at Bir Hospital, Kathmandu. It was endorsed by the WHO with technical assistance from the Nepal Public Health Foundation and Health Care Without Harm. The Center is based on three pillars – waste management, injection safety, and mercury elimination. Prior to the Center's development on the hospital grounds, the site was used for dumping waste.

The Center has three main functions – i) recycling; ii) biological treatment of food/human waste and iii) safe storage of mercury.

The waste that is able to be recycled, including plastics, paper, rubber and glass, is segregated and sold, while the non-recyclable infectious waste - including bandages and cotton – is treated in the autoclave for sterilisation and then placed in the vermicomposter (worm farm). A trolley is fitted with colour-coded buckets for risk and non-risk waste collection within the hospital. Approximately 80-100 kilograms of waste is collected per day from the hospital.

The second function of the Center is a biogas plant which manages biodegradable waste, including food and human waste (e.g. from surgical operations). The plant then produces fertiliser (slurry) - which will eventually be sold to farmers once safety tests are completed - and methane and carbon dioxide, which is currently being used to run the Center's kitchen and autoclaves. Future plans include the purchase of a generator for electricity to power the street lamps within the hospital compound.

contd...

20

Waste management at Bir Hospital, Kathmandu, Nepal

The third function is to safely store mercury.

Many benefits are observable from the Center's operation, ranging from climate change mitigation to capacity development. The total reduction of greenhouse gases within the hospital as a result of the Center's activities was estimated to be **75.8 tonnes of carbon dioxide per annum,** equating to **US$ 531**. In 2012, 79% of total waste was being recycled in the hospital. The cost of setting up the Center was approximately US$ 6000 and it is expected that this cost will be paid back in three to four years. An additional benefit of the Center is that burn injury patients are trained to make handicrafts for purchase from the plastic waste.

21

GROUP EXERCISE –

“In this short exercise, I’d like you to reflect on the changes to public health practice you could be implemented in your country, that also has benefits for the climate.

Think about which of the activities we’ve discussed might be appropriate for mitigation in your setting, ensuring that these have win-wins. For example, could you use E-Health more widely, moving away from in-situ visits to medical facilities by accessing health information online, which has benefits for health, but also for the environment in reducing travel emissions?” (PLoS Holmner & Ebi).

“Make a list of possible changes to public health practice that would also act as mitigation activities in the notes next to this slide in your handouts. I’ll give you 3 minutes for this, working on your own. You’ll then have the opportunity to share your ideas with a colleague at the end.”

At 2 mins 30 secs: “Please finish off your notes in the next 30 seconds.”

“Ok, now that you have a list of public health changes that are win-win in also being mitigation activities for your country, I’ll ask you to turn to the person next to you and share some of the activities you came up with that could be possible in your country. You’ll have a minute each to remind your colleague of your country and to give an overview of the options you came up with. The other person should listen and ask questions if they need to, to understand how these activities have co-benefits.”

contd...

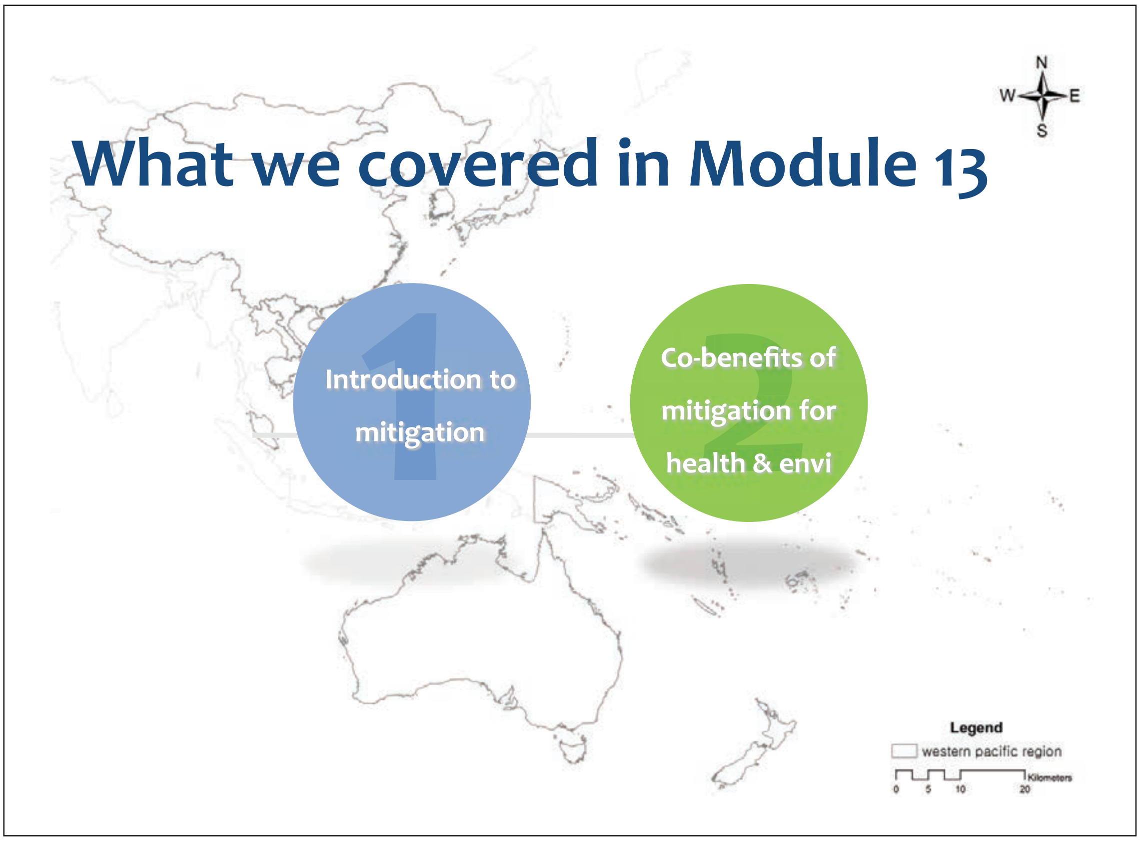
21

(reset timer)

At 1 min: "Please swap over now, so that the other person is giving an outline of the mitigation activities they came up with that could be implemented in their country, and the co-benefits these would provide."

At 2 mins: "Ok, please finish your conversation now. Thank you for sharing your mitigation ideas. I hope many of these will be implemented in your countries with your support!"

22



So let's finish off Module 13 now. A reminder that in this module we've:

Firstly looked at the concept of mitigation, an overview of different sectors' contributions to emissions, and why it is so important to reduce our emissions.

Secondly, we discussed the co-benefits of climate change mitigation for the environment, and for human health. This framing of health and mitigation activities as 'co-benefits' (or 'win-win' strategies) has arisen in the last twenty years or so, and in the last ten years the health sector has started to focus more research on demonstrating co-benefits. We looked at examples of win-win/co-benefit approaches to climate change and health relevant to the SE Asia and Western Pacific regions, and we also discussed potential trade-offs that we need to consider when designing mitigation activities relevant to health.

Learning from Module 13

- Climate change mitigation is vital, & the health sector has an important role to play
- The framing of mitigation activities with relevance to health as ‘co-benefits’ or ‘win-win’ is strategic & useful
- Many co-benefits projects are underway, & need to be scaled up where possible

The three key messages to take away from this module are:

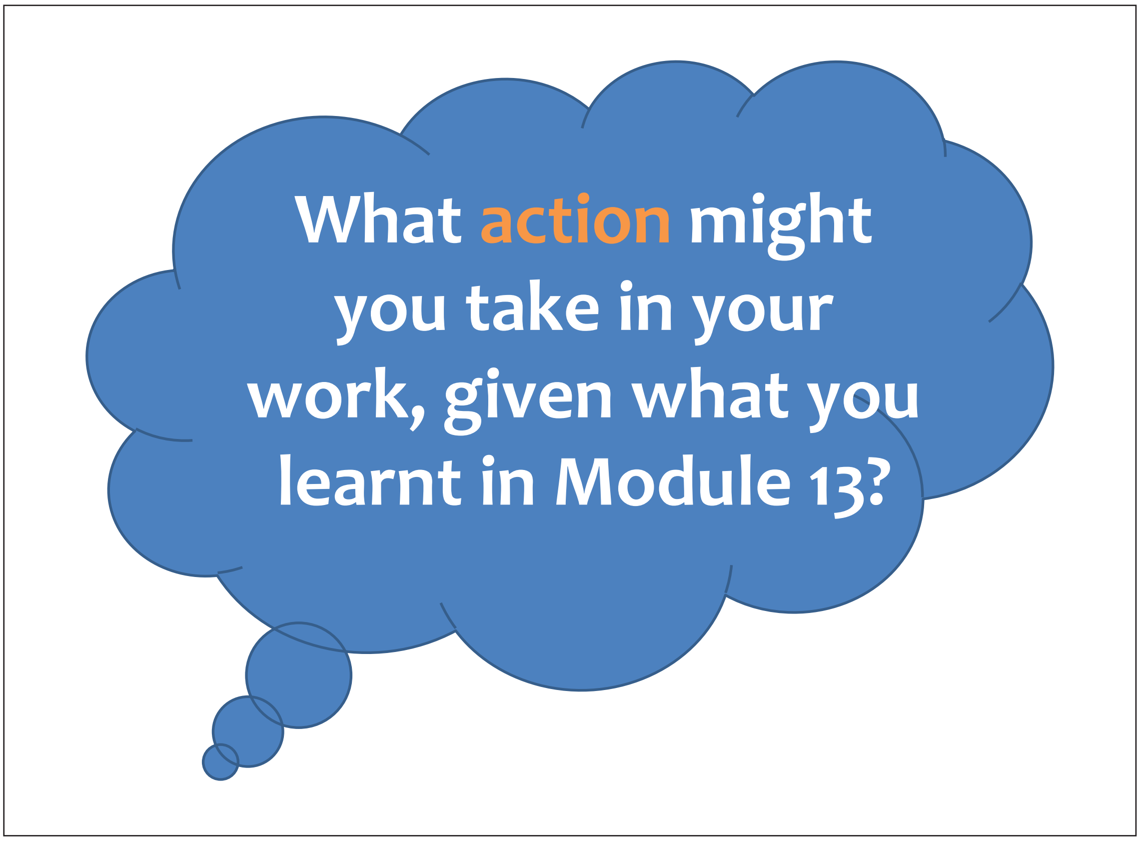
CLICK to animate each message

Given our rapidly increasing GHG emissions, we need to focus on ways in which we can reduce (and in an ideal world, reverse) this trajectory.

The health sector can be more involved in this conversation, particularly via the framing of climate change mitigation and health activities as ‘win-win’ or projects with co-benefits. In addition it is important for the health sector to reduce its emissions, by greening hospitals and other health care facilities, for example.

It is useful to know the sort of co-benefits projects are currently occurring, to see to what extent we can incorporate these in our own contexts (and in particular, scale these up).

24



To finish off Module 13, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module around mitigation and co-benefits for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around the assessment & prediction of health impacts of climate change.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes:** "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 14

Health and the UNFCCC

Key learning messages in Module 14

- The United Nations Framework on Climate Change (UNFCCC) is an international process for negotiating agreements on climate change
- A series of agreements have been reached on promoting adaptation, including establishing international funding for adaptation
- There has been inadequate representation of health in the agreements and adaptation funding
- There are significant opportunities for health engagement and taking further adaptation and mitigation action in the health sector.

Estimated length: 60 minutes

Structure of Module 14

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. Overview of the United Nations Framework Convention on Climate Change (UNFCCC)	4–20	QUESTION on slide 19: ● Have any of you participated in a Plenary or assessment report? If so, can you tell us about your experiences?
2. Adaptation activities under the UNFCCC	21–32	Memory challenge on slide 32 ● Name 2 different activities related to adaptation under the UNFCCC
3. Financial mechanisms for support of country action on health and climate change	33–41	
4. Health action within the UNFCCC	42–53	QUESTION on slide 53: ● Any questions on the opportunities for health under the UNFCCC?
Module outline	54	
Learning from Module 14	55	
Learning reflection, action generation	56	

Required resources

- Data projector and slide changer
- Module 14 slides.

Instructions for delivery of Module 14

Module 14 is relatively long and focuses in detail on mechanisms that exist under the United Nations Framework Convention on Climate Change to assist countries to respond to climate change. Throughout the module, continue to emphasise what participants could utilise under the UNFCCC and its funding mechanisms, and how the content relates to countries under the UNFCCC. It's not so important that participants understand the full workings of the UNFCCC in detail, but the implications and support that the UNFCCC and its subsidiaries and partners can provide for health practitioners in countries severely affected by climate change.

Key terms introduced in Module 14

- United Nations Framework Convention on Climate Change (UNFCCC)
- Conference of Parties (COP)
- Subsidiary Body for Scientific & Technological Advice (SBSTA)
- Subsidiary Body for Implementation (SBI)
- The Kyoto Protocol
- Intergovernmental Panel on Climate Change (IPCC)
- IPCC assessment reports
- National Communications
- National Adaptation Programmes of Action (NAPA)
- The Nairobi Work Programme (NWP)
- National Adaptation Plans (NAP)
- Loss & Damage work program
- Global Environment Facility (GEF)
- Least Developed Country Fund (LDCF)
- Special Climate Change Fund (SCCF)
- Green Climate Fund (GCF)
- Adaptation Fund (AF).

References (in order of presentation)

- United Nations Framework Convention on Climate Change. 2014. www.unfccc.int.
- Intergovernmental Panel on Climate Change. 2014. www.ipcc.ch.
- United Nations Framework Convention on Climate Change. 2014. *Progress made in implementing activities under the Nairobi work programme on impacts, vulnerability and adaptation to climate change*. http://unfccc.int/resource/docs/2014/sbsta/eng/inf07.pdf.

- The Global Environment Facility. 2014. www.thegef.org.
- The Global Environment Facility. 2014. *How to access LDCF resources*. http://thegef.org/gef/node/4433.
- Accessing Resources under the Special Climate Change Fund. 2014. http://thegef.org/gef/sites/thegef.org/files/publication/23470_SCCF.pdf.
- Green Climate Fund. 2014. http://news.gcfund.org/.
- IPCC, 2007, Summary for policy makers, 4th Assessment report
- WHO, health in Green economy;
- Haines A, McMichael AJ, Smith KR, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. Lancet 2009; 374:2104-14.

Module 14:
Health & the UNFCCC

United Nations Framework
Convention on Climate Change

In Module 14 we're going to look at some of the global level bodies that influence the work around climate change, including the inclusion of health in mitigation and adaptation efforts. We'll look at the United Nations Framework Convention on Climate Change (the UNFCCC) and the Intergovernmental Panel on Climate Change (the IPCC).

2

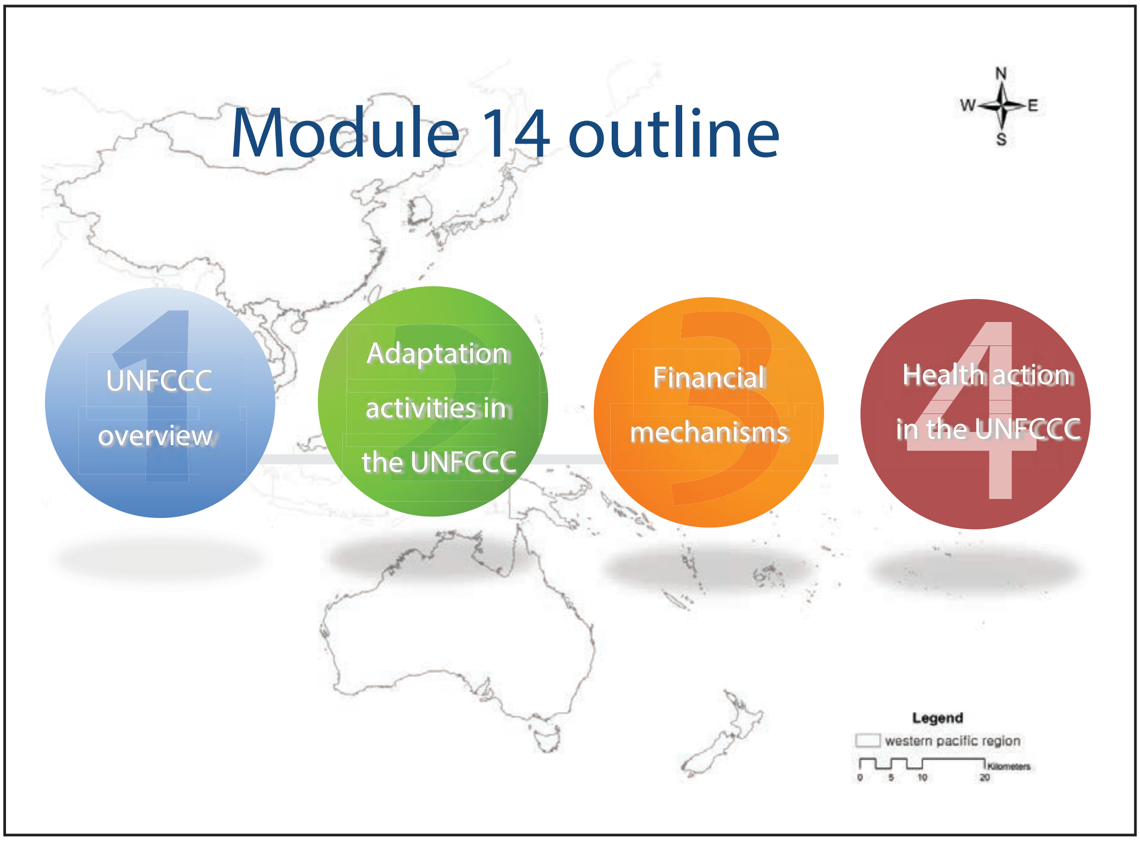
Key messages in Module 14

- The United Nations Framework on Climate Change (UNFCCC) is an international process for negotiating agreements on climate change
- A series of agreements have been reached on promoting adaptation, including establishing international funding for adaptation
- There has been inadequate representation of health in the agreements & adaptation funding
- There are significant opportunities for health engagement & taking further adaptation & mitigation action in the health sector

Here are the key messages we'll cover in Module 15.

CLICK to animate each of the four key messages, and read aloud.

3



Here's what we'll cover in Module 14:

1. Basic orientation to the United Nations Framework Convention on Climate Change (UNFCCC)
2. Adaptation activities under the UNFCCC
3. Financial mechanisms for support of country action on health and climate change
4. Health action within the UNFCCC

4

1

The United Nations Framework Convention on Climate Change (UNFCCC)

Let's start off by covering some of the basics on the United Nations Framework Convention on Climate Change, or UNFCCC.

5

United Nations Framework Convention on Climate Change

- The science & politics of climate change are more than 100 years old. Historically important conferences include:
  - Toronto Conference on *The Changing Atmosphere: Implications for Global Security* in 1988
  - UN *Conference on Human Environment* held in 1972
- The United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the UN *Conference on Environment & Development* in Rio de Janeiro in 1992

The slide provides a brief history of the UNFCCC.

Source: *www.unfccc.int*

6

UNFCCC

- International treaty to address challenges of climate change
- 192 countries have ratified
- Entered into force on 21 March 1994

The Convention:

- Recognizes the global, shared problem
- Provides a framework for discussion
- Supports first steps: reporting, assessment, planning
- Establishes principle of "common but differentiated responsibilities"
- Covers mitigation & adaptation

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenges posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 192 countries having ratified. The Convention entered into force on 21 March 1994.

The UNFCCC Secretariat, located in Bonn, supports the negotiation processes, particularly the annual Conference of Parties (COP) (meeting of all signatories to the UNFCCC), the Members of the Parties to the Kyoto Protocol (MOP), and the two Subsidiary Bodies and their Bureau.

One of the key agreements reached was the Kyoto Protocol in which most highly industrialized countries agreed to legally binding measures for reducing emissions.

For the purpose of the Convention, "Adverse effects of climate change" means changes in the physical environment or biota resulting from climate change that can have significant deleterious effects on the composition, resilience, or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.

Under the Convention, governments:

- Gather and share information on greenhouse gas emissions, national policies, and best practices;
- Launch national strategies for reducing greenhouse gas emissions and adapting to expected risks, including the provision of financial and technological support to developing countries; and
- Cooperate in preparing for adaptation to the impacts of climate change.

Source: *www.unfccc.int*

7

Health in UNFCCC legal framework

- Article 1: Definitions – human health & welfare mentioned
- Article 4: Commitments, para 1 (f) – public health mentioned
- Within the biannual National Communication, both non-ANNEX 1 & ANNEX 1 countries are required to report on health co-benefits
- Decision 5 at COP 7 – human health recognized & decision for implementation in health to be supported through Special Climate Change Fund & Adaptation fund

This Article – 1 - is frequently mentioned in discussions of the risks of climate change. Note the concerns at the time the convention was drafted (ecosystems, food production, and economic development). Health and other issues were not explicitly mentioned; their importance became clear with subsequent research and experience.

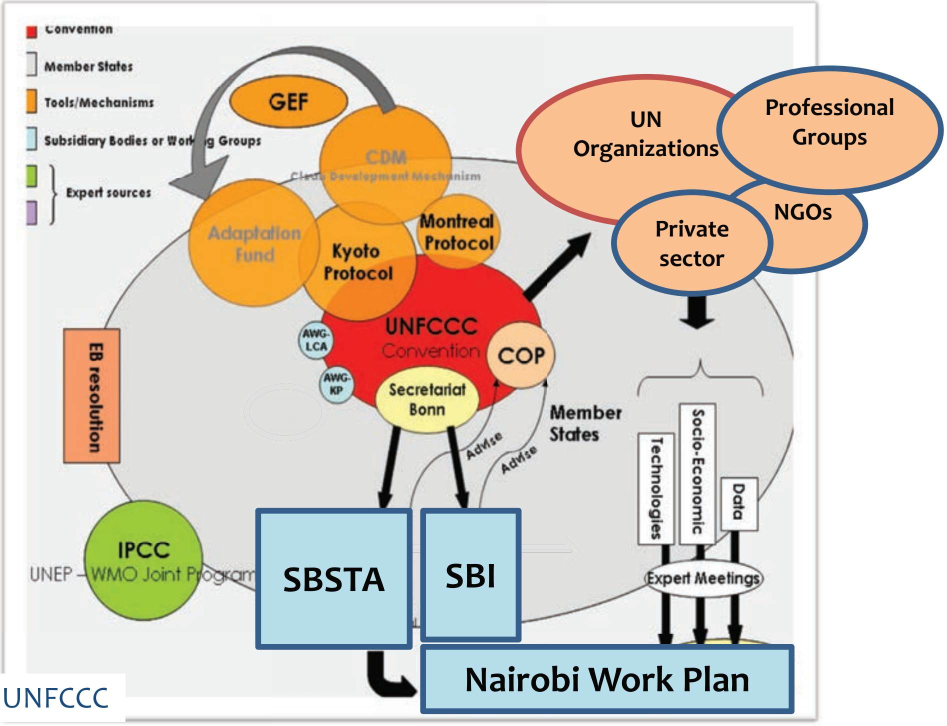
Decision 5/CP.7

Recognizes that the problems of poverty, land degradation, access to water and food, and human health remain at the centre of global attention, and that synergies and channels are needed to achieve sustainable development.

Decides that implementation of the activities in the area of health, among others, should be supported through the Special Climate Change Fund and the Adaptation Fund, and other bilateral and multilateral sources. These are funds established under the Convention but administered by other bodies. Additional funds were established in subsequent COPs, particularly the Green Climate Fund.

Source: *www.unfccc.int*

UNFCCC, its partners & relations



Source: UNFCCC

The Conference of the Parties (COP) is the prime authority of the UNFCC Convention. It is an association of all member countries (or "Parties") and usually meets annually for a period of two weeks. These sessions are attended by several thousand government delegates, observer organizations, and journalists. The COP evaluates the status of climate change and the effectiveness of the treaty. It examines the activities of member countries, particularly by reviewing national communications and emissions inventories; it considers new scientific findings; and it tries to capitalize on experience as efforts to address climate change proceed.

A Subsidiary Body for Scientific and Technological Advice (SBSTA) counsels the COP on matters of climate, the environment, technology, and method. It meets twice a year.

A Subsidiary Body for Implementation (SBI) helps review implementation of UNFCCC and deals with financial and administrative matters. SBI meets twice each year.

Several expert groups exist under the Convention.

Partner agencies include the Global Environment Facility (GEF) who administers grants and loans to poor countries to help them address climate change, as called for by the Convention.

The Intergovernmental Panel on Climate Change (IPCC) provides services to the Convention, although it is not part of it, through conducting comprehensive reviews every 5 to 7 years of the status of climate change and climate-change science, along with special reports and technical papers on request.

SOURCE: *www.unfccc.int*

9

Conference of Parties (COP)

- The COP is the supreme decision-making body of the Convention
- All States that are Parties to the Convention are represented at the COP
- COPs review the implementation of the Convention & any other legal instruments that the COP adopts & take decisions necessary to promote the effective implementation of the Convention
- COP usually meets every year

A key task for the COP is to review the national communications and emission inventories submitted by Parties. Based on this information, the COP assesses the effects of the measures taken by Parties and the progress made in achieving the ultimate objective of the Convention.

COPs review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.

The COP meets every year, unless the Parties decide otherwise. The first COP meeting was held in Berlin, Germany in March, 1995. The COP meets in Bonn, the seat of the secretariat, unless a Party offers to host the session. Just as the COP Presidency rotates among the five recognized UN regions - that is, Africa, Asia, Latin America and the Caribbean, Central and Eastern Europe and Western Europe and Others – there is a tendency for the venue of the COP to also shift among these groups.

Source: *www.unfccc.int*

10

CMP

- **CMP** – The conference of parties serving as the meeting of the Parties to the Kyoto protocol
- All States that are Parties to the Kyoto Protocol are represented at the CMP, while States that are not Parties participate as observers
- Reviews the implementation of the Kyoto Protocol & takes decisions to promote its effective implementation

The CMP meets annually during the same period as the COP. Parties to the Convention that are not Parties to the Protocol are able to participate in the CMP as observers, but without the right to take decisions. The functions of the CMP relating to the Protocol are similar to those carried out by the COP for the Convention.

The first meeting of the Parties to the Kyoto Protocol was held in Montreal, Canada in December 2005, in conjunction with the eleventh session of the Conference of the Parties (COP 11).

The Parties to the Kyoto Protocol also formally adopted the “rulebook” of the 1997 Kyoto Protocol, the so-called ‘Marrakesh accords’, which sets the framework for implementation of the Protocol.

11

Subsidiary Body for Scientific & Technological Advice (SBSTA)

- Supports the work of the COP & CMP through provision of timely information & advice on scientific & technological matters related to the Convention or its Kyoto Protocol
- Key areas of work :
  - Impacts, vulnerability & adaptation to climate change
  - Emissions from deforestation & forest degradation in developing countries
  - Promoting development & transfer of environment-friendly technologies
  - Technical work to improve guidelines for preparing & reviewing greenhouse gas emission inventories from Annex I Parties

The Subsidiary Body for Scientific & Technological Advice, or SBSTA, is one of two permanent subsidiary bodies to the Convention established by the COP/CMP. It supports the work of the COP & CMP through provision of timely information & advice on scientific & technological matters related to the Convention or its Kyoto Protocol.

Key areas of work for the SBSTA are impacts, vulnerability and adaptation to climate change; emissions from deforestation and forest degradation in developing countries; promoting the development and transfer of environmentally-sound technologies; and conducting technical work to improve the guidelines for preparing and reviewing greenhouse gas emission inventories from Annex I Parties. The SBSTA carries out methodological work under the Convention and the Kyoto Protocol, and promotes collaboration in the field of research and systematic observation of the climate system.

In addition, the SBSTA plays an important role as the link between the scientific information provided by expert sources such as the IPCC on the one hand, and the policy-oriented needs of the COP on the other hand. It works closely with the IPCC, sometimes requesting specific information or reports from it, and also collaborates with other relevant international organizations that share the common objective of sustainable development.

The SBSTA and SBI work together on cross-cutting issues that touch on both their areas of expertise. These include capacity building, the vulnerability of developing countries to climate change and response measures, the Kyoto Protocol mechanisms, and key political issues such as the 2013-2015 review, the full spectrum of discussions under the Technology Mechanism, and co-ordination of support for REDD plus.

The SBSTA and the SBI have traditionally met in parallel, twice a year. When they are not meeting in conjunction with the COP, the subsidiary bodies usually convene at the seat of the secretariat in Bonn, Germany.

Source: *www.unfccc.int*

12

Subsidiary Body for Implementation (SBI)

- Supports the work of the COP & the CMP through assessment & review of the effective implementation of the Convention and its Kyoto Protocol
- Advises the COP on budgetary & administrative matters
- Works together with the SBSTA on cross-cutting issues that touch on both their areas of expertise

The SBI is currently shifting to a new and transitional phase towards monitoring, reviewing and verifying (MRV) functions and demonstrating progress in implementing the Bali Action Plan.

In 2013, the SBI had the challenging task of managing the shift in focus towards the MRV issues with the launch of the international assessment and review (IAR) and international consultations and analysis (ICA) in 2014, and work on nationally appropriate mitigation actions (NAMAs). Loss and damage and adaptation finance is another area where progress was made under the SBI by reaching an agreement on a loss and damage mechanism and pledging funds in the range of US$ 100 million to the adaptation fund.

On adaptation, finance and technology transfer, the focus was on finding the best way to manage relevant issues in the SBI agenda while making the best use of the increasing role of the specialized bodies and institutions that have been created in Cancun and Durban and operationalized in Doha (e.g. Adaptation Committee, Standing Committee on Finance, and the Technology Mechanism), to deal with the relevant issues. While the technical discussions under these traditional items are now being taken up under the constituted bodies, the SBI has the responsibility of maintaining the political momentum and ensuring transparency on these matters.

The SBI works together with the SBSTA on cross-cutting issues that touch on both their areas of expertise. These include capacity building, the vulnerability of developing countries to climate change and response measures, the Kyoto Protocol mechanisms, and key political issues such as the 2013-2015 review, the full spectrum of discussions under the Technology Mechanism, the work of the Adaptation Committee and co-ordination of support for REDD plus.

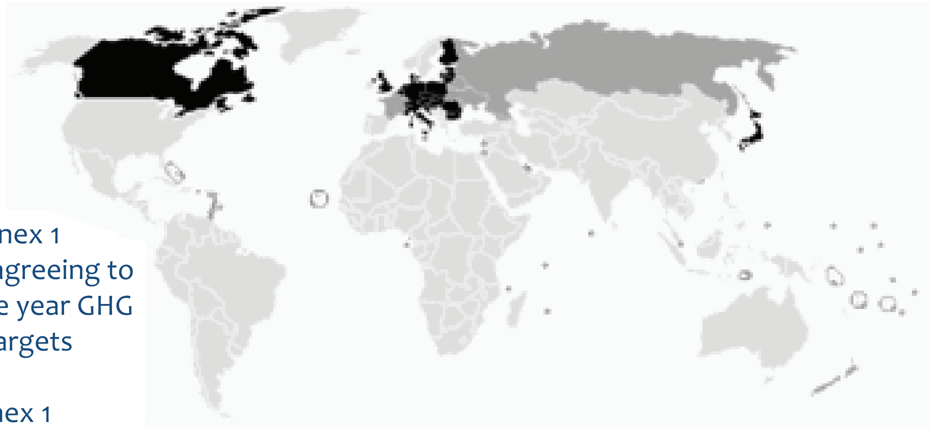
The SBSTA and the SBI have traditionally met in parallel twice a year. When they are not meeting in conjunction with the COP, the subsidiary bodies usually convene at the seat of the secretariat in Bonn.

Source: www.unfccc.int

13

The Kyoto Protocol

- Reaffirmed responsibility of all countries
- Set GHG targets for industrialized countries



Black = Annex 1 countries agreeing to below base year GHG emission targets

Grey = Annex 1 countries agreeing to base year GHG emission targets

Image source: http://en.wikipedia.org/wiki/Kyoto_protocol

The Kyoto Protocol is an international legally binding agreement under the Convention to reduce greenhouse gas emissions worldwide. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community (Annex 1) for reducing greenhouse gas emissions. There are 83 countries and ratifiers of the Kyoto Protocol.

The Protocol's first commitment period began in 2008 and ended in 2012; this was extended while the next agreement is negotiated. The COP in Paris in 2016 is the deadline for the next agreement.

The Kyoto targets are an average of 5% reduction in greenhouse gas emissions below 1990 levels over the five-year period 2008-2012. The major distinction between the Protocol and the Convention is that while the Convention encourages industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.

Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."

Source: *www.unfccc.int*

14

Intergovernmental Panel on Climate Change (IPCC) overview

- Formed in 1988 by the United Nations Environment Program & the World Meteorological Organization to conduct assessments of the state of knowledge of climate change, vulnerabilities to & consequences of any changes, & options to avoid, prepare for & respond to changes
- All governments that signed either the UNEP or WMO convention are members of the IPCC

The next series of slides will cover the history, mandate, and process of the IPCC.

Further information is available at www.ipcc.ch

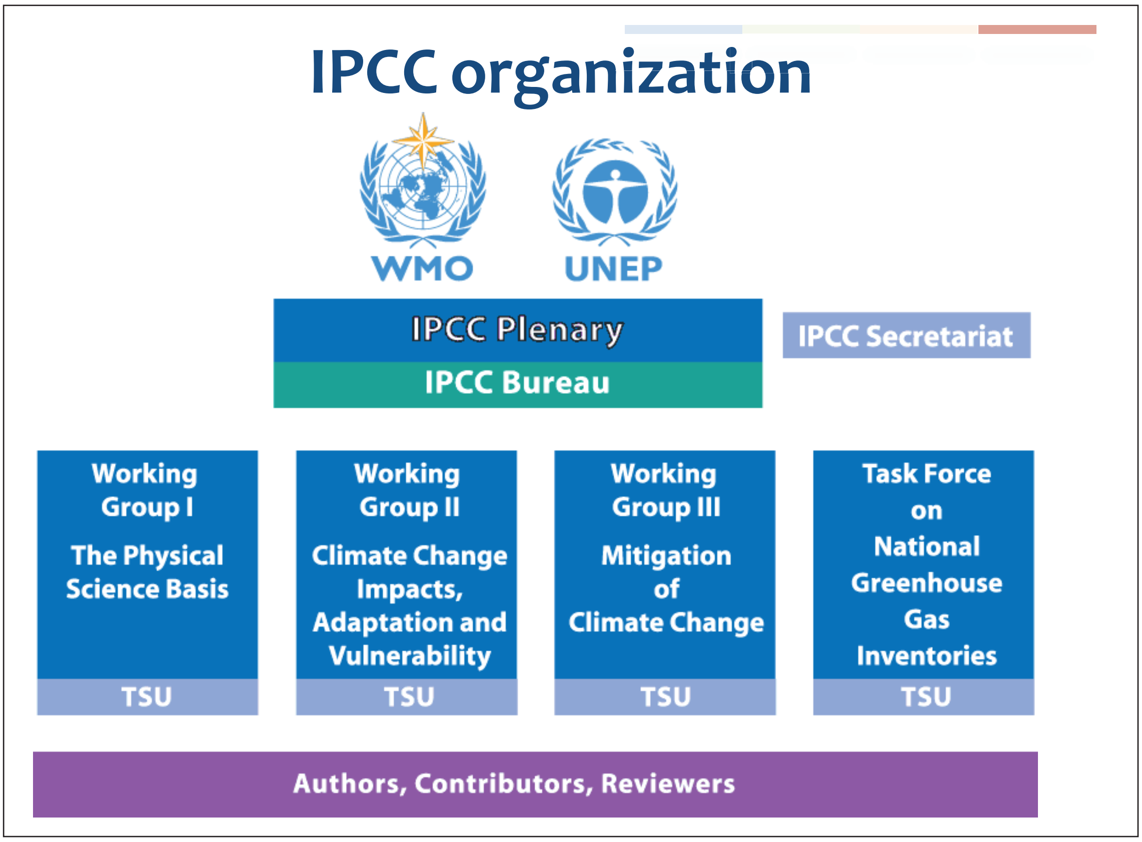
15

IPCC assessment reports

These are the covers of IPCC assessment reports that have been produced

Further information is available at www.ipcc.ch

16



The IPCC holds annual meetings (or plenaries) where the government representatives meet to take decisions relative to the work of the IPCC. To further support the work of the Working Groups, a Bureau meets twice a year to discuss progress on assessment reports and other related issues. The IPCC Secretariat supports the work of the Plenary and Bureau; it is based in Geneva, Switzerland in the WMO building.

Under the Plenary are a Task Force on National Greenhouse Gas Inventories (based in Japan) and, when assessment reports are being conducted, Working Groups to conduct the assessments. Traditionally there have been three Working Groups, one on the physical science basis; one on impacts, adaptation, and vulnerability; and one on mitigation. The number and focus of Working Groups is up to the Plenary. There are many discussions on possible organization of Working Groups for the next assessment report. Each Working Group is led by two Co-Chairs, one from a developed and one from a developing country.

A Technical Support Unit supports each Working Group. It is their job to run the assessment.

The assessment reports are the work of the authors, contributors, and reviewers, all of whom are volunteers. Authors volunteer about 6-9 months of time during an assessment.

Source: *www.unfccc.int*

17

Role of Governments

- Governments request the scientific community to conduct comprehensive assessments
- Governments elect a Bureau to ensure assessments are conducted following the IPCC Rules & Procedures
- Proposed outlines are discussed & approved line-by-line by the governments in a Plenary
- Bureau approves the chapter author teams
  – Based on scientific expertise, geography & gender

Governments are members of the IPCC. As such, it is up to them to request the scientific community to conduct assessments. Governmental also elect the Bureau that ensures assessments are conducted following the IPCC Rules and Procedures; each Working Group Bureau has one representative from each WMO region. Governments also discuss and approve outlines for assessment reports. Governments and organizations officially recognized by the IPCC nominate authors for each Working Group assessment report.

A Working Group Bureau approves the author teams for its Working Group. Authors are chosen based on their scientific expertise, and to achieve geographic and gender balance. The IPCC mandates that 40% of a Working Group author team be from developing countries.

18

Role of Governments

- Governments participate in the review process & in the IPCC Plenary sessions, where main decisions about the IPCC work program are taken & reports are accepted, adopted, & approved
- Summary for Policymakers approved line-by-line by the governments in a final Plenary

Other activities of governments are to participate in the review process for an assessment report and the Plenary sessions.

The last step of an assessment report is for governments to approve the Summary for Policymakers. This is done in a Plenary where the SPM is discussed and approved line-by-line. Approval is by consensus; all governments have to agree to each word in a SPM.

19

IPCC: correcting misperceptions

- *Does not* conduct research or monitor trends
- *Does* conduct comprehensive assessments
- *Does* provide statements that are policy-relevant & policy-neutral
- Review is an essential part of the IPCC process, to ensure an objective & comprehensive assessment
- Differing viewpoints existing within the scientific community are reflected in the IPCC reports

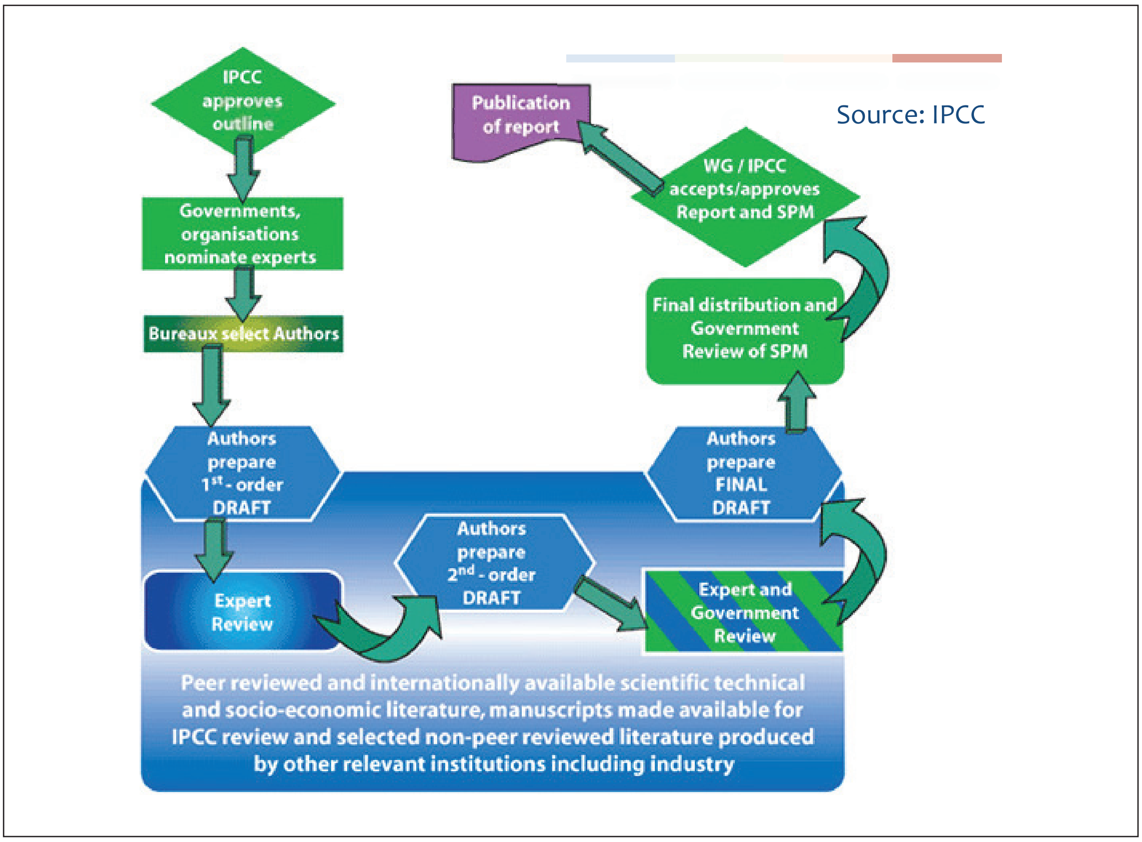
A few notes on the IPCC to correct any misperceptions. The IPCC does not conduct research or monitor trends. It does conduct comprehensive assessments, providing statements that are policy relevant while being policy neutral.

Assessment reports need to provide the full range of viewpoints in the scientific community.

Review is an essential component of the IPCC process, helping ensure objective and comprehensive assessments.

Q: Have any of you participated in a Plenary or assessment report? If so, can you tell us about your experiences?

20



The diagram I'll show you in a minute outlines the process of an IPCC assessment. **CLICK** to show diagram. This starts with the approval by the Plenary of an outline for the report (point). This is called a Plenary Approved Outline and is posted on the IPCC and Working Group websites. It is a high level summary of what the Working Group commits each chapter to cover, at a minimum.

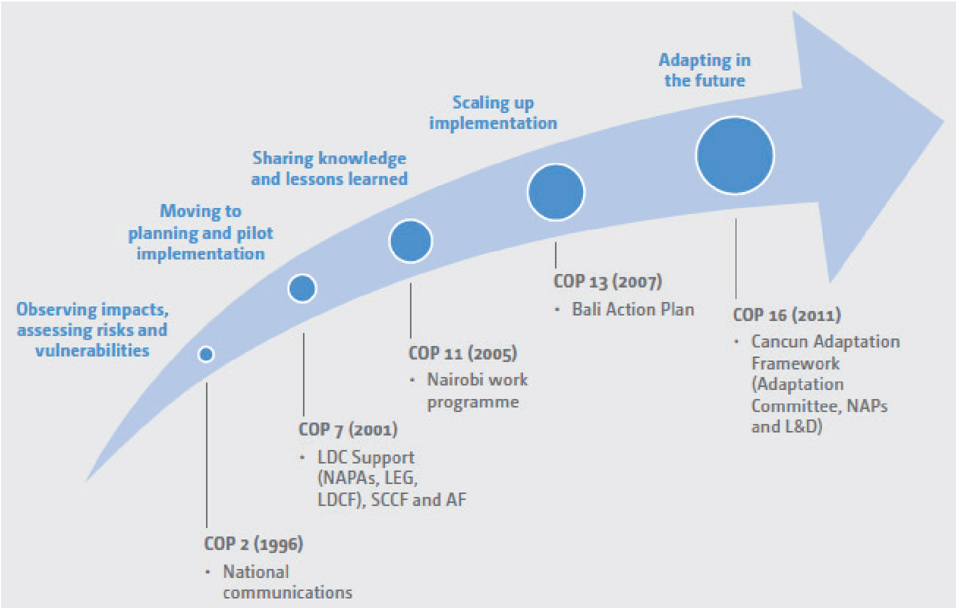
There is a formal process by which governments and organizations nominate experts to be considered as authors. In the 5th Assessment Report, approximately three times as many people were nominated as were selected to be authors. As noted previously, the author team needs to include the relevant expertise, to represent all world regions, and to be gender balanced to the extent possible. The Working Group Bureau then approves the author team, sometimes with modifications to improve expertise and balance. Each author team includes a few Coordinating Lead Authors who are tasked with leading the work of the chapter; Lead Authors who conduct assessments on particular topics in the chapter; and Review Editors whose job is to ensure that all review comments are adequately addressed.

The above figure explains the entire process. For more information please visit www.ipcc.ch

21

We've covered some foundational information on the UNFCCC and IPCC. Let's now look at UNFCCC activities on adaptation to climate change.

Adaptation mechanisms under the UNFCCC



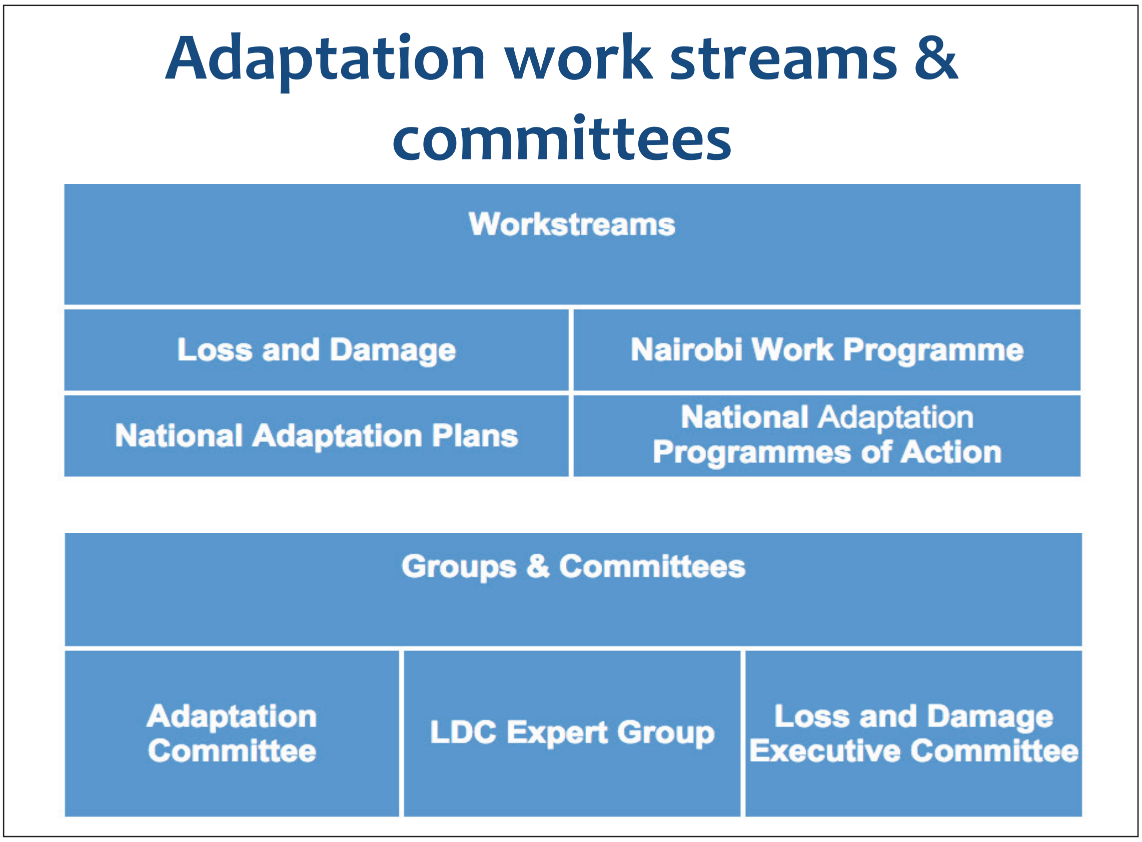
This slide lists the adaptation mechanisms agreed under the Convention, the dates they were agreed, and how these agreements relate to the process of adaptation.

All signatories to the Convention are required to submit regular National Communications. These are all available on the UNFCCC website.

LDC support included National Adaptation Programmes of Action (NAPAs) to identify their most urgent and immediate adaptation needs. The Least Developed Country Expert Group (LEG) provided guidance for conducting the NAPAs. COP 7 also agreed the Least Developed Country Fund, the Special Climate Change Fund, and the Adaptation Fund. Important milestones in adaptation mechanisms under the Convention were the Nairobi Work Programme, the Bali Action Plan, and the Cancun Adaptation Framework. The later included an agreement on supporting LDCs to conduct National Adaptation Plans (NAPs) to identify their medium-term adaptation needs. Discussions also were started in COP 16 on the issue of Loss and Damage; this considers the issue of compensation to developing countries because of the impacts they are experiencing from climate change when their emissions contributed little to the impacts.

Source: *www.unfccc.int*

23



Four UNFCCC work streams, two committees and one group form the basis of the efforts to increase adaptation to climate change.

24

National Communications

All Parties must report on the steps they are taking or envisage undertaking to implement the Convention:

- National Communications Annex I
- National Communications from Non-Annex I Parties

Under the Convention, all Parties should report on the steps they are taking to implement the Convention (Articles 4.1 and 12). In accordance with the principle of "common but differentiated responsibilities" enshrined in the Convention, the required contents of these National Communications and the timetable for their submission is different for Annex I and non-Annex I Parties.

Annex 1 Parties (developed countries as negotiated under the Convention) provide National Communications on a regular schedule. Most of the 41 Annex I Parties submitted their first national communication in 1994 or 1995, their second in 1997–1998, the third in 2001 – 2002, etc. Since 1996, Annex I Parties also submit an annual inventory of their greenhouse gas (GHG) emissions to the Secretariat.

Each non-Annex I Party were supposed to submit its initial communication within three years of the entry into force of the Convention for that Party, or of the availability of financial resources (except for the Least Developed Countries, who did so at their discretion). All Parties have completed their First National Communication, most their Second, and some are working on their 4th.

All National Communications are available on the UNFCCC website.

This slide can be used to ask participants if they have read their National Communications or if they participated in producing it.

Source: *www.unfccc.int*

National Adaptation Programmes of Action (NAPA)

- In 2001, COP established a Least Developed Country (LDC) work program which included NAPAs
- NAPAs to support LDCs to identify priority activities that respond to their urgent & immediate needs
- COP also established a LDC fund to fund preparation & implementation of NAPAs

In implementing Article 4.9 of the Convention, the COP, in 2001, established an LDC work programme, that included NAPAs, to support LDCs to address the challenge of climate change given their particular vulnerability. The COP also established a Least Developed Countries Fund (LDCF) to fund the preparation and implementation of NAPAs and an LDC Expert Group to provide technical support and advice to the least developed countries (LDCs).

NAPAs provide a process for the LDCs to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change - those needs for which further delay could increase vulnerability or lead to increased costs at a later stage. The rationale for NAPAs rests on the limited ability of the LDCs to adapt to the adverse effects of climate change. In the NAPA process, prominence is given to community-level input as an important source of information, recognizing that grassroots communities are the main stakeholders. NAPAs use existing information and no new research is needed. They are action-oriented, country-driven, are flexible and based on national circumstances. In order to effectively address urgent and immediate adaptation needs, NAPA documents are presented in a simple format, easily understood both by policy-level decision-makers and the public.

contd...

25

National Adaptation Programmes of Action (NAPA)

- In 2001, COP established a Least Developed Country (LDC) work program which included NAPAs
- NAPAs to support LDCs to identify priority activities that respond to their urgent & immediate needs
- COP also established a LDC fund to fund preparation & implementation of NAPAs

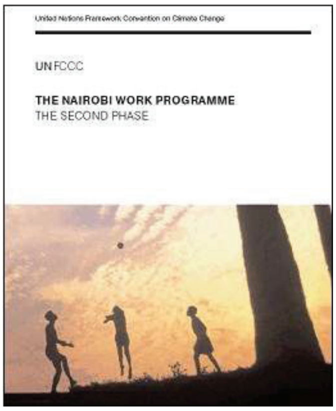
As at November 2013, 50 countries* had completed and submitted their NAPAs to the secretariat. The main content of the NAPA document is a list of ranked priority adaptation activities/projects, as well as short profiles of each activity, designed to facilitate the development of project proposals for implementation of the NAPA. Priority sectors/ areas addressed in the NAPAs are agriculture and food security, water resources, coastal zones, and early warning and disaster management. Most LDCs are in the process of implementing their NAPAs.

Once a NAPA has been submitted to the UNFCCC secretariat, the LDC Party is eligible to access funding under the Least Developed Countries Fund (LDCF), which is managed by the Global Environment Facility (GEF), for the implementation of the NAPA. To initiate the process of accessing funding, an LDC Party prepares a concept note and requests the assistance of a GEF implementing agency (currently there are 10 of them) for submitting a project identification form and then a full project proposal to the LDCF. The GEF agency works closely with the country during each successive step of the LDCF cycle, and ultimately supports the country in implementing the project.

The Nairobi Work Programme (NWP)

The Nairobi work programme on impacts, vulnerability & adaptation to climate change assists all Parties (in particular developing countries, including LDCs & SIDS), to:

- Improve their understanding & assessment of impacts, vulnerability & adaptation; &
- Make informed decisions on practical adaptation actions



The **NWP** was mandated by the Subsidiary Body for Scientific and Technological Advice (**SBSTA**) as a five-year programme (2005-2010) whose objective was to assist all Parties, particularly developing countries, including the LDCs and Small Island Developing States (SIDS), to:

- Improve their understanding and assessment of impacts, vulnerability and adaptation to climate change; and
- Make informed decisions on practical adaptation actions and measures to respond to climate change on a sound scientific, technical and socio-economic basis, taking into account current and future climate change and variability.

The NWP is structured around 9 areas of work (listed. During the 1st phase, which ended in June 2008, workshops and expert meetings allowed Parties to identify gaps and needs, and make recommendations for possible next steps in each area of work/ Workshops were conducted on a range of topics, including Climate-related risks and extreme events; Adaptation planning and practices, Socio-economic information, and Climate modelling, scenarios and downscaling.

The 2nd phase of the NWP emphasises activities dealing with economic diversification; adaptation planning and practices; and community, national and regional activities, including those based on education, training, and awareness-raising.

In addition, the following forms of engagement are being e enhanced throughout the second phase: (1) Calls for Action, (2) Action Pledges, and (3) Engaging the private sector.

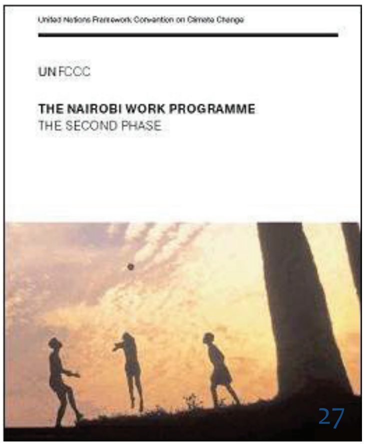
Source: *www.unfccc.int*

27

The Nairobi Work Programme

9 areas of work:

- Climate-related risks & extreme events
- Adaptation planning & practices
- Socio-economic information
- Methods & tools
- Data & observations
- Economic diversification
- Research
- Climate modeling, scenarios & downscaling
- Technology for adaptation



27

The NWP was mandated by the Subsidiary Body for Scientific and Technological Advice **(SBSTA)** as a five-year programme (2005–2010) whose objective was to assist all Parties, particularly developing countries, including the LDCs and Small Island Developing States (SIDS), to:

- Improve their understanding and assessment of impacts, vulnerability and adaptation to climate change; and
- Make informed decisions on practical adaptation actions and measures to respond to climate change on a sound scientific, technical and socio-economic basis, taking into account current and future climate change and variability.

The NWP is structured around the 9 areas of work listed. During the 1st phase, which ended in June 2008, workshops and expert meetings allowed Parties to identify gaps and needs, and make recommendations for possible next steps in each area of work/ Workshops were conducted on a range of topics, including Climate-related risks and extreme events; Adaptation planning and practices, Socio-economic information, and Climate modelling, scenarios and downscaling.

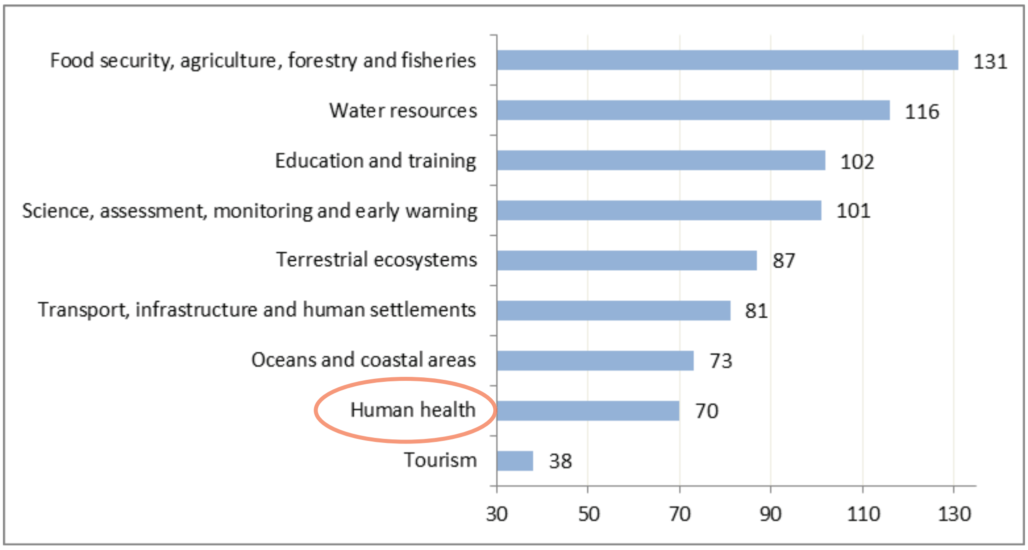
The 2nd phase of the NWP emphasises activities dealing with economic diversification; adaptation planning and practices; and community, national and regional activities, including those based on education, training, and awareness-raising.

In addition, the following forms of engagement are being enhanced throughout the second phase: (1) Calls for Action, (2) Action Pledges, and (3) Engaging the private sector.

Source: *www.unfccc.int*

28

Number of Nairobi work programme partner organizations by sector



Source: UNFCCC (2014)

Note: A partner organization may address issues related to more than one sector.

Source: *http://unfccc.int/resource/docs/2014/sbsta/eng/inf07.pdf, page 11*

29

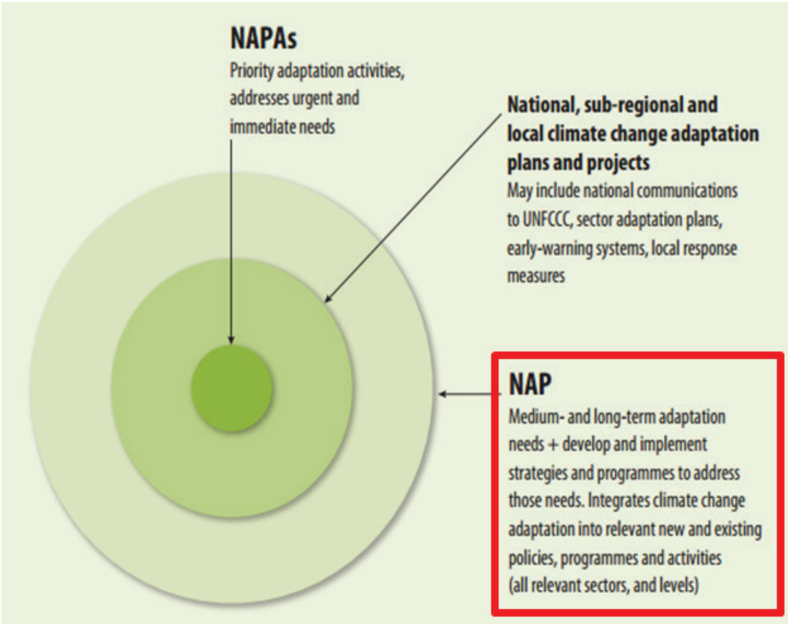
National Adaptation Plans (NAP)

- To reduce vulnerability to the impacts of climate change, by building adaptive capacity & resilience
- To facilitate the integration of climate change adaptation, in a coherent manner, into relevant new & existing policies, programmes & activities, in particular development planning processes & strategies, within all relevant sectors & at different levels, as appropriate

The objectives of the NAPs are extremely relevant to the protection of human health against adverse effects of climate change.

The national adaptation plan (NAP) process was established under the Cancun Adaptation Framework (CAF). It enables Parties to formulate and implement national adaptation plans (NAPs) as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is a continuous, progressive and iterative process which follows a country-driven, gender-sensitive, participatory and fully transparent approach.

Difference between NAPs & NAPAs



NAPs were developed building on NAPAs

New opportunities for health

NAPAs – National Adaptation Programmes of Action were addressing urgent and immediate adaptation needs.

NAPs – National Adaptation Plans address medium and long-term national adaptation needs. Issues related to vulnerable groups, communities and ecosystems have been identified. NAPs are keen on integrating climate adaptation into national development processes.

31

Loss & Damage work programme

- Failed mitigation & adaptation
- For most vulnerable countries
- Compensation from developed countries
- Institutional mechanism established

Another area under the Subsidiary Body for Implementation is the Loss and Damage work programme.

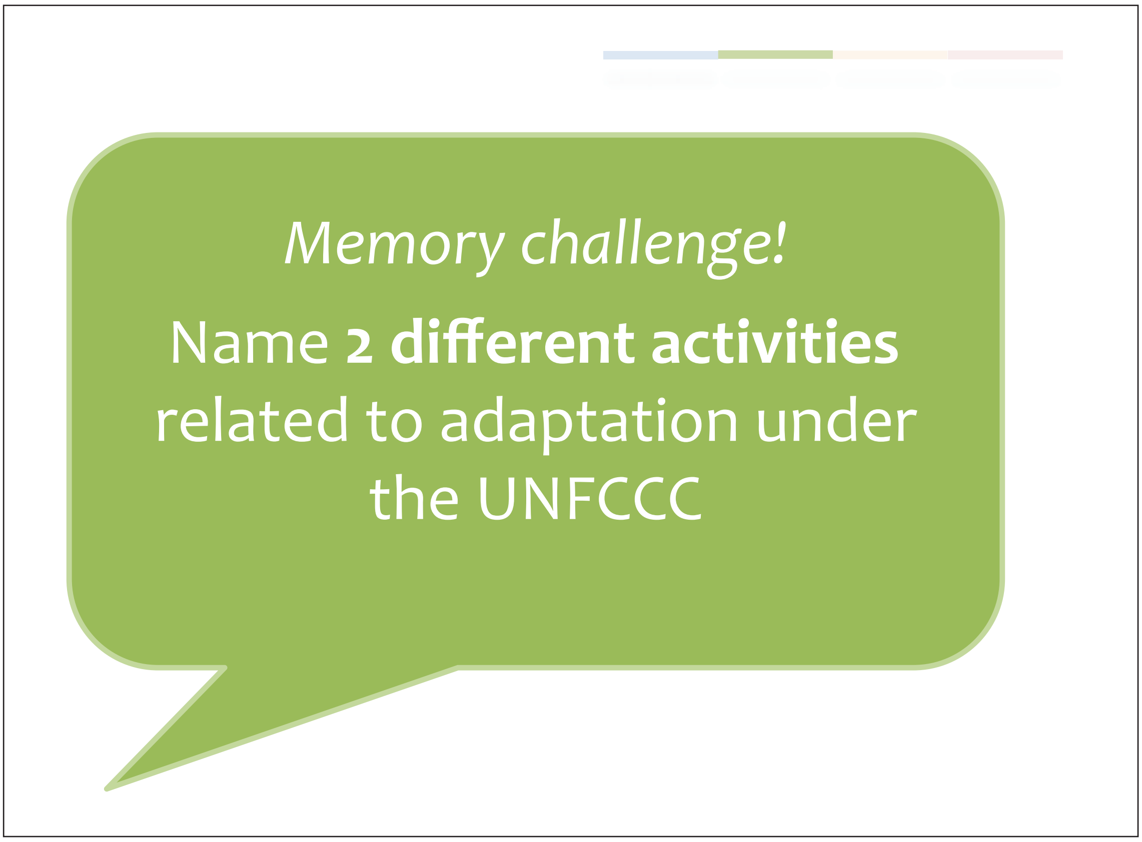
Loss and damage due to climate change happens when countries fail to both mitigate and to adapt to some effects of climate change. Climate change causes loss of livelihood, economic loss and of course loss of health as well.

Loss and damage is common in the most vulnerable communities with the least resources.

There is the idea of developed countries compensating for the loss and damage due to climate change paying for the damage that their greenhouse gas emission has caused.

During COP 18 (2012) in Doha, Countries agreed to establish an institutional mechanism on loss and damage.

32



Ok, I've introduced you to a range of different adaptation activities under the UNFCCC.

"On your notes page, write two that you can remember." Give everyone 30 seconds.

"Ok, did everybody come up with at least two activities?"

33

3

Financial mechanisms

In this third section we're going to look at some of the financial mechanisms available under the UNFCCC to support action on climate change in the health sector.

34

Financial Mechanisms

- Global Environment Facility (GEF)
  - Least Developed Country Fund (LDCF)
  - Special Climate Change Fund (SCCF)
- Green Climate Fund (GCF)
- Adaptation Fund (AF)

The three most relevant financial mechanisms under or entrusted by the Framework Convention on Climate Change are:

- Global Environment Facility (GEF), which is made up of the:
  - Least Developed Country Fund (LDCF)
  - Special Climate Change Fund (SCCF); and the
- Green Climate Fund (GCF) and
- Adaptation Fund (AF)

35

Global Environment Facility (GEF)

- A global partnership among 178 countries to address global environmental issues while supporting national sustainable development initiatives
- The designated financial mechanism for the UNFCCC (among others)
- GEF supports projects in climate change mitigation & climate change adaptation

The Global Environment Facility (GEF) is a global partnership among 178 countries, international institutions, non-governmental organizations (NGOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives. GEF is the designated financial mechanism for a number of multilateral environmental agreements (MEAs) or conventions, including the UNFCCC. The GEF assists countries in meeting their obligations under the conventions that they have signed and ratified. These conventions and MEAs provide guidance to the two governing bodies of the GEF: the GEF Council and the GEF Assembly.

The GEF is the largest funder of projects to improve the global environment. Since 1991, GEF has provided US$8.26 billion in grants and leveraged US$33.7 billion in co-financing for over 2200 projects in over 165 countries. The GEF provides grants for projects related to the following six focal areas: biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants.

GEF projects in climate change help developing countries and economies in transition to contribute to the overall objective of the UNFCCC "to achieve [...] stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." As the financial mechanism of the UNFCCC, GEF allocates and disburses about US$250 million dollars per year in projects in energy efficiency, renewable energies, and sustainable transportation. It manages the Least Developed Countries Fund and the Special Climate Change Fund.

contd...

35

Global Environment Facility (GEF)

- A global partnership among 178 countries to address global environmental issues while supporting national sustainable development initiatives
- The designated financial mechanism for the UNFCCC (among others)
- GEF supports projects in climate change mitigation & climate change adaptation

GEF supports projects in:

- Climate Change Mitigation: Reducing or avoiding greenhouse gas emissions in the areas of renewable energy, energy efficiency, and sustainable transport.
- Climate Change Adaptation: Aiming at increasing resilience to the adverse impacts of climate change of vulnerable countries, sectors, and communities.

Source: *The Global Environment Facility. www.thegef.org*

36

Adaptation funds

- **Least Developed Country Fund**
- **Special Climate Change Fund**
  – Set up to finance projects relating to adaptation: technology transfer & capacity building; energy, transport, industry, agriculture, forestry & waste management; & economic diversification
- **Adaptation Fund**
  – Set up under the Kyoto Protocol to finance the full costs of adaptation in developing countries that are parties to the Kyoto Protocol. May be replaced by the Green Climate Fund
- **Green Climate Fund**

These are the four adaptation funds under the Convention. Despite several years of negotiations, the Adaptation Fund is only now operational. The Green Climate Fund was recently agreed, with its mandate and process still to be determined.

Source: *www.unfccc.int*

Opportunities for health via Adaptation Fund

Several expected results of the Fund Framework in line with protection of human health:

- **Output 1:** Risk & vulnerability assessments conducted & updated at a national level
- **Output 2:** Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic & environmental losses
- **Output 4:** Vulnerable physical, natural & social assets strengthened in response to climate change impacts
- **Output 7:** Improved integration of climate-resilience strategies into country development plans

There are a range of opportunities for health to be supported via the Global Environment Facility.

- The project "Assisting non-LDC developing countries with country driven process to advance national adaptation plans" provides an opportunity for non-LDC countries to access funds for NAPA.
- The GEF runs two trust funds under the UNFCCC: the LDCF and the SCCF. The LDCF is targeted at LDC countries. The LDCF:
  - Focuses on urgent and immediate adaptation needs of developing countries.
  - Funds the preparation of NAPAs and focuses on several sectors, including health.

Source: *GEF. 2014. How to access LDCF resources, http://www.thegef.org/gef/node/4433*

38

Opportunities for health via GEF

Special Climate Change Fund (SCCF)

- Open to all developing countries
- Wider time windows & wider range of adaptation options
- Adaptation given preference, but technology transfer, mitigation & economic diversification also considered

Source: GEF - How to access SCCF resources

While LDCF focuses on adaptation the SCCF covers a wider range of activities including mitigation, economic diversification and technology transfer and within adaptation addresses longer-term adaptation options. It is open to all developing countries, not only LDCs.

More information is available at GEF. 2014. 'Accessing Resources under the Special Climate Change Fund' at http://thegef.org/gef/sites/thegef.org/files/publication/23470_SCCF.pdf

Opportunities for health via Green Climate Fund (GCF)

- Established at COP16, reports to COP
- Objective: Mobilize & administrate US$100 billion by 2020 (including $30 billion fast-starting financing by 2012)
- 50% adaptation, 50% mitigation
- Finance result-based
- Results area ‘Population, health & well-being’
- Readiness programme for countries prepared to comply with the requisites of the fund

Source: http://news.gcfund.org/

The Green Climate Fund is currently being operationalized. The methodologies for project proposals submissions and agencies accreditation are being currently developed.

It has been agreed in the last meeting that contributions from donors and parties can’t be earmarked.

50% of funds will be allocated to mitigation and 50% to adaptation.

As the finance is results-based, the projects will be evaluated against the defined results areas. Luckily a health-based results area has been included as part of the 13 results areas listed so far by the Fund. The areas is called: “population, health and well-being”.

The readiness programme is designed to help countries prepared to comply with the requisites of the fund - meeting required standard for direct assess, be able to monitor and report on results, develop strategies and plans, needs assessments and gap analysis, etc.

Source: *Green Climate Fund. 2014. http://news.gcfund.org/*

40

Opportunities for health via GCF

- Indirect links can be made to several program areas under the Population Health & Well-being results area:
- *Mitigation logic model & performances measurement framework* – Greening of health facilities
- *Adaptation logic model & performance measurement framework* – Several results mention health directly

The Green Climate Fund is a great emerging opportunity. Let's take a quick look at the results areas and expected results of the Fund.

Within the mitigation area, there are no specific mentions of health, but indirect links can be made to several programme areas as explained in the slide, areas as listed:

- Building and appliances energy efficiency (health facilities)
- Building access to low-carbon energy sources (health facilities)
- Knowledge on green transportation alternatives (health sector to provide information to populations)

In the adaptation logic model:

- Enhanced human health and well-being
- Climate Change adaptation mainstreamed into governments are societies

Adaptation performance measurement framework:

- Enhanced human health and well-being
- Increased coverage of vector borne and infectious disease prevention programmes
- Increased supply and sustainable use of clean water
- Climate Change Adaptation mainstreamed into governments and societies
- Increase awareness of climate change threats and self-help responses among vulnerable groups
- Strengthened awareness and adaptive capacity of health systems and vulnerable groups
- Infrastructure and the built environment more resilient to climate change threats

Opportunities for health via Adaptation Fund

Several expected results of the Fund Framework in line with protection of human health:

- **Output 1:** Risk & vulnerability assessments conducted & updated at a national level
- **Output 2:** Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic & environmental losses
- **Output 4:** Vulnerable physical, natural & social assets strengthened in response to climate change impacts
- **Output 7:** Improved integration of climate-resilience strategies into country development plans

Many of the expected results within the Adaptation Fund Results Framework are in line with the protection of human health. This is a list of the results that relate more closely to the health sector:

Output 1: Risk and vulnerability assessments conducted and updated at a national level

1.2 Development of early warning systems

Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses

2.1.1. No. of staff trained to respond to, and mitigate impacts of, climate-related events

2.2.1. Percentage of population covered by adequate risk-reduction systems

Output 4: Vulnerable physical, natural, and social assets strengthened in response to climate change impacts, including variability

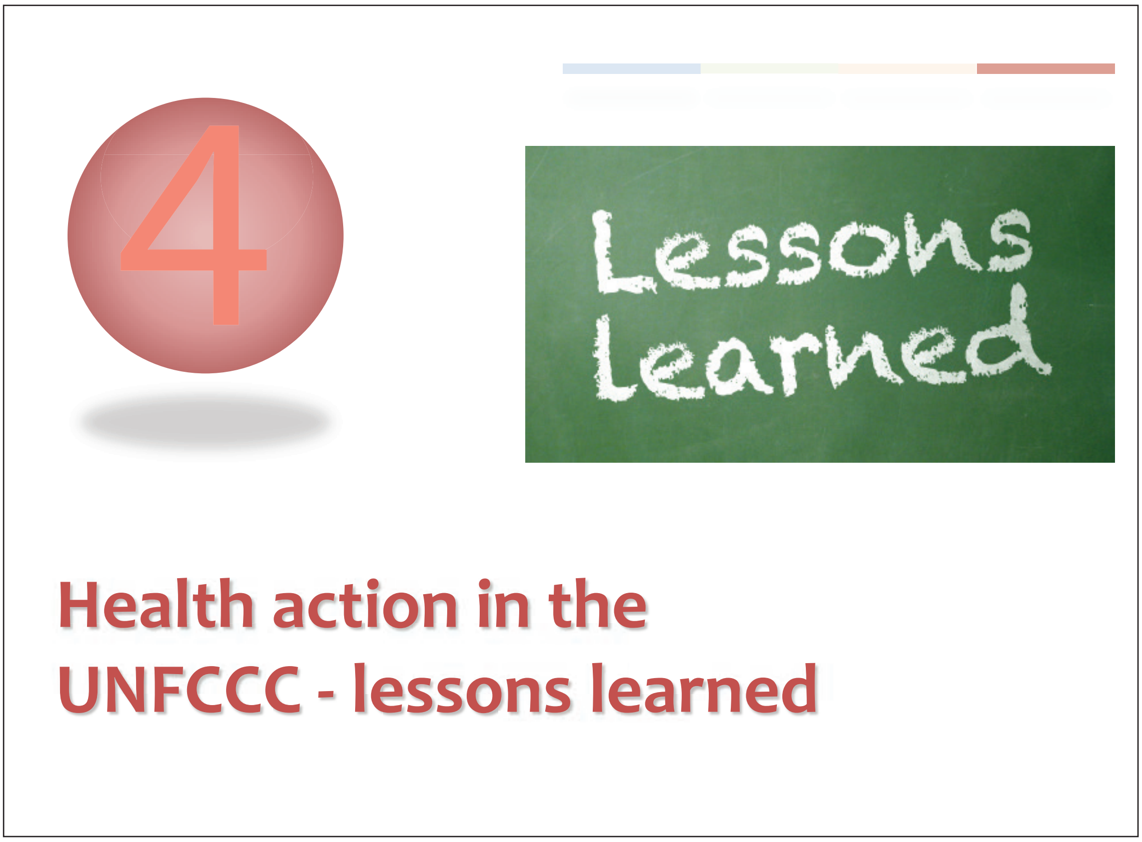
4.1. Development sectors' services responsive to evolving needs from changing and variable climate

4.1.1. No. and type of health or social infrastructure developed or modified to respond to new conditions resulting from climate variability and change (by type)

Output 7: Improved integration of climate-resilience strategies into country development plans

7.1. No., type, and sector of policies introduced or adjusted to address climate change risks

42



Lastly, we'll look at actions around health within the United Nations Framework Convention on Climate Change, including what's been learnt throughout the UN process around climate change and health.

43

Lessons learned

- Poor engagement of health sector in UNFCCC negotiations
- Health mentioned only once in 200-page draft agreement proposed at Copenhagen UNFCCC CoP
- Only one of the 323 side events at COPs focussed on health
- One percent of global climate funds allocated to health projects
- Of the 13 main economic models to inform climate mitigation decisions, only one incorporated health co-benefits

So why has health been undervalued in the UNFCCC negotiations so far?

Firstly, it may have something to do with the relative lack of engagement of the health sector , due to lack of understanding of the impacts of climate on health.

Secondly, the health sector uses a different language compared to the economic sector or the climate change negotiations.

Thirdly, the climate change negotiations is very market and economy-centred as opposed to health-centred or right-based.

44

Lessons learned

Health community absent from the NAPA process

Lack of technical assistance

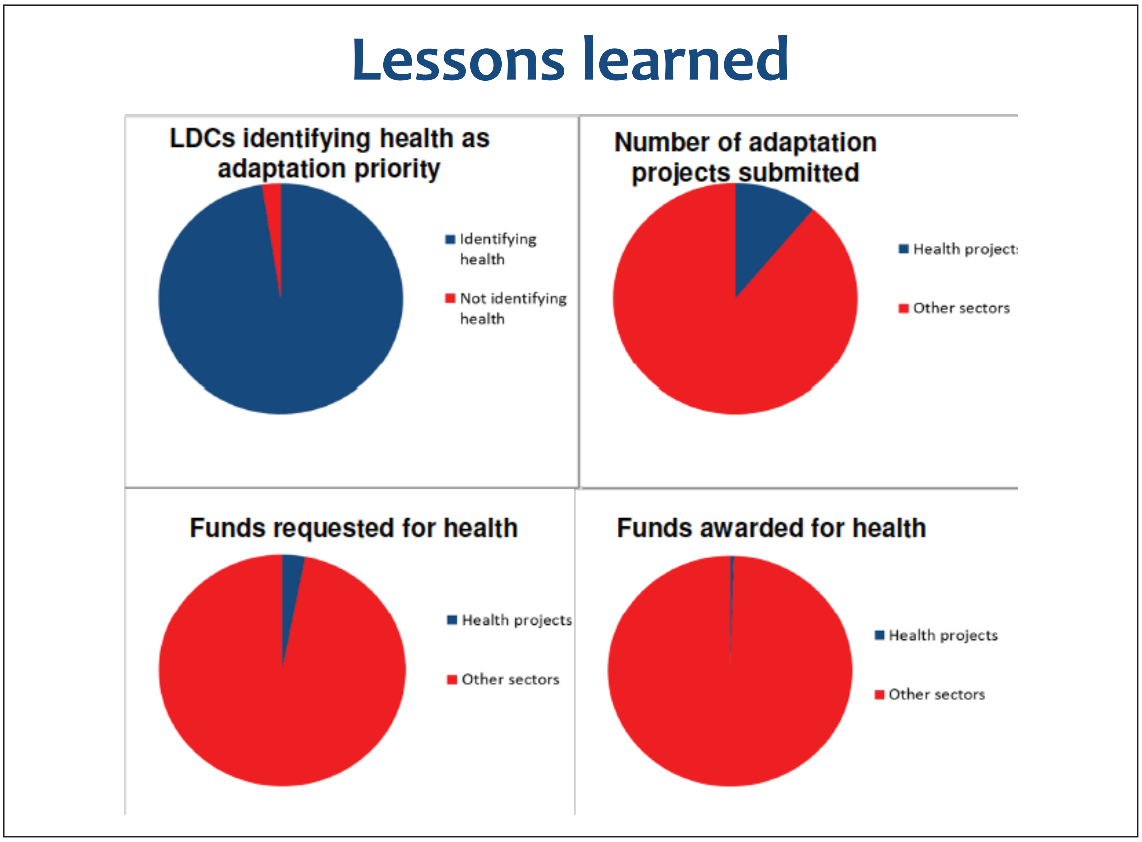
↓

Under-representation of health in NAPA projects and funds allocation

Limited submissions to LDCF

The LDCF was tasked with funding the development and implementation of NAPA. However due to the limited presence of the health community in NAPA processes and the consequent lack of technical assistance, the health sector have submitted very few proposals to the LDCF.

However, this is changing within the NAP (National Adaptation Plans) processes - technical assistance is now provided and the health sector's capacity to benefit from financial support for the development of the new NAPs has increased.



Over 95% of LDCs identified health as a priority sector for climate adaptation

- 73% included health interventions within adaptation needs and proposed actions.
- Less than 30% had adequate health vulnerability assessments and health adaptation plans.
- health has received ~ $2.5 million of $1.3 billion (0.2%) of support granted under the UNFCCC.

Health is represented by ~20 of the 10 000 participants (0.2%) in the UNFCCC Conference of the Parties.

This slide can be used to ask if any of the participants have been to a COP.

Source: *IPCC, Summary for policy makers, 4th Assessment report, 2007; Haines A, McMichael AJ, Smith KR, et al. Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. Lancet 2009; 374:2104-14.*

What's been done to address this?

1. WHO & partners organized conferences on climate & health, health side events during COPs to build engagement
2. WHO, IPCC, researchers provided scientific evidence on health impacts of climate change & learning tools
3. WHO & partners provide technical expertise - Vulnerabilities & Adaptation Assessment, Health NAPs, etc.
4. Preparatory workshops for COP on health & environment (WHO-GIZ)

In order to address previous difficulties, several action have been taken in the last years. WHO has been strongly advocating for the mainstreaming of health within the climate change debates.

To the problem of "poor engagement of the health sector" .. (read point 1)

To the difficulty of lack of knowledge on climate impacts .. (read point 2) – including this guidance document pictured.

To the issues of the lack of technical assistance.. (read point 3).

To the lack of understanding of processes, WHO, with support from the German sustainable development support organisation GIZ, have organised .. (read point 4).

47

What needs to be done?

- Health should be central in negotiations:
  - Main reasons for climate concern (e.g. disasters, food shortage, displacement, disease) are health & wellbeing issues
  - Most energy & environment decisions have major direct health implications
  - Addressing climate change = sustainable development = health protection
- Need to improve representation in COPs & actively participate in negotiations on high health priority areas

This summary recalls the entry points for health in the UNFCCC.

48

The health sector have great opportunities ahead to promote health as a key reason for the need to win the battle against climate change. These include…

Read the list of opportunities

Looking at the different mechanisms we've discussed, let's finish off by examining the opportunities for health of each of these work programmes.

Opportunities for health in Nairobi Work Programme

- Consult information in the NWP
- Inform NWP on health adaptation activities
- Provide tools to NWP regarding evaluation of health impacts & vulnerabilities
- Become NWP partners
- Participate in workshops & meetings organized by NWP

The health sector can engage in multiple ways, from informing NWP of its activities to actively participating in workshops and meetings.

Under the submissions welcome in the revision of the NWP for COP19, Australia made a submission on how health should be one of the future areas of the work of NWP and how the health sector should be engaged in this process.

- To incorporate health in NWP, we need to call for:
- Greater health sector engagement and representation in climate change adaptation projects

The health sector can also offer technical and policy support for assessment and for implementation.

50

Opportunities for health in NAPs

NAPs

- Recognize health as a priority sector
- Can identify national strategies & goals to build health resilience
- Health assessments in Health National Action Plans can provide evidence of losses

Health sector

- Can access funds from LDCF, GEF & AF
- Engage with general NAPs to ensure adaptation activities don't harm health
- Promote health co-benefits across health-determining sectors

There are several opportunities for health to engage with general NAPs processes. These include: READ

CLICK to show 'Health sector' section. The health sector can…READ

Health ties in very closely with the work programme on loss and damage.

- Negative health effects of climate change must be recognized as one of the losses due to climate change - Evidence is embedded in NAPs.
- There needs to be health risk assessment and assessment of the impact on health that includes slow-onset impacts.
- Health assessment should also include the concept of loss and damage and the health sector should find a common way to address loss and damage, and engage in the definition of what is "loss".
- There needs to be estimation of how much health loss costs.
- Negative health effects must also be covered by the compensation mechanism for loss and damage.

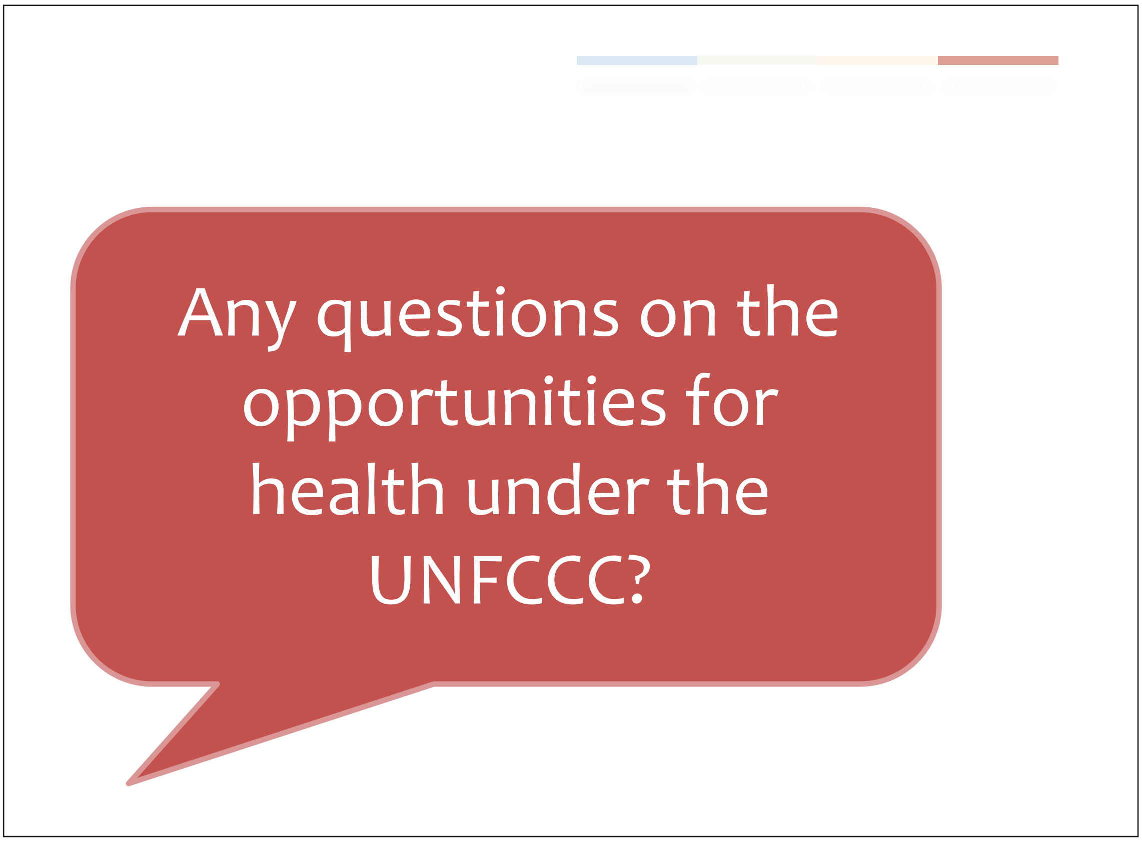
52

First WHO Conference on Health & Climate, 2014

The first WHO international conference on climate change and health was held in Geneva in August 2014. It was attended by 360 participants, including health and environment ministers of WHO member states, senior civil servants, technical experts, UN agencies, NGOs, chief executives from health authorities and relevant private sector entities. The meeting discussed: the state of climate science, particularly as it relates to health; the public health response to climate change; health resilience; health benefits while mitigating climate change; and the economics of health and climate change. Throughout the conference, participants discussed linking climate, sustainable development, and health policy.

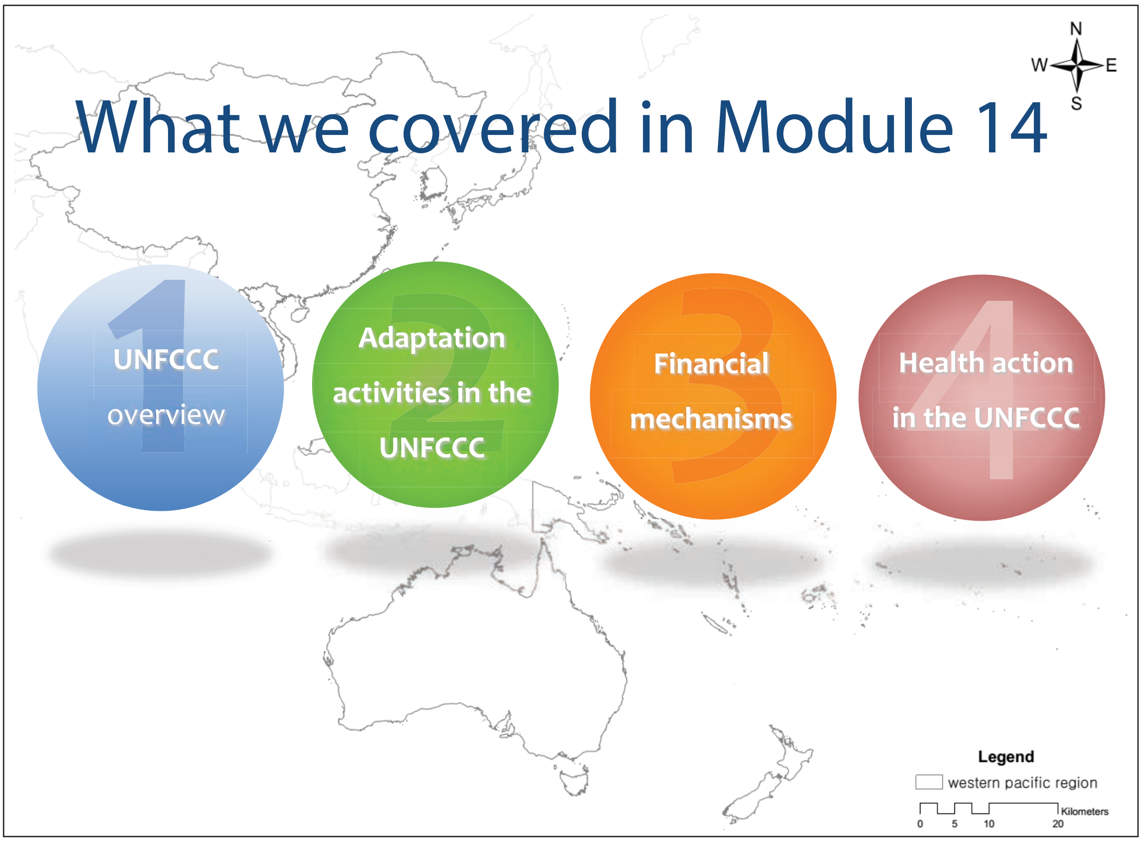
The meeting produced a draft summary that recognized both the need to strengthen health resilience to climate change and the opportunity to make gains in public health through well-planned mitigation measures. The document also recognized policy gaps and next steps. A final outcome document was produced by the WHO Secretariat as input to the UN 2014 Climate Summit and the COP meeting in Peru in 2014.

53



Does anyone have questions on the IPCC process?

54



Here's what we covered in Module 14:

1. Basic orientation to the United Nations Framework Convention on Climate Change (UNFCCC)
2. Adaptation activities under the UNFCCC
3. Financial mechanisms for support of country action on health and climate change
4. Health action within the UNFCCC

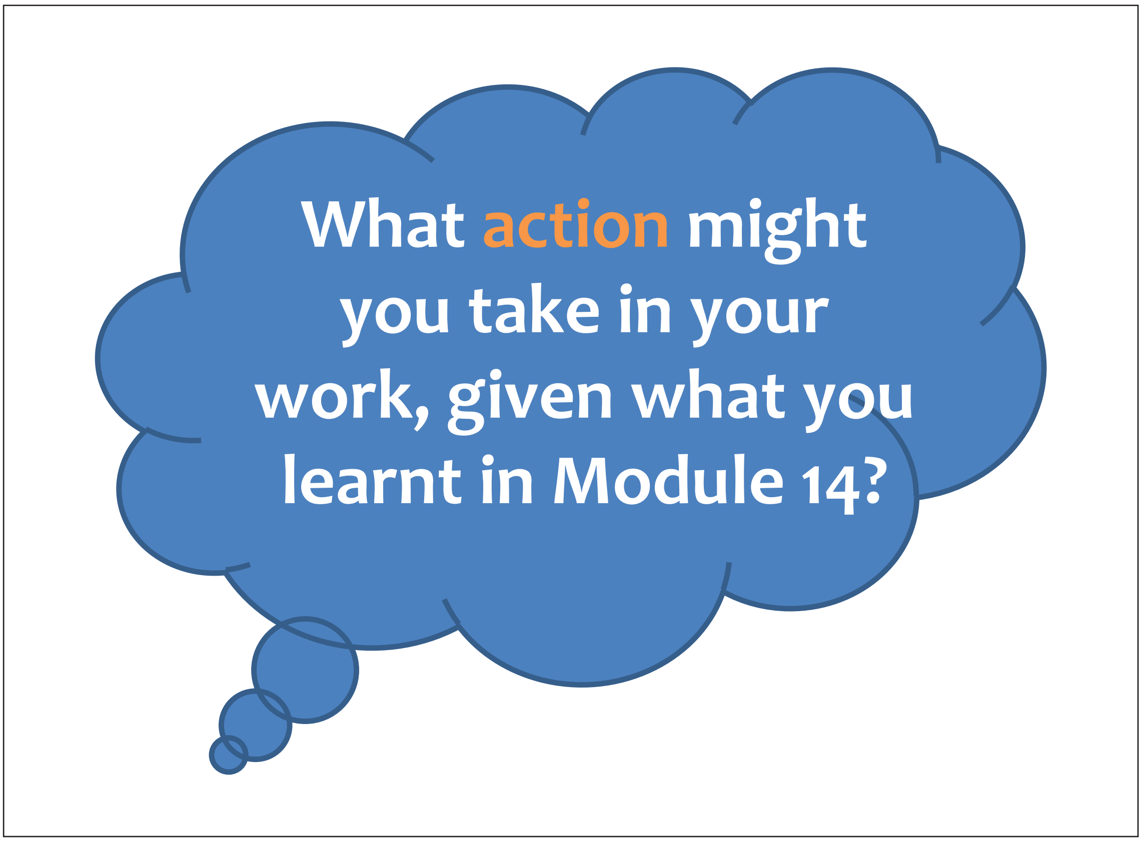
Learning from Module 14

- The United Nations Framework on Climate Change (UNFCCC) is an international process for negotiating agreements on climate change
- A series of agreements have been reached on promoting adaptation, including establishing international funding for adaptation
- There has been inadequate representation of health in the agreements & adaptation funding
- Opportunities for health engagement & taking further adaptation & mitigation action in the health sector

Here are the key messages covered in Module 14.

CLICK to animate each of the four key messages, and read aloud.

56



To finish off Module 14, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around the UNFCCC and the international IPCC negotiations?

Encourage quiet reflection (verbally if needed). At the end of **2 minutes:** "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 15

Disaster risk management

Key learning messages in Module 15

- Southeast Asia and the Pacific are highly vulnerable to extreme weather and climate events and disasters, with a history of significant impacts on humans and society
- Disaster risk management is a structured process for increasing resilience
- International process through UN International Strategy for Disaster Risk Reduction should be followed
  - Hyogo Framework for Action
- Early warning and response systems are effective.

Estimated length: 60 minutes

Structure of Module 15

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3	
1. The multiple sources of vulnerability to extreme weather and climate events and disasters in Southeast Asia and the Pacific	4–15	Questions for the group on slide 7: • Q: What has been your experience with cyclones in your country? • Follow up Q's: What has been learned? Are any efforts underway to increase resilience?
2. UNISDR Hyogo Framework for Action	16–18	
3. Disaster risk management vs. climate change adaptation	19–22	Question for the group on slide 21: Q: I'm interested to hear what partners are involved in disaster risk management in your country. Would anybody like to share?

Section	Slides	Activity (if any)
4. Early warning and response systems	23–36	Question for the group on slide 26: Can I ask you to raise your hand if you think your country is doing: 1. Pretty well in its early warning systems 2. Can definitely improve its early warning systems 3. Has strong early warning systems in place for disasters. EXERCISE on slide 27: Reflect on where you think your country is placed in regards to the 5 components of an early warning system. In the boxes on the notes page in your folder, spend 3 minutes giving a score or symbol to each of these 5. Sharing: ● Areas they feel their country is most prepared with in their early warning system. 2 – 3 responses. ● Components of an early warning system that still need to be put in pla ce or further developed. 2 – 3 responses. Question for the group on slide 31: ● Q: Would anybody like to share their experiences with monitoring and evaluation plans for early warning or other systems? ● Follow up Q: Where there any lessons learned in your country re your monitoring and evaluation plans for early warning systems?
Module outline	37	
Learning from Module 15	38	
Learning reflection, action generation	39	

Required resources

- Data projector and slide changer
- Module 15 slides
- Stopwatch
- Bell or noise maker.

Instructions for delivery of Module 15

Module 15 may appear to be rather theoretical to some participants. Emphasise that preparedness through risk management and planning is a critical step in reducing the impacts of climate change on their country. Most emphasis in the module should be given to Section 4, preparing participants to establish or improve early warning and response systems in their country.

Key terms introduced in Module 15

- Disasters
- Climate hazard map
- Climate change vulnerability map
- Land use change
- Urbanisation
- Slum areas
- Hyogo Framework for Action (HFA)
- Disaster risk management
- Early warning and response systems
- Response plan
- Monitoring and evaluation
- Climate disaster resilience levels
- Community early warning systems.

References (in order of presentation)

- Yumul et al. 2013. *Abnormal weather events in 2009, increased precipitation and disastrous impacts in the Philippines*. Climatic Change 118:715–727 DOI 10.1007/s10584-012-0661-8.
- World Bank. 2010. *Natural Hazards, Unnatural Disasters: The economics of effective prevention*. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf.
- Keim M. 2006. *Cyclones, tsunamis, and human health: the role of preparedness*. Oceanography 19:2;40-49.
- Yusuf and Francisco. 2009. *Climate Change Vulnerability Mapping for Southeast Asia*. http://web.idrc.ca/uploads/user-S/12324196651Mapping_Report.pdf.
- World Bank. 2011. *Jakarta: Urban Challenges in a Changing Climate*. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/10/19/000356161_20111019004946/Rendered/PDF/650180WP0Box360ange0Jakarta0English.pdf.
- Hahm and Fisher. 2010. *Can Jakarta Become Flood-Free: Sustainable Flood Mitigation Measures for a Coastal City*. Presentation at Singapore International Water Week, June 28–July 2. Slide 14.
- The United Nations Office for Disaster Risk Reduction. 2014. *Hyogo Framework for Action*. http://www.unisdr.org/we/coordinate/hfa.
- Gero, A et al. 2011. *How local communities and global development agencies reduce vulnerability to natural disasters and climate change: Examples from the Pacific*. Natural hazards and earth system sciences.
- International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. *Community early warning systems: guiding principles*. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf.
- School of Ocean & Earth Science and Technology Hawaii. 2009. *Pacific ENSO Update. 1st Quarter 1999 - Vol. 5 No. 1*. http://www.soest.hawaii.edu/MET/Enso/peu/update.dir/Update-1stQtr1999/Update-1stQtr1999.html.
- Ebi KL, Schmier JK. 2005. *A stitch in time: improving public health early warning systems for extreme weather events*. Epidemiologic Reviews 2005; 27:115-121.

- Parvin, GA and Shaw R. 2011. *Climate disaster resilience of Shaka City corporation; an empirical assessment at zone level*. Risk, Hazards, and Crisis in Public Policy. 2;2: article 6. DOI: 10.2202/1944-4079.1069.
- Nahar et al. 2014. *Increasing the provision of mental health care for vulnerable, disaster-affected people in Bangladesh*. BMC Public Health 14:708. http://www.biomedcentral.com/1471-2458/14/708.
- International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. *Community early warning systems: guiding principles*. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf.

Module 15: Disaster risk management

In Module 15 we're going to look at disaster risk management – an important area for managing the risks arising from climate change that we've discussed earlier.

2

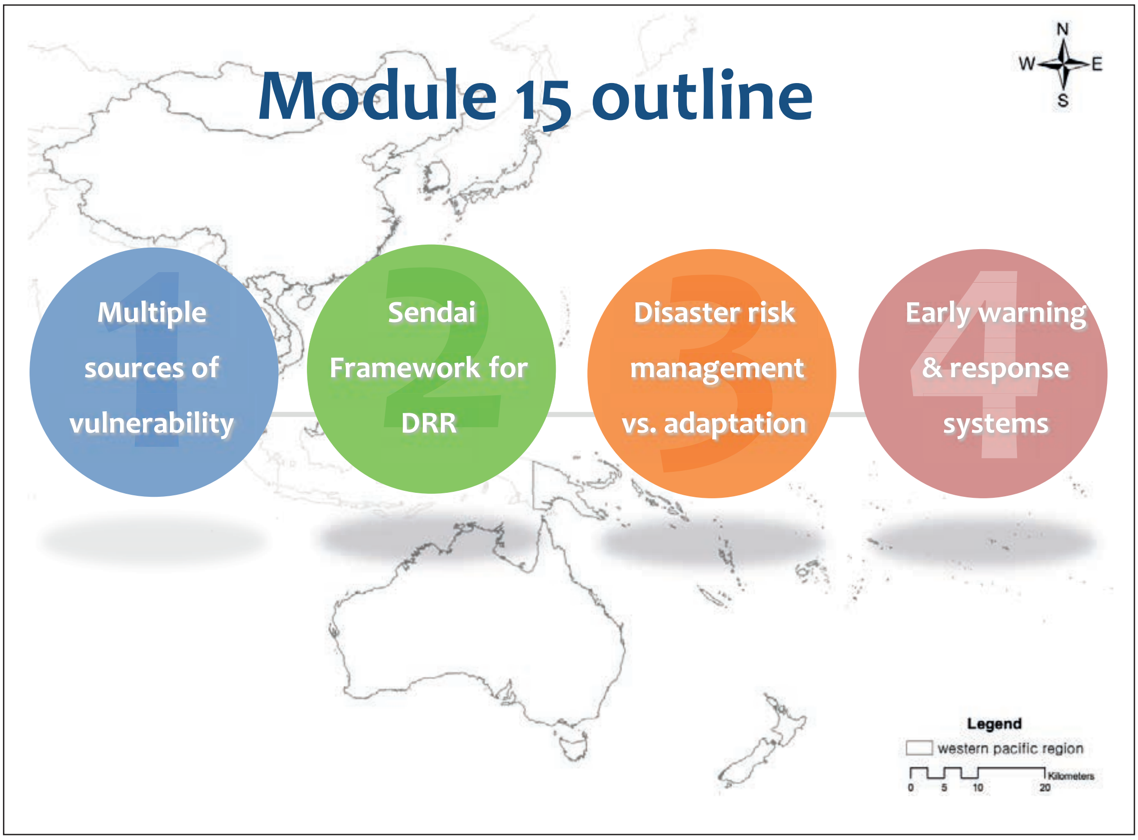
Key messages in Module 15

- Southeast Asia & the Pacific are highly vulnerable to extreme weather & climate events & disasters, with a history of significant impacts on humans & society
- Disaster risk management is a structured process for increasing resilience
- International process through UN International Strategy for Disaster Risk Reduction should be followed:
  - Sendai Framework for disaster risk reduction
- Early warning & response systems are effective

Here are the key messages we'll go over in the content of Module 15:

CLICK to animate each of the four key messages & read aloud.

3



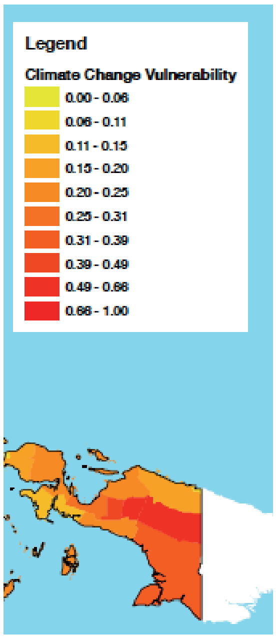
Here's what we'll cover in Module 15:

1. The multiple sources of vulnerability to extreme weather and climate events and disasters in Southeast Asia and the Pacific
2. UNISDR Hyogo Framework for Action
3. Disaster risk management vs. climate change adaptation
4. Early warning and response systems

4

1

Multiple sources of vulnerability to disasters in SE Asia & the Pacific



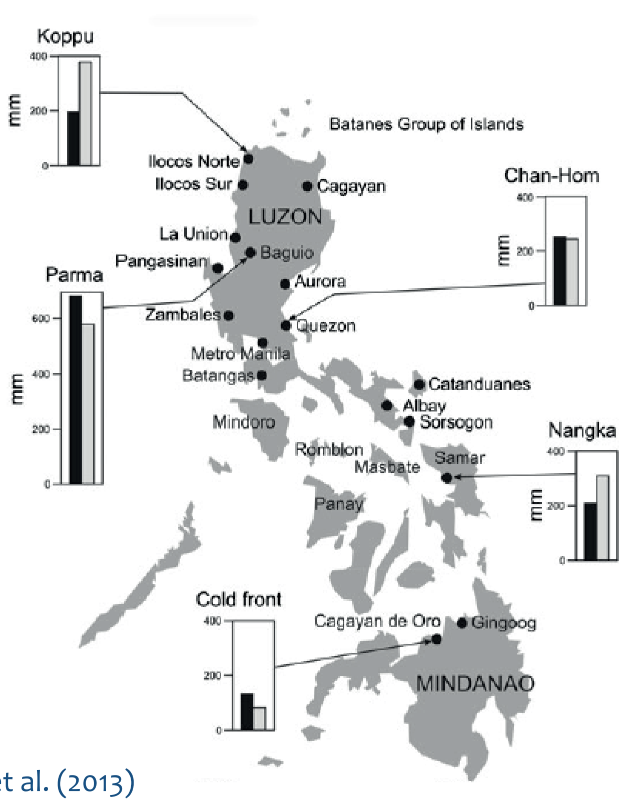
Let's first look at the multiple sources of vulnerability to extreme weather and climate events and disasters in Southeast Asia and the Pacific

5

Weather events in the Philippines 2009

Gray = normal monthly rainfall

Black = 24 hour rainfall (mm)



Source: Yumul et al. (2013)

The year 2009 was a remarkable year for the Philippines in terms of natural hazards and disasters; enormous destruction of properties and loss of lives occurred. The map shows areas affected by various weather events in that year. Rainfall data (in millimeters) associated with specific weather events (i.e. tropical cyclones and tail-end of the cold front) are shown for some of the areas affected.

Extremes experienced included:

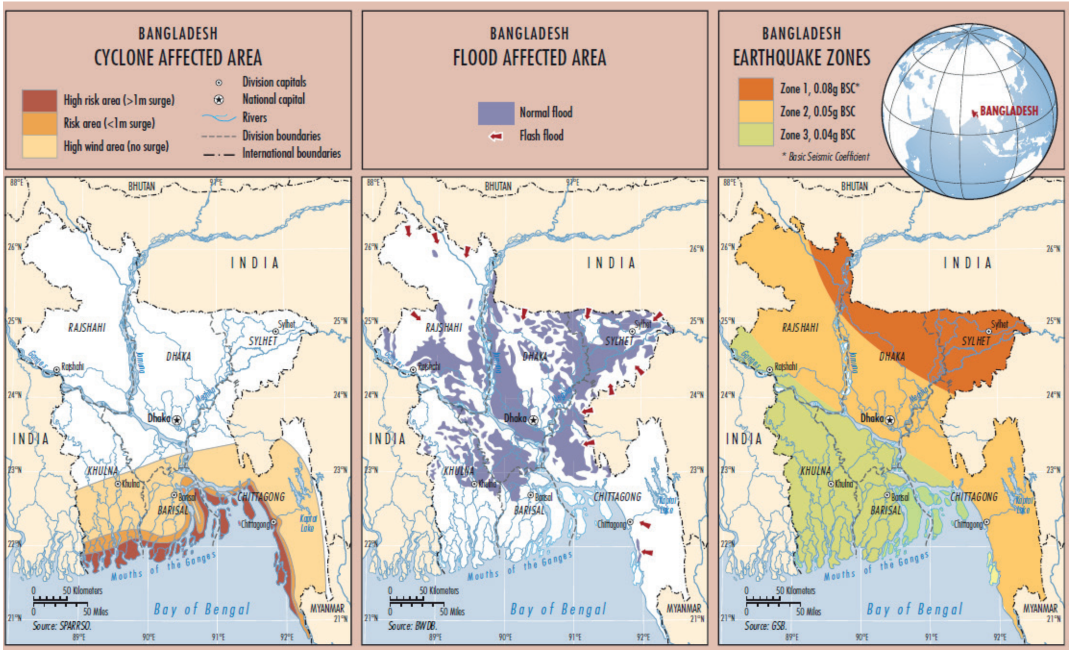
- too much precipitation throughout the year;
- some areas received a lot of rain while other parts of the country went through dry spell and drought conditions; and
- abnormalities and variance in weather patterns (e.g. multiple entry of a tropical cyclone during an El Niño event; longer duration of tropical cyclone; deviations from the normal tropical cyclone path).

The disaster risk management program has decreased the cost of damage and the number of casualties due to weather-related disasters. However, in some instances, disaster risk response was made difficult due to other factors (e.g. degraded ecosystem, ill-managed land use, and risk denial by people and communities). In general though, the resiliency and ability to recover by the people devastated by these disasters and the availability of community-based support systems provided the best means of coping with these catastrophic events.

Source: *Yumul et al. 2013. Abnormal weather events in 2009, increased precipitation and disastrous impacts in the Philippines. Climatic Change 118:715–727 DOI 10.1007/s10584-012-0661-8*

6

Bangladesh & disasters



Source: World Bank (2010)

These maps shows the areas of Bangladesh that can be affected by cyclones, floods, and earthquakes. Nearly all of the country is vulnerable to at least one natural hazard.

Source: *World Bank. 2010. Natural hazards, Unnatural disasters: The economics of effective prevention. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf.*

7

Estimated relative frequency of health effects associated with cyclones

Crush injury	++
Head injury	+
Asphyxiation	+
Isolated bone injury	+
Skin soft tissue injury	+
Burns	+
Drowning	++
Asthma / emphysema	+
Starvation	+
Tetanus	+
Wound infections	+
Psychological illness	+

Source: Keim (2006)

Cyclones are associated with a wide range of health effects. This figure summarizes these, crush injuries and drowning are most common.

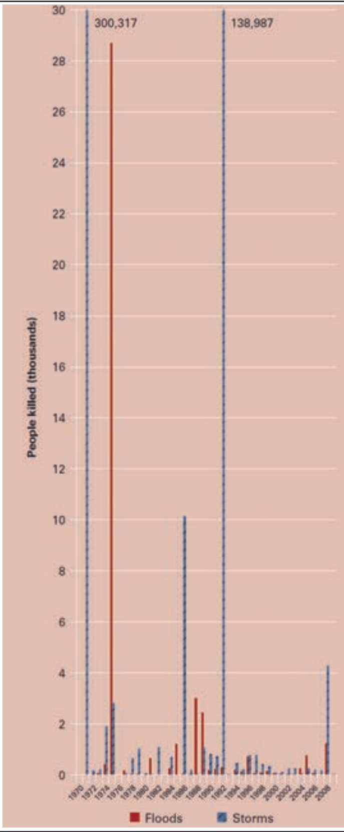
This slide can be used to ask the participants:

Q: What has been your experience with cyclones in your country?
Follow up Q's: What has been learned? Are any efforts underway to increase resilience?

Source: *Keim M. 2006. Cyclones, tsunamis, and human health: the role of preparedness. Oceanography 19:2;40-49.*

8

Mortality from floods & storms in Bangladesh



Source: World Bank (2010)

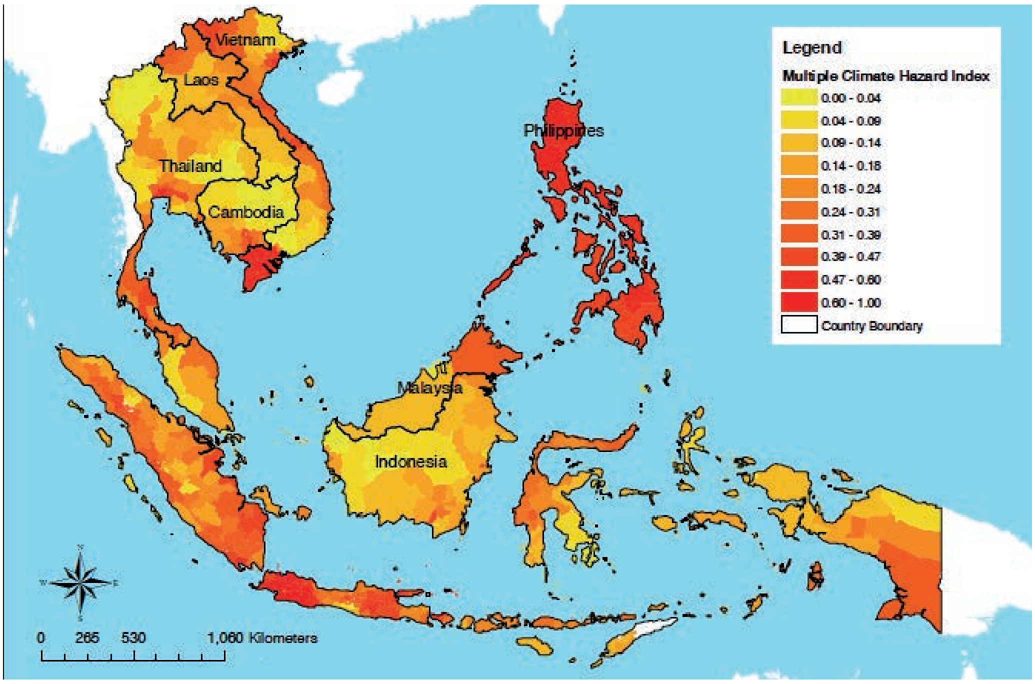
This figure highlights the mortality from floods and storms in Bangladesh, with red lines representing mortality from floods and blue from storms. The 1970s and 1980s were deadly.

After the 1970 cyclone and independence, and building on the early cyclone shelter construction that started in the late 1960s, the government, in partnership with the Bangladesh Red Crescent Society, established the Cyclone Preparedness Program in 1972. Working with local communities, a system appropriate to the area was developed to transmit hazard warnings — radio broadcasts complemented by flags of various colors hoisted for all to see. People were taught what they signified and what to do. Cyclone shelters began to go up in the late 1960s, and the livestock refuges in the early 1970s. But after 138 000 people died in the April 1991 eastern coastal zone cyclone, the Multipurpose Cyclone Shelter Project began to increase the number of shelters. Each district's deputy commissioner chaired a disaster management committee that included local representatives, elected and from nongovernmental organizations (NGOs). The May 1997 cyclone, of similar magnitude, claimed 111 lives — far fewer than the cyclone in 1970. Cyclone shelters have reduced cyclone risks for millions. More remains to be done: shelters have space for about 2.8 million people, or 7 percent of the coastal area's population, but many shelters are not functional.

Source: *World Bank. 2010. Natural hazards, Unnatural disasters: The economics of effective prevention. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf.*

9

Multiple climate hazard map of SE Asia



Source: Yusuf & Francisco (2009)

The map summarizes information on the sub-national areas (regions/districts/provinces) most vulnerable to climate change impacts in Southeast Asia. This assessment was carried out by overlaying climate hazard maps, sensitivity maps, and adaptive capacity maps. The study used data on the spatial distribution of various climate-related hazards in 530 sub-national areas of Indonesia, Thailand, Vietnam, Lao PDR, Cambodia, Malaysia, and the Philippines.

The climate change vulnerability index was derived from:

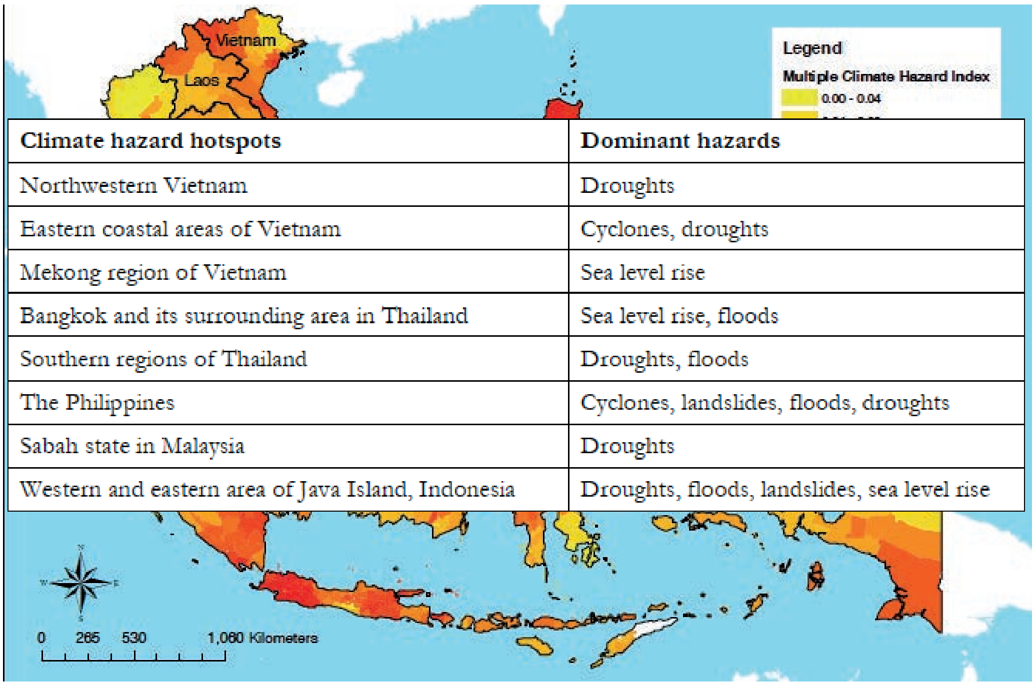
- Historical records of climate-related hazards;
- Climate hazard maps for five climate-related risks: tropical cyclones, floods, landslides, droughts, and sea level rise;
- Population density as a proxy for human sensitivity to climate-hazard exposure;
- The ecological sensitivity of the region using biodiversity information as a proxy variable. A biodiversity-rich region, measured by the percentage of protected areas, is thus considered here as more vulnerable than other areas to climate hazards, other things being equal; and
- An index of adaptive capacity as a function of socio-economic factors, technology, and infrastructure.

For the legend, the scale used was 0-1, with 0 indicating the lowest vulnerability level and 1 indicating the highest vulnerability level.

Source: *Yusuf & Francisco. 2009. Climate Change Vulnerability Mapping for Southeast Asia. http://web.idrc.ca/uploads/user-S/12324196651Mapping_Report.pdf*

10

Multiple climate hazard map of SE Asia



Climate hazard hotspots	Dominant hazards
Northwestern Vietnam	Droughts
Eastern coastal areas of Vietnam	Cyclones, droughts
Mekong region of Vietnam	Sea level rise
Bangkok and its surrounding area in Thailand	Sea level rise, floods
Southern regions of Thailand	Droughts, floods
The Philippines	Cyclones, landslides, floods, droughts
Sabah state in Malaysia	Droughts
Western and eastern area of Java Island, Indonesia	Droughts, floods, landslides, sea level rise

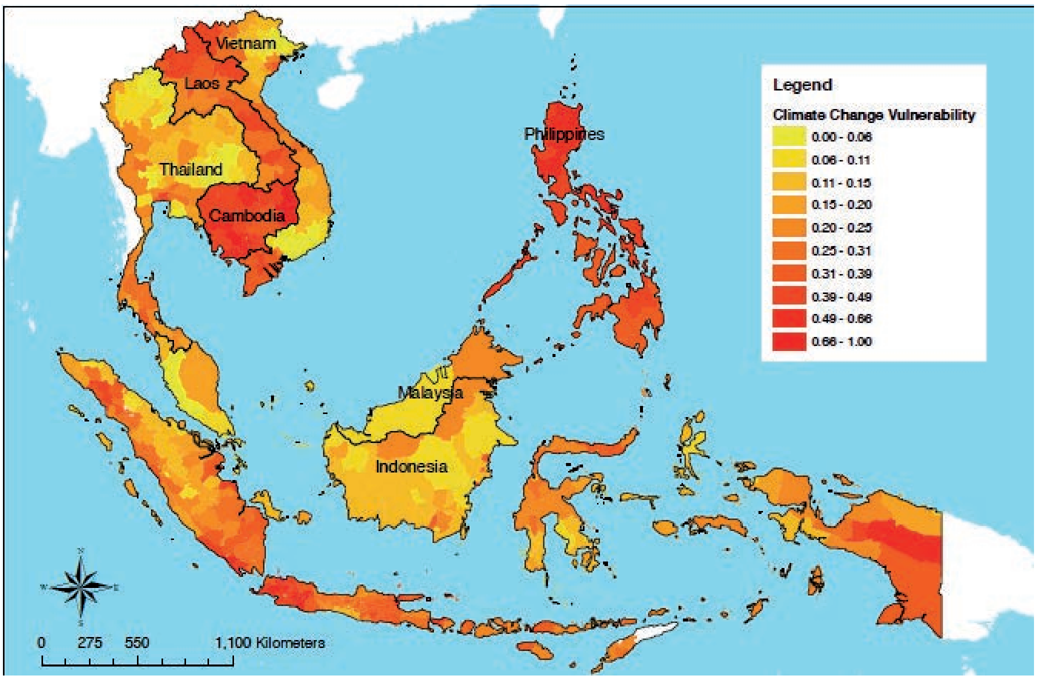
Source: Yusuf & Francisco (2009)

The most vulnerable regions include all areas of the Philippines; the Mekong River Delta in Vietnam; almost all the regions of Cambodia; North and East Lao PDR; the Bangkok region of Thailand; and West Sumatra, South Sumatra, West Java, and East Java of Indonesia. The table lists the dominant climate hazards (including sea level rise) that various regions experience.

Source: *Yusuf & Francisco. 2009. Climate Change Vulnerability Mapping for Southeast Asia. http://web.idrc.ca/uploads/user-S/12324196651Mapping_Report.pdf*

11

Climate change vulnerability map of SE Asia



Source: Yusuf & Francisco (2009)

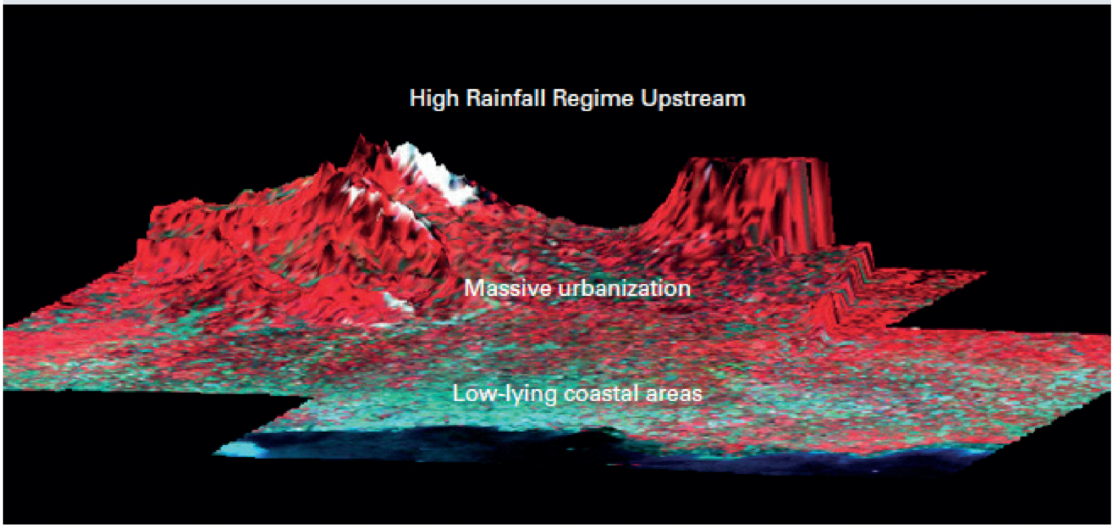
Based on the vulnerability map shown in slide 8, the authors developed a climate change vulnerability index by averaging each of the normalized indicators of exposure (multiple hazard risk exposure), sensitivity (human and ecological), and adaptive capacity. To identify the vulnerable areas, they ranked the regions according to the index and divided the list into four equal parts. Those provinces/districts falling in the fourth quartile were considered the vulnerable areas and further classified as mildly vulnerable, moderately vulnerable, or highly vulnerable.

In general, these results provide few surprises as they confirm commonly-held suspicions that Jakarta is the most vulnerable region in Southeast Asia, with the Mekong River Delta in Vietnam and Bangkok also highly vulnerable due to their exposure to sea level rise, as is the northern part of the Philippines due to its exposure to tropical cyclones. Central Jakarta ranks first in the overall vulnerability assessment even though it has the highest adaptive capacity index because this district is the intersection of all the climate-related hazards, except tropical cyclones. It is frequently exposed to regular flooding but most importantly, it is highly sensitive because it is among the most densely-populated regions in Southeast Asia. Areas in western Java are also highly vulnerable due to exposure to multiple hazards (namely, floods and landslides) as well as having high population densities.

Source: *Yusuf & Francisco. 2009. Climate Change Vulnerability Mapping for Southeast Asia. http://web.idrc.ca/uploads/user-S/12324196651Mapping_Report.pdf*

12

Example of interaction of development patterns & climate variability: Jakarta



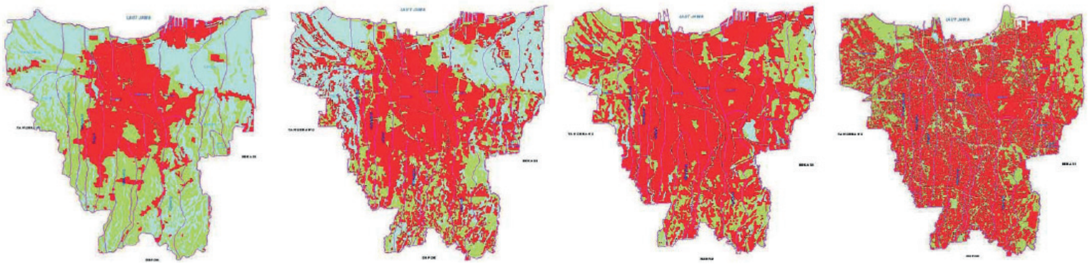
Source: World Bank (2010)

This is an orographic map of the greater Jakarta region, showing the rainfall regions, where urbanization has occurred, and the low-lying coastal areas. The bottom figures show urbanization in 1994 (when flooding occurred) and 2009.

Source: *World Bank. 2010. Natural hazards, Unnatural disasters: The economics of effective prevention. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf.*

13

Land use change in Jakarta, 1970, 1980, 1990 & 2000



Area (Ha) of Jakarta affected by flooding

1980	1996	2002	2007
770	2,259	16,778	23,832

Source: World Bank (2011)

As noted in the module on disasters, a key reason for the increase in vulnerability to disasters is there are more people living in harms' way. One driver is urbanization. These four maps show the significant change in urbanization in Jakarta (shown in red) and the growing area in Jakarta (in hectares) affected by flooding over time as the city has spread.

Urbanization is rapidly increasing in all low- and middle-income countries, often without regard to flood risks. This is especially true for unplanned urbanization.

Source: *World Bank. 2011. Jakarta: Urban Challenges in a Changing Climate.http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/10/19/000356161_20111019004946/Rendered/PDF/650180WP0Box360ange0Jakarta0English.pdf*

14

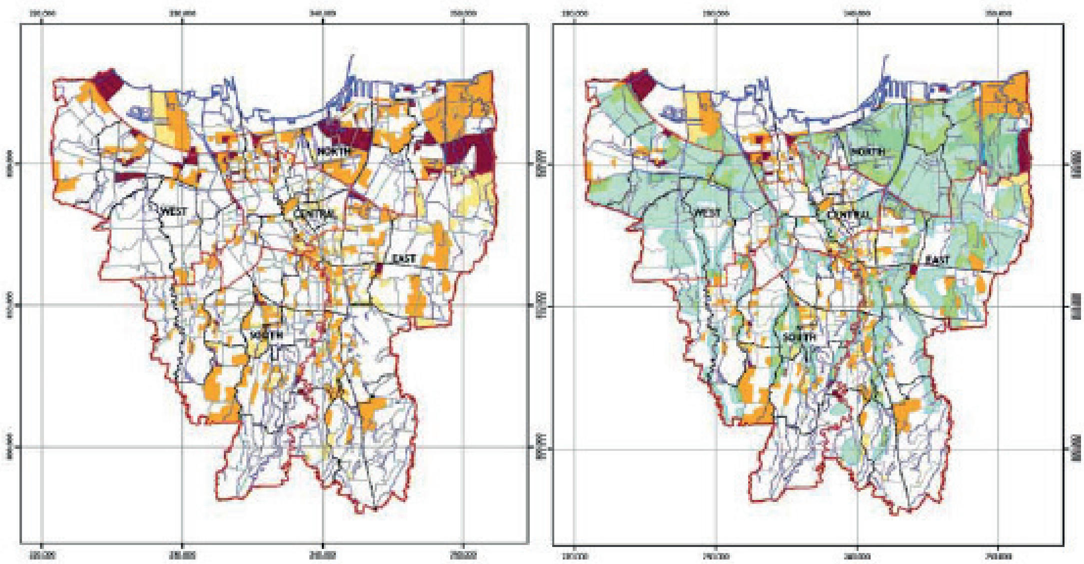
Fifteen years of urbanization in Jakarta, 1994 vs. 2009

Source: Hahm & Fisher (2010)

This figure shows flooding in 1994 in Jakarta and what urbanization looked like in 2009. The circle on the right photo shows the building in the left figure, to highlight the degree of change that's occurred in the urban landscape.

Source: *Hahm and Fisher. 2010. Can Jakarta Become Flood-Free: Sustainable Flood Mitigation Measures for a Coastal City. Presentation at Singapore International Water Week, June 28–July 2.*

Jakarta slum areas affected by flooding



Source: World Bank (2011)

These figures highlight the flood risk to unplanned settlements in Jakarta. The left map shows slum areas, and the right map has these slum areas overlaid with a flood map. This is true for many coastal settlements in Asia and the Pacific. The increases in the unplanned settlements are a particular challenge for disaster risk management.

Source: *World Bank. 2011. Jakarta: Urban Challenges in a Changing Climate.http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/10/19/000356161_20111019004946/Rendered/PDF/650180WP0Box360ange0Jakarta0English.pdf*

16

Now that we have some of the background about why disaster is a significant risk to manage in SE Asia and the Pacific, let's now look at a framework for actions in managing disaster risk: the United Nations Office for Disaster Risk Reduction – or UNISDR - Hyogo Framework.

17

History

Hyogo frameworks fro Action – 2005 -2015

–Called for governments , international and national agencies to mainstream Disaster risk management

–Certain achievements were gained in this period however still there are gaps

Sendai Framework for Disaster Risk Reduction 2015-2030

–Supported and ratified by Member states in March 2015 – calls for more comprehensive commitments, key priority areas and targets

–Climate change is recognized as a driver fro better DRM

–Health is also recognized as a critical sector

Key Message from: Hyogo to Sendai –

The UN's World Conference on Disaster Reduction, in Kobe Japan in 2005, began the process of pushing international agencies and national governments toward setting clear target and commitments for disaster risk management. The first step in this process was the forma approval at the WCDR of the Hyogo Framework for Action. This is the first internationally accepted framework for disaster risk management.

There is a UN Global Platform for Disaster Risk Reduction held every other year at which the UN and its member states can review progress against the Hyogo Framework.

In March 2015, the Hyogo Framework for Action (HFA) has come to an end and replaced by a new post-2015 international framework for disaster risk reduction (Sendai). There have been calls for an improved version of the current HFA and thus the sendai framework is the product (March 2015), with a set of common standards, a comprehensive framework with achievable targets, and a legally-based instrument for disaster risk management.

Member states have also emphasized the need to tackle disaster risk management and climate change adaption when setting the Sustainable Development Goals and these concepts are incorporated also in the Sendai Framework for action.

18

Sendai Framework for DRR 2015-2030

One of the **key lessons/gaps** of the Hyogo Framework for Action stated in Sendai framework is

- Addressing climate change as one of the drivers of disaster risk
- The UN Convention on CC represents an opportunity to reduce disaster risk in a meaningful and coherent manner throughout the interrelated intergovernmental processes.

Building on the Hyogo Framework for Action, this Framework aims to achieve the following outcome over the next 15 years:

- The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets

One of the key lessons/gaps of the Hyogo Framework for Action is Para 13 Addressing climate change as one of the drivers of disaster risk, while respecting the mandate of the United Nations Framework Convention on Climate Change, represents an opportunity to reduce disaster risk in a meaningful and coherent manner throughout the interrelated intergovernmental processes.

Building on the Hyogo Framework for Action, this Framework aims to achieve the following outcome over the next 15 years:

19

Sendai Framework for DRR 2015-2030

To attain the expected outcome, the following goal must be pursued:

•Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience

20

Four priority areas of Sendai

- Understanding disaster risk
- Strengthening disaster risk governance to manage disaster risk
- Investing in disaster risk reduction for resilience
- Enhancing disaster preparedness for effective response, and to “Build Back Better” in recovery, rehabilitation and reconstruction.

Taking into account the experience gained through the implementation of the Hyogo Framework for Action, and in pursuance of the expected outcome and goal, there is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas:

1. Understanding disaster risk.
2. Strengthening disaster risk governance to manage disaster risk.
3. Investing in disaster risk reduction for resilience.
4. Enhancing disaster preparedness for effective response, and to “Build Back Better” in recovery, rehabilitation and reconstruction.

In their approach to disaster risk reduction, States, regional and international organizations and other relevant stakeholders should take into consideration the key activities listed under each of these four priorities and should implement them, as appropriate, taking into consideration respective capacities and capabilities, in line with national laws and regulations.

In the context of increasing global interdependence, concerted international cooperation, an enabling international environment and means of implementation are needed to stimulate and contribute to developing the knowledge, capacities and motivation for disaster risk reduction at all levels, in particular for developing countries.

21

7 Global Targets of Sendai

The framework sets to substantially:

•reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015;

•reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020-2030 compared to the period 2005-2015;

•Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

Goal of this Framework, seven global targets have been agreed. These targets will be measured at the global level and will be complemented by work to develop appropriate indicators. National targets and indicators will contribute to the achievement of the outcome and goal of this Framework. The seven global targets are:

(a) Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100 000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015;

(b) Substantially reduce the number of affected people globally by 2030, aiming to lowerthe average global figure per 100 000 in the decade 2020-2030 compared to the period 2005-2015;

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030;

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by

22

7 Global Targets of Sendai

The framework sets to substantially:

•increase the number of countries with national and local disaster risk reduction strategies by 2020;

•enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030;

•increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by

goal of this Framework, seven global targets have been agreed. These targets will be measured at the global level and will be complemented by work to develop appropriate indicators. National targets and indicators will contribute to the achievement of the outcome and goal of this Framework. The seven global targets are:

(a) Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100 000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015;

(b) Substantially reduce the number of affected people globally by 2030, aiming to lowerthe average global figure per 100 000 in the decade 2020-2030 compared to the period 2005-2015;

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

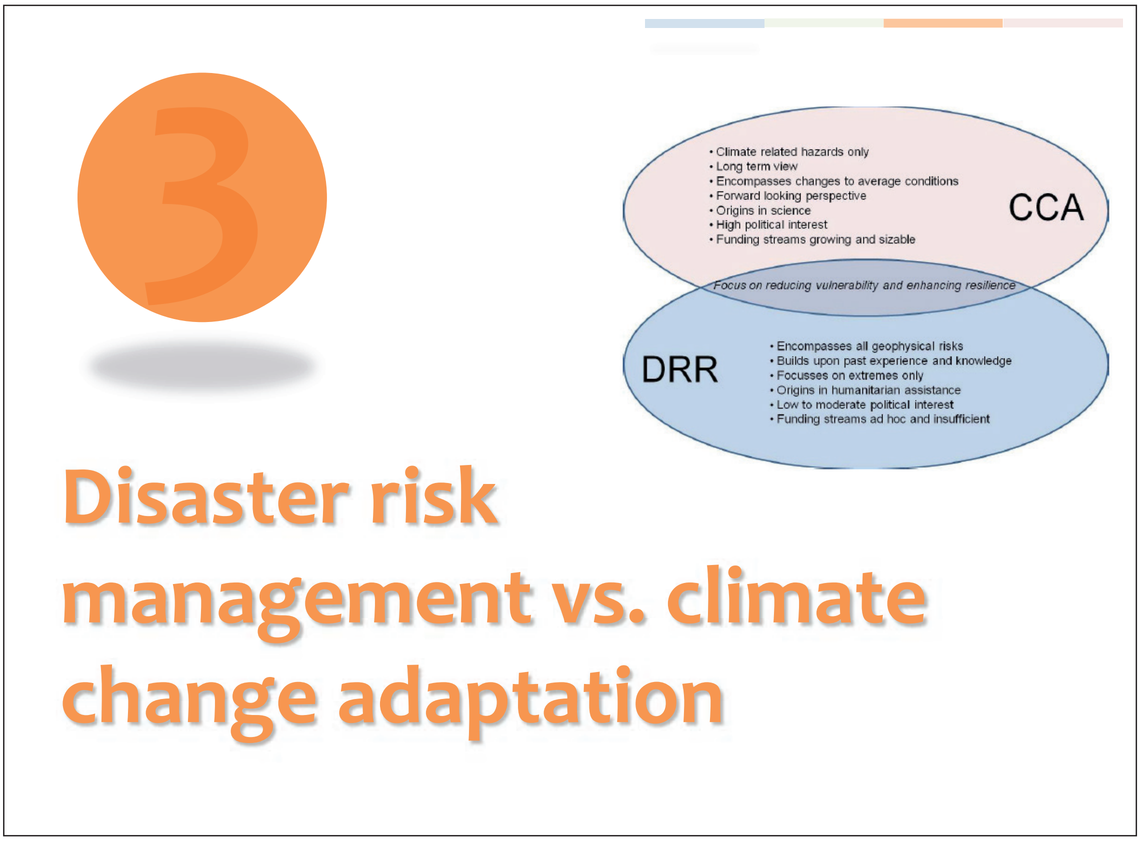
(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this Framework by 2030;

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by

23



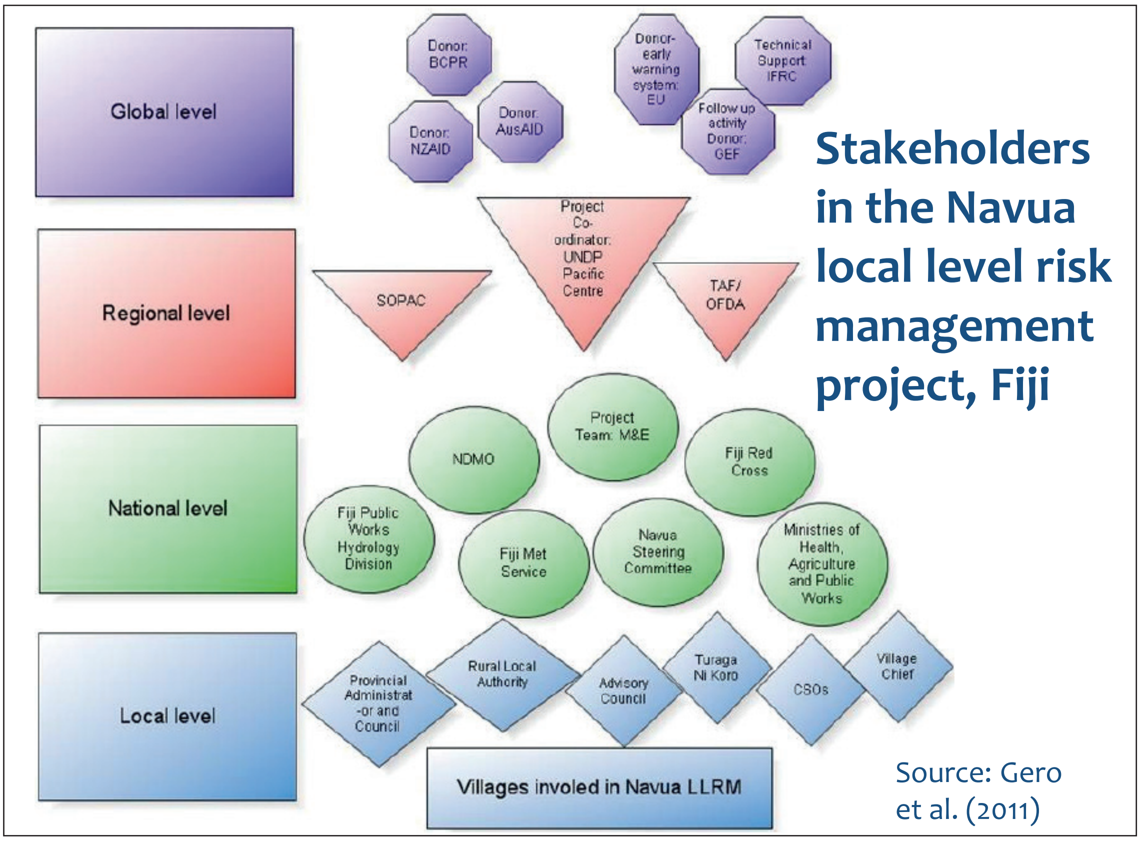
In the next section we will focus on the differences between disaster risk management and climate change adaptation.

24

This slide lists the key components of effective disaster risk management. Risks need to be identified and understood so that the actions can be identified to reduce the underlying risk factors. Previous slides provided an overview off drivers of disaster risk. Disaster preparedness and emergency management are key to reducing the risks of extreme weather and climate events. Building institutional and financial capacities and resources is important as countries start facing an increasing number of extreme weather and climate events.

The cross-cutting issues are important for ensuring broad buy-in to the program, linkage across local to national scales, and collection lessons learned to share with other health authorities to facilitate uptake of best practices.

Source: *The United Nations Office for Disaster Risk Reduction. 2014. Hyogo Framework for Action. http://www.unisdr.org/we/coordinate/hfa*



This figure shows the Navua (Fii) local to global stakeholders for their disaster risk management. A disaster risk management project began in 2007 and built upon an earlier project to develop an early warning system for flood. The early warning system was implemented following major flooding of the Navua river system in 2004. The 2004 event and previous flood events in Navua resulted in widespread damage to homes, infrastructure, and subsistence and commercial agriculture. The follow-up project aimed to raise the awareness of the early warning system while at the same time, mainstream the issue of disaster risk management into provincial planning and development. The Local Level Risk Management (LLRM) approach was employed, which addresses risk in areas defined by similar natural and physical hazards, and not bounded by political or administrative borders that often define risk management strategies.

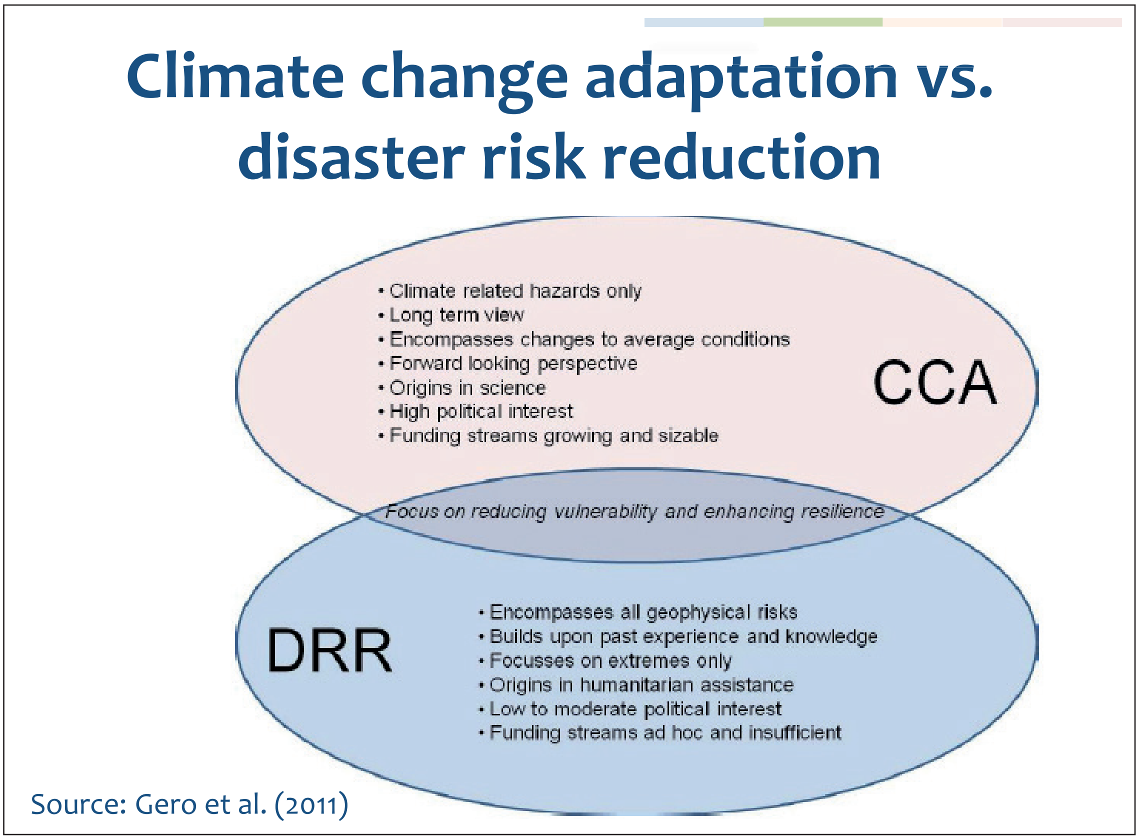
This figure shows the local to global partners involved in the project. Many of the major players in DRR in the country and region are involved, the Fiji Red Cross, with technical input from their global partner, the International Federation of the Red Cross/Red Crescent Societies (IFRC), SOPAC (initiated the early warning system along with the Fiji Public Works (Hydrology Division) and Fiji Meteorological Service), the National Disaster Management Office (NDMO), TAF/OFDA for training assistance, and global donors such as the Global Environment Facility (GEF) and the Bureau for Crisis Prevention and Recovery (BCPR, a UNDP body) who also provide technical assistance in devising strategies for implementation.

This slide can be used to ask participants:

Q: I'm interested to hear what partners are involved in disaster risk management in your country. Would anybody like to share?

Source: *Gero A, et al. 2011. How local communities and global development agencies reduce vulnerability to natural disasters and climate change: Examples from the Pacific. Natural hazards and earth system sciences.*

26



This slide, from the project shown on the previous slide, highlights the differences and overlap between climate change adaptation and disaster risk management.

Disaster risk management has a long history in the region. There has been growing realization that climate change is an urgent issue to which countries needs to pay attention. There are increasing efforts to integrate these activities. Challenges to doing so include institutional, financial, and political barriers that inhibit actors and stakeholders from truly collaborating and creating cross-disciplinary programs. Adaptation focuses on climate variability and change only, takes a longer-term perspective, is more focused on proactive efforts to increase resilience, and has high political interest. Disaster risk management covers all "natural hazards", builds on experience and knowledge (e.g. generally does not use projections of potential future changes), focuses on extremes only, and has low to moderate political interest. Funding streams also differ. For example, the Global Environment Facility (GEF) is a funding mechanism for adaptation formed under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC). The Global Facility for Disaster Risk Reduction (GFDRR) is a global partnership between the United Nations International Strategy for Disaster Reduction (UNISDR), World Bank, and donor countries that focuses on disaster risk management.

However, at the level of implementation, specific disaster risk management and adaptation activities can often be classified as either. For example, mangrove habitats are well known to provide a barrier to coastal risks whilst also serving as a crucial element of the coastal and estuarine environment. With the threat of rising seas and increased coastal erosion associated with more frequent severe weather, mangroves are also a possible intervention to prepare for additional climate change.

Source: *Gero A, et al. 2011. How local communities and global development agencies reduce vulnerability to natural disasters and climate change: Examples from the Pacific. Natural hazards and earth system sciences.*

4

Early warning & response systems

Now that we understand some of the issues around risk management, let's look lastly at an important tool for managing risk: early warning and response systems

28

Early warning systems

- Improved weather forecasting offers the opportunity to develop early warning systems for weather-based events
  - Use of early warning systems can save lives
- The system should be developed with all relevant stakeholders to ensure that the issues of greatest concern are addressed
- A basic requirement is that the community or region has sufficient public health & social infrastructure to undertake its design & implementation

This is the first of two slides providing a synthesis of attributes of and requirements for early warning systems.

Early warning systems are being successfully used in many circumstances to increase the lead time before an outbreak occurs, to take advantage of growing understanding of the associations between environmental variables and adverse health outcomes. Effective early warning systems provide needed time to undertake actions to prevent significant numbers of cases.

Strong stakeholder engagement will help ensure an early warning system addresses local needs and constraints.

As noted in the slide, there has to be sufficient public health and social infrastructure for an early warning system to be effective.

Source: *International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf*

29

Effective early warning systems

- Multiple disciplines are required to develop accurate, effective & efficient population - & location-specific early warning systems
- Provide warning in sufficient time for action
- Are affordable
  - Require minimal skill & training to operate & maintain
- Give minimal false positive or negative responses
- Are robust, reproducible & verifiable
- Can be easily modified to address a changing climate

An effective early warning system will provide sufficient lead time for action, be affordable (including in terms of training), give minimal false positive and false negative responses, and be robust, reproducible, and verifiable. Further, the system should be designed so that it can be easily modified as the weather continues to change (and thus changing exposure-response relationships, or geographic extent of the system, etc.).

Source: *International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf*

30

Principal components of an EWS

1. Identification & forecasting of **weather conditions**
2. **Prediction of** possible **health outcomes**
3. Effective & timely **response plan**
4. **Ongoing monitoring & evaluation** of the system & its components
5. **Communication plan**

Source: IFRC (2012)

The principle components of an early warning system are listed here. Designing and implementing these components requires range of expertise across different institutions and organizations.

I'm curious in how your country is going in applying principles like this to the early warning systems that you have in place, particularly in predicting health outcomes that may arise from disasters.

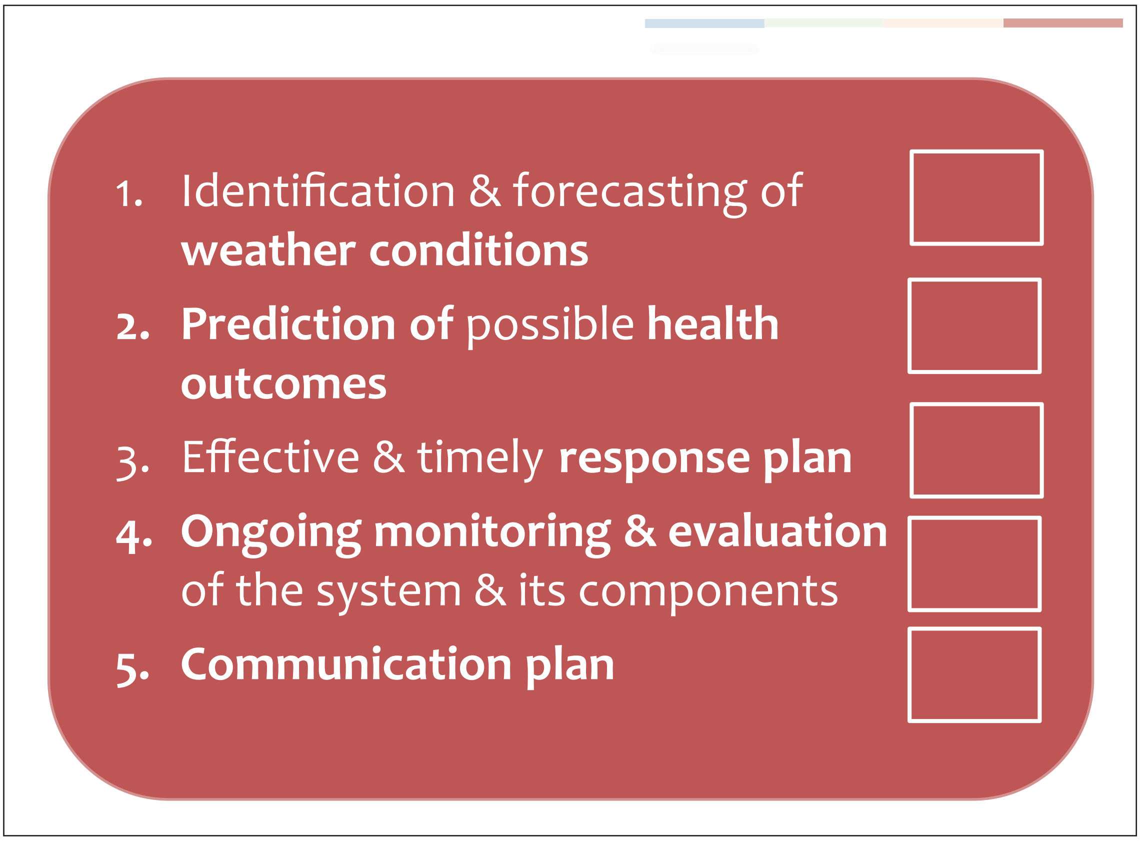
Q: Can I ask you to raise your hand if you think your country is doing:

1. **Pretty well in its early warning systems –** "Ok, thank you. You can put down your hands"
2. **Can definitely improve its early warning systems –** "Thank you"
3. **Has strong early warning systems in place for disasters –** "Thank you"

Thanks all. We're now going to look at a guide that can be of assistance in establishing better early warning systems, that looks at principles and best practice around the world.

Source: *IFRC. 2012. Look up title. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf*

31



Reflection exercise on early warning systems:

“Within this training we won’t have time to actually design an integrated early warning system for your country or region. But I’d like to ask you to reflect on where you think your country is placed in each of these 5 components of an early warning system. In the boxes on the notes page in your folder, please spend **three minutes** giving a score or symbol to each of these 5 components – whatever makes sense to you as an evaluation. If you don’t know whether one of these components is in place, writing down a question mark will give you an indication of an area for more research and learning when you’re back at work.

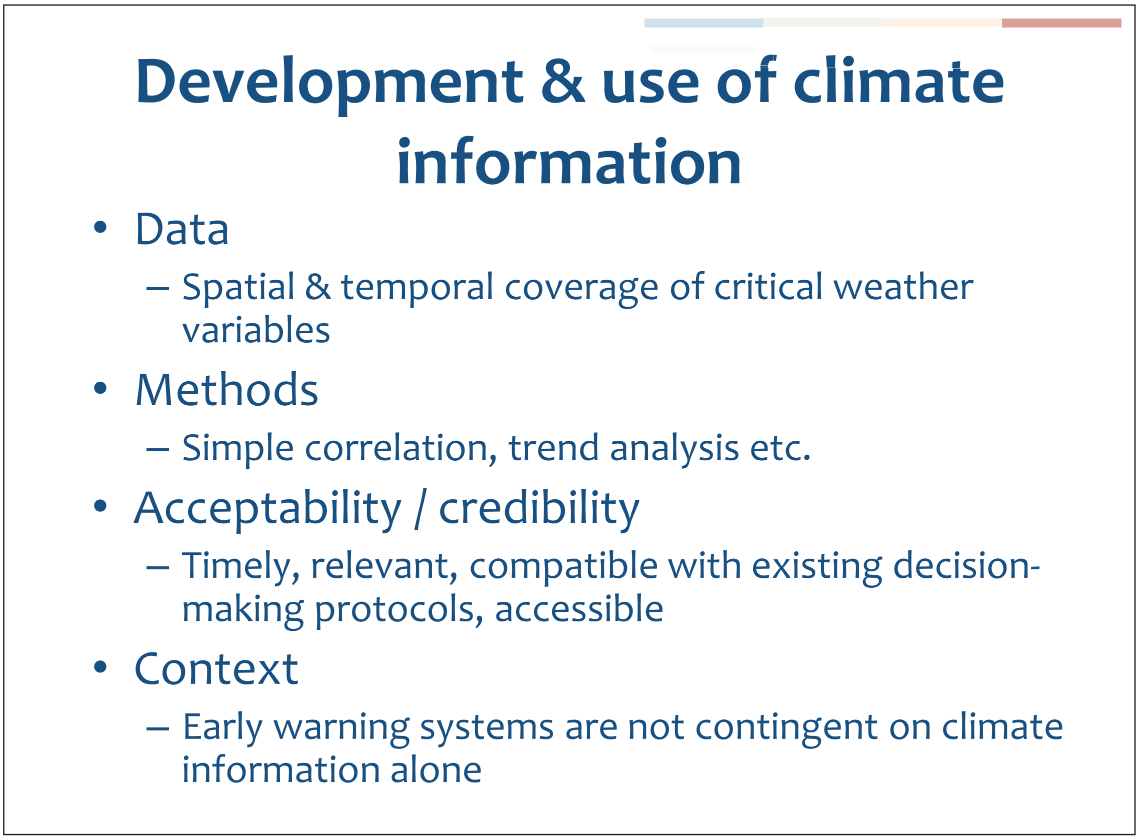
Any questions? No? Ok, I’ll give you 3 minutes to go through this exercise.”

Give a time warning at **2 mins**: “You have another minute to finish off your evaluation.”

At **3 mins**: “Would anybody like to share the areas they feel their country is most prepared with in their early warning system?” Take 2 – 3 responses. “What about components of an early warning system that still need to be put in place or further developed – the ones that scores lowest in your evaluation?” Take 2 – 3 responses.

“Thanks everyone. We’ll now look at these components in more detail to learn more about how they can be implemented.”

32

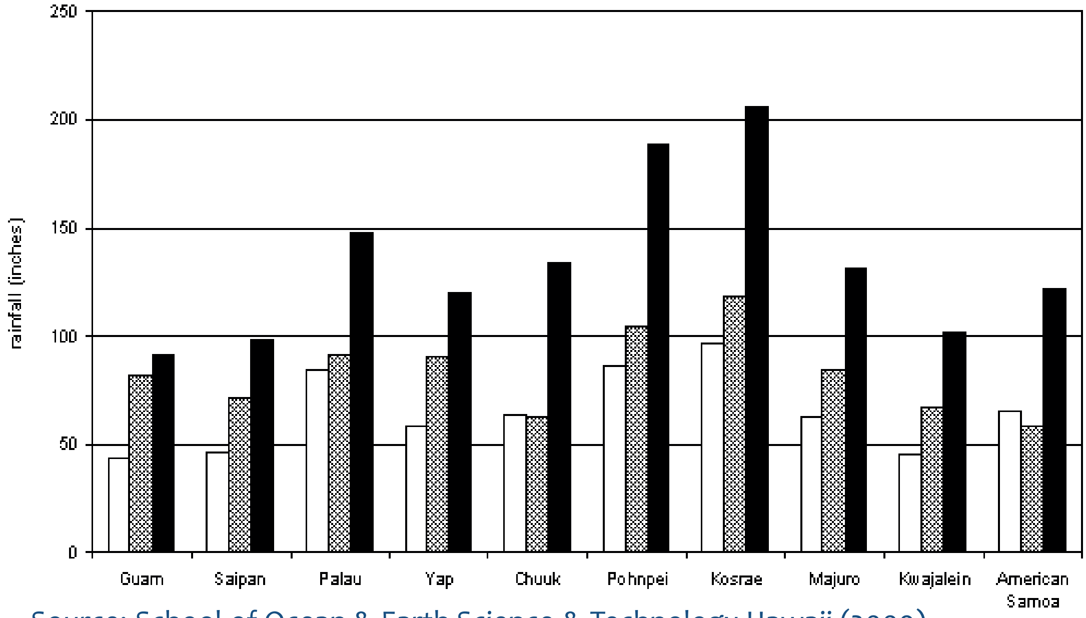


This slide lists some of the issues with using climate information in early warning systems. The spatial and temporal scale of the critical weather variables need to match well-enough with the health data. Appropriate statistical methods need to be applied to the analysis. The analysis must be credible, timely, etc. and address key issues raised by decision-makers and the public. The analyses should consider all relevant factors that affect the appearance of a disease outbreak (such as location of vulnerable populations, etc.).

Source: *http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf*

33

Predicted vs. observed rainfall, Micronesia & American Samoa



Source: School of Ocean & Earth Science & Technology Hawaii (2009)

This graph shows a comparison of the **predicted** Oct 97-Sep 98 (white bars), **observed** Oct 97-Sep 98 (cross hatched bars), and the long-term average (1965-1995) (black bars) rainfall in inches of rain for the major Micronesian Islands and Pago Pago, American Samoa. 1997/98 was when the largest El Nino on record occurred. The black bars show the average precipitation in non-El Niño years, showing the large impact these events have in many Pacific nations

Overall, for the 12-month period, the predictions were very accurate. However, at certain locations, there were some problems in predicting the onset of the drought and in anticipating the return of rains that broke the drought. For example, the onset of the drought was predicted a few weeks too early for Guam, Saipan, Palau, and Yap. And the drought onset was predicted to start a few weeks too late for Kosrae and American Samoa. It was even more difficult to predict the re-establishment of the rains. For example, the drought was forecast to end several weeks too early for Guam, Saipan, and American Samoa, and several weeks too late for Yap, Palau, and the Marshall Islands. Part of the problem in determining the end of the drought is that there was no real definition of the "end of drought".

The correlations between El Niño and rainfall were used to prepare nations for expected impacts in the 1997/98 El Niño. Governments developed public education programs, implemented water rationing, identified emergency food and water supplies, and other activities.

Source: *School of Ocean & Earth Science & Technology Hawaii. 2009. Pacific ENSO Update. 1st Quarter 1999 - Vol. 5 No. 1. . http://www.soest.hawaii.edu/MET/Enso/peu/update.dir/Update-1stQtr1999/Update-1stQtr1999.html>>*

34

Components of a response plan

- Where the response plan will be implemented
- When interventions will be implemented, including thresholds for action
- What interventions will be implemented
- How the response plan will be implemented
- To whom the interventions will be communicated

Source: Ebi & Schmier (2005)

Equally as important as developing thresholds for identifying what an extreme event occurs is the response plan. Such a plan needs to include explicit identification of where and when the plan will be implemented (including thresholds for action), what and how specific interventions will be implemented, and to whom the interventions will be communicated. Health professionals need to be integral to the team developing a response plan.

Source: *Ebi KL, Schmier JK. 2005. A stitch in time: improving public health early warning systems for extreme weather events. Epidemiologic Reviews 2005;27:115-121.*

35

Monitoring & evaluation

Need to establish programs to answer these questions (at a minimum):

- What are the chances that the forecast will be wrong?
- What are the chances of sounding a false alarm, thereby wasting resources & undermining public trust?
- Is the system as responsive as needed? How many lives could have been saved if the system response was faster?
- Is the system cost-effective?

Source: Ebi & Schmier (2005)

Once an early warning system is implemented, there needs to be ongoing monitoring and evaluation of the system to ensure it is timely and effective. The slides lists some of the requirements of an effective monitoring and evaluation program.

Participants can be asked:

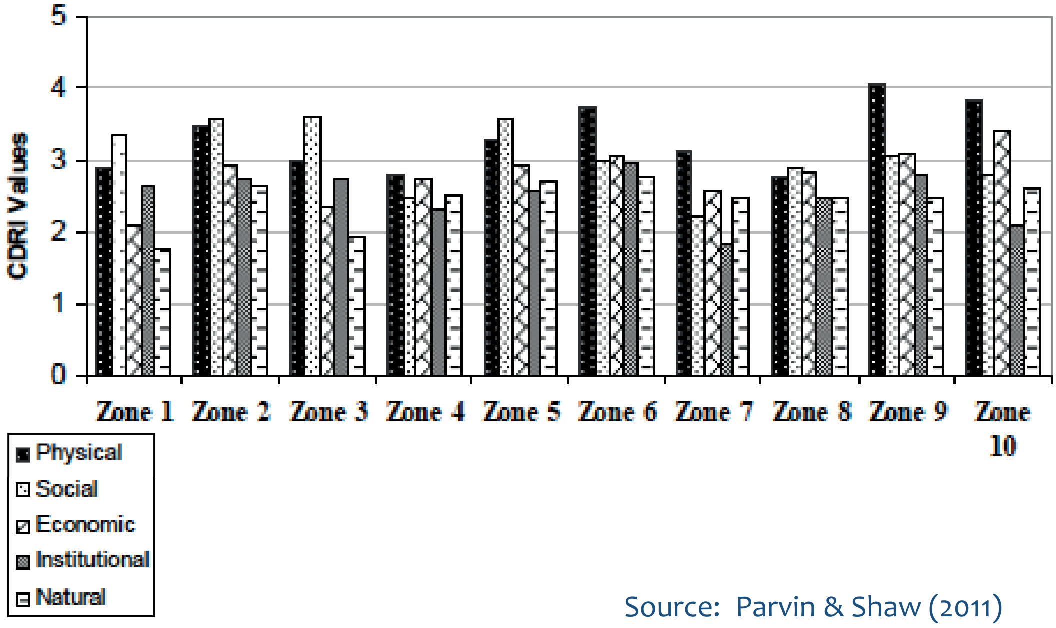
Q: Would anybody like to share their experiences with monitoring and evaluation plans for early warning or other systems?

Follow up Q: Where there any lessons learned in your country re your monitoring and evaluation plans for early warning systems?

Source: *Ebi KL, Schmier JK. A stitch in time: improving public health early warning systems for extreme weather events. Epidemiologic Reviews 2005;27:115-121.*

36

Climate disaster resilience levels in 10 zones in Dhaka



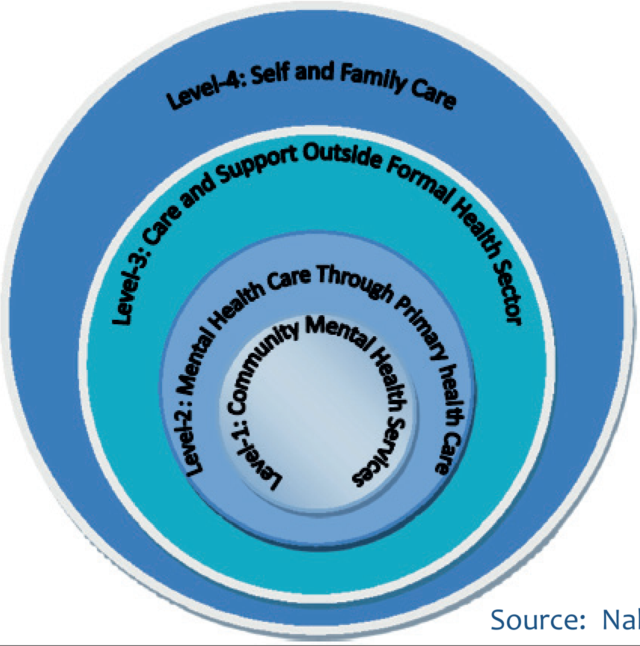
Source: Parvin & Shaw (2011)

When designing an early warning system, it is important to take into consideration the variability in resilience across the region covered. This is an example from Dhaka of variability in climate disaster resilience levels. For 10 zones, the slide shows the differences in physical, social, economic, institutional, and natural dimensions. Each dimension has multiple components. The most important parameters were ecosystem services, environmental polices, education and awareness, employment, accessibility of roads, and community preparedness. The most important variables were:

1. Incorporation of DRR and CCA measures in zone's development plan
2. Extent of participation of zone's population in community activities
3. Capacity of zone's health facility to face emergency/hazardous situations
4. Total % of zone's population living in proximity to polluted industry/dumping ground/sea/beach
5. % of zone's annual budget targeting disaster risk management
6. Existence of an emergency team during disaster
7. Extent of use of zone-level hazard maps in development activities
8. Awareness or knowledge of population about the threat and impacts of disasters
9. Extent of support from NGOs/CBOs or religious organizations after a disaster
10. Interconnectedness/collaboration with neighboring zones for emergency management during a disaster
11. Promptness of zone authorities to disseminate emergency information to communities during a disaster

Source: *Parvin GA, Shaw R. 2011. Climate disaster resilience of Shaka City corporation; an empirical assessment at zone level. Risk, Hazards, & Crisis in Public Policy. 2;2:article 6. DOI: 10.2202/1944-4079.1069*

Structure of mental health services in Bangladesh



Source: Nahar et al. (2014)

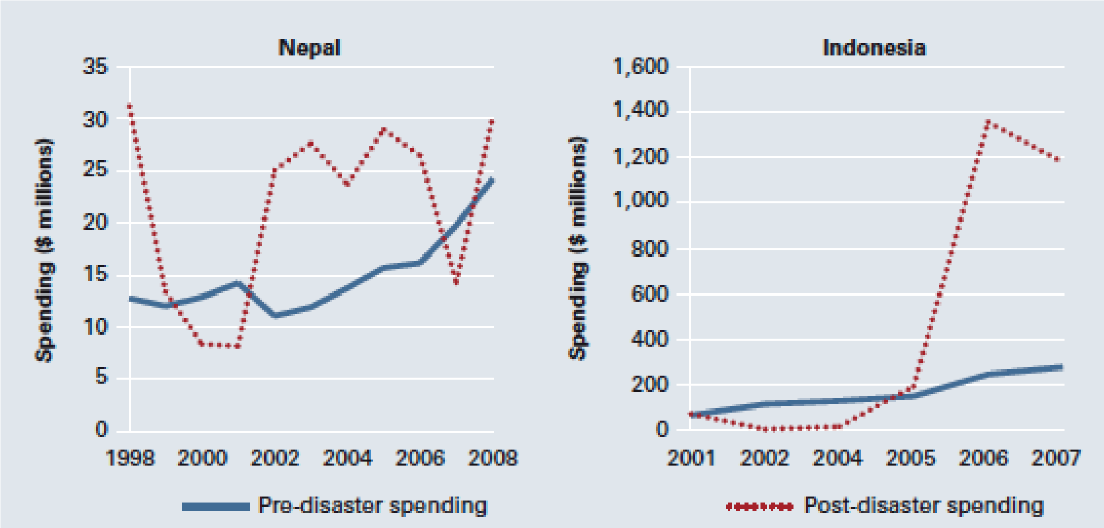
An issue often overlooked in disaster risk management response plans is mental health services. Studies indicate that mental health issues often arise after disasters and can last for months after the event. This slide shows the structure of mental health services in Bangladesh, with self and family care embedded in care and support outside the formal health sector. These are embedded in mental health care through primary health care, which is within the purview of community mental health services.

The study adapted a framework developed by WHO in response to the 2004 Indian Ocean tsunami for providing mental health and psychosocial support after major disasters; the framework was adapted to Bangladeshi post-cyclone and post-flood contexts. The framework is community-based, it includes both medical and non-clinical components, and it could be adapted so that women and the poor are actively sought out and provided for. After training, these services could be run by Bangladesh' s pre-existing 50 000-strong Cyclone Preparedness Programme workforce, alongside the country' s extensive network of community-based health workers.

Source: *Nahar et al. 2014. Increasing the provision of mental health care for vulnerable, disaster-affected people in Bangladesh. BMC Public Health 14:708. http://www.biomedcentral.com/1471-2458/14/708*

38

Pre- & post-disaster government spending: Nepal & Indonesia



Source: World Bank (2011)

Post-disaster spending fluctuates more than pre-disaster spending, as shown for Nepal and Indonesia. Governments can help in effective prevention, but struggle to do so. It is difficult to measure how much governments spend on prevention because this is not a specific budget item. Detailed analysis in Indonesia and Nepal found that prevention spending was less than post-disaster spending. But this does not imply that it was "too little," for it is hard to isolate what constitutes prevention and even harder to determine adequate spending. Effective prevention measures are often embedded in other spending (in such infrastructure as an embankment), and there are indications that reversing the past neglect of maintenance (painting bridges to reduce corrosion and subsequent failure) and investing in intangibles (tallying decrepit structures) has large benefits.

This pattern also highlights that there is often a window of opportunity after a disaster to encourage financing projects to prepare for the next disaster.

Source: *World Bank. 2011. Look up title. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/11/12/000334955_20101112050234/Rendered/PDF/578600PUB0epi2101public10BOX353782B.pdf>*

39

The International Federation of the Red Cross/Red Crescent Societies (IFRC) has been working for many years to integrate disaster risk management and climate change adaptation. They have unparalleled expertise in reducing vulnerability to disasters. Among their many publications is this guide to developing community early warning systems.

Source: *International Federation of the Red Cross/Red Crescent Societies (IFRC). 2012. Community early warning systems: guiding principles. http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf*

40

RED CROSS

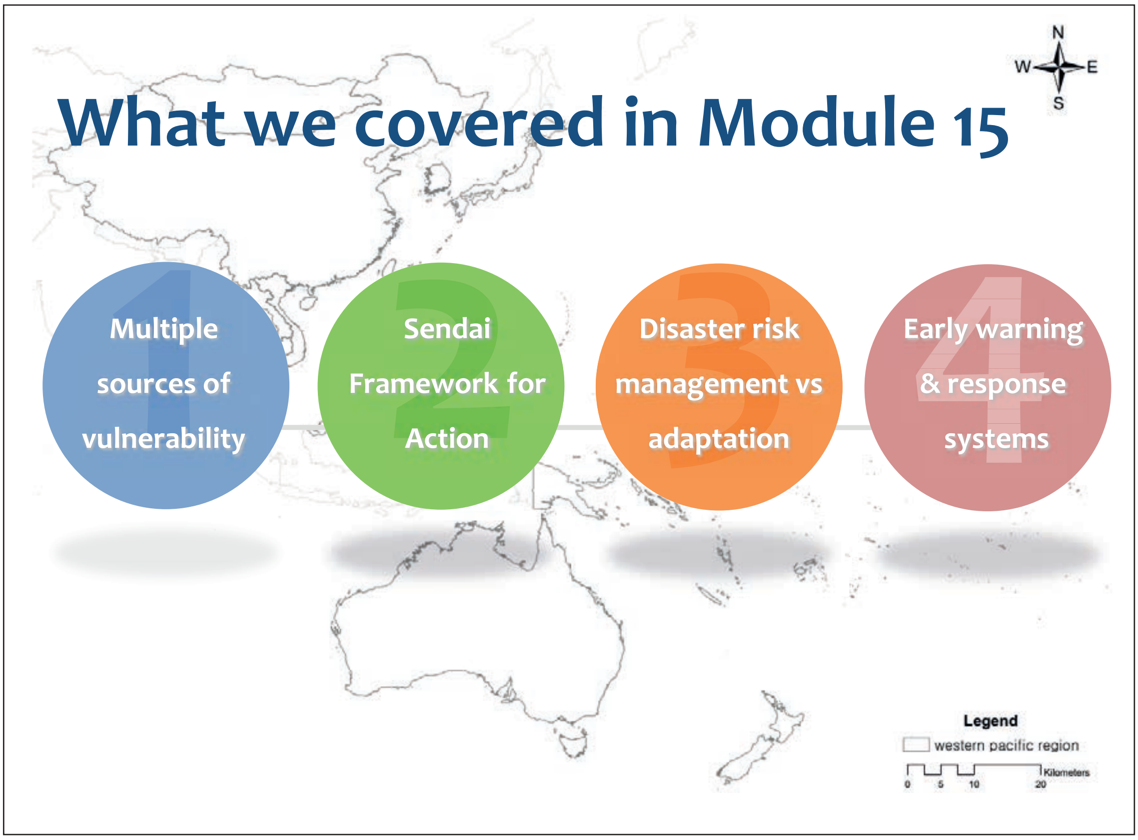
Hazard	Global entities active in EWS monitoring
Severe weather/ storms	• **World Meteorological Organization** WMO provides their respective countries (189 member countries / territories) with hydro-meteorological hazard observing, monitoring, forecasting and warning capabilities, including regional specialized centres. http://severe.worldweather.org/; www.wmo.int • **University of Hawaii** www.solar.ifa.hawaii.edu/Tropical/tropical.html • **IFRC in partnership with International Research Institute for Climate and Society** http://iridl.ldeo.columbia.edu/maproom/.IFRC/.Forecasts/
Flooding and landslides	• **Dartmouth** www.dartmouth.edu/~floods • **Ifnet** www.internationalfloodnetwork.org/03_f_info.html • **International Consortium of Landslides** http://icl.dpri.kyoto- u.ac.jp/Landslides%20Alert.html
Drought	• **Humanitarian Early Warning Service** www.hewsweb.org/drought/ • **Global Information and Early Warning System** www.fao.org/giews/english/i ndex.htm • **Benfield Hazard Research Center** http://drought.mssl.ucl.ac.uk/droug ht.html • **Famine Early Warning System** www.fews.net/
Wildland Fire	• **Experimental Climate Prediction Center** • **Global Fire Monitoring Center** www.fire.uni-freiburg.de • **Webfire Mapper (U. Maryland)** http://maps.geog.umd.edu/default.asp
Earthquakes, volcanoes, tsunamis	• **US Geological Survey and Global Volcanism Program** http://earthquake.usgs.gov/eqcenter/recenteqsww/catalo gs/caprss1days2.5.xml www.volcano.si.edu/reports/usgs/ • **Geofon** www.gfz- potsdam.de/geofon/new/rt.html • **UNESCO/Intergovernmental Oceanic Commission** http://ioc3.unesco.org/indotsunami/ • **Pacific Tsunami WS** www.prh.noaa.gov/ptwc/
Epidemics/health	• **World Health Organization** www.who.int/csr/outb reaknetwork/en/
Conflict	• African Union's Continental EWS for conflict

Source: IFRC (2012)

This slide from the IFRC report summarizes some of the global entities active in early warning systems. National and regional organizations and institutions also play important roles in developing, deploying, and monitoring early warning systems.

Participants can follow up on their comments about local and national early warning systems to talk about the partners with whom they work.

Source: *International Federation of the Red Cross/Red Crescent Societies (IFRC) http://www.ifrc.org/PageFiles/103323/1227800-IFRC-CEWS-Guiding-Principles-EN.pdf*



So to finish off, in Module 15 we covered these topics:

1. There are multiple sources of vulnerability to extreme weather and climate events and disasters in Southeast Asia and the Pacific
2. Learning about the UNISDR Hyogo Framework for Action
3. Disaster risk management vs climate change adaptation; and
4. Early warning and response systems

42

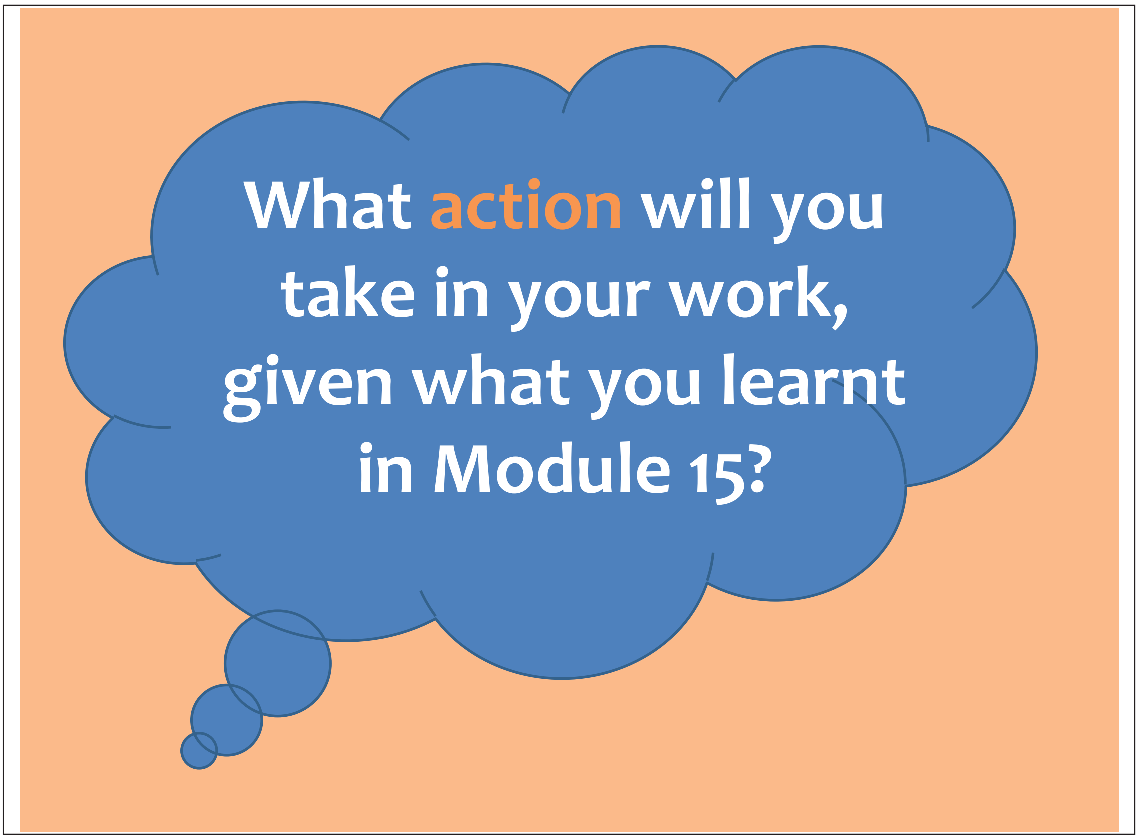
Learning from Module 15

- Southeast Asia & the Pacific are highly vulnerable to extreme weather & climate events & disasters, with a history of significant impacts on humans & society
- Disaster risk management is a structured process for increasing resilience
- International process through UN International Strategy for Disaster Risk Reduction is followed
  – Hyogo Framework for Action
- Early warning & response systems are effective

The key messages to take away are:

CLICK to animate each of the four key messages & read aloud.

43



To complete Module 15, I'll ask you to spend the next few minutes looking over your notes and reflecting on the key learnings from this module for you.

Please take some notes on any action steps you'd like to take once you're back at work, based on what you've learnt around disaster risk management.

Encourage quiet reflection (verbally if needed). At the end of **2 minutes**: "Thanks. I look forward to hearing some of the actions that were captured over the coming days."

Module 16

Communicating climate change and health

Key learning messages in Module 16

- Communicating the main messages of climate change and health is one of the health sector's responsibilities
- It is important to know the fundamentals of good communication
- Clarifying the message will help to advocate for appropriate responses to the health risks posed by climate change.

Estimated length: 60 minutes or less

Structure of Module 16

Section	Slides	Activity (if any)
Key learning messages	2	
Module outline	3–4	
1. Why communicate	5–6	QUESTION to the group on slide 6: ● Why do you think we need to communicate around climate change & health? ● Facilitate responses from hands raised, getting a wide range of reasons from across the room
2. Communicate with whom	7–8	INDIVIDUAL EXERCISE on slide 8: 4 minutes to list down/map out your key audiences that you want to reach (in notes space in handout book or on another piece of paper). Be specific about the departments, groups, and representative organisations you may need to influence.

Section	Slides	Activity (if any)
3. How to communicate	9–15	GROUP EXERCISE on slide 18 and 19: ● Divide into 5 groups ● Point out the five tables in number order around the room ● Divide yourselves evenly ● Write your key point at the top of a flipchart page – table 1 will write on communication point one (Climate change is real & human-induced), table 2 on point 2 etc. ● List down examples of what that key communication point could sound like when communicated to the public ● Project slide 19 ● 7 minutes Create gallery of flipchart pages ● 4 mins to explore gallery and 'vote' - place a tick or mark on the examples that you think are particularly strong messages to use around climate change and health, using a marker near the wall.
4. What to communicate	16–19	
5. 6 principles for good communication	20–22	
Module outline	23	
Learning from Module 16	24–27	
Learning reflection, action generation	28	INDIVIDUAL LEARNING REFLECTION AND SHARING EXERCISE on slide 28: ● Write 2–3 take aways for your work on how you will communicate on health & climate change from now on ● (1 per post it note) ● Get people to post their notes on a back/side wall ● Encourage informal reading and discussion around the post its. If you have time, get people to group the post its into themes.

Required resources

- Data projector and slide changer
- Module 16 slides
- 5 empty tables for groups to stand around (free of chairs) at back of the room
- A pad of flipchart paper or a stack of A4 paper on each table
- Packet of markers per table
- 2 free wall spaces (1 for flipchart pages, 1 for post its)
- Blue tak or tape to stick up flipchart pages
- Post it notes – enough on tables for 4 per participant

- Stopwatch
- Bell or noise maker
- Print off of 'Communications tip sheet', filed in training handout booklet.

Instructions for delivery of Module 16

Module 16 contains two exercises that require materials and movement within the training room: the group exercise on slides 18 and 19, and the sharing of individual learnings on slide 28. Ensure that you have the following set up for the two exercises:

Group exercise:

- 5 tables at the back of the training room with no chairs
- Flipchart paper and pack of markers per table
- Blu tak or tape to adhere pages to a 'gallery' wall.

Individual learning reflection and sharing exercise:

- At least a few stacks of post it notes on each table of participants (enough for 4 per participant)
- Clear wall for post its to be stuck to.

Key terms introduced in Module 16

- Communication
- Audience
- Framing.

References (in order of presentation)

- Climate Access. 2014. *Communication Tips for Public Health Professionals*. http://climateaccess.org/resource/tip-sheet-communication-tips-public-health-professionals.
- Centre for Research on Environmental Decisions, Columbia University. 2009. *Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public*. *http://guide.cred.columbia.edu/guide/principles.html*.
- Heath, C., and Heath, D. 2007. *Made to stick: Why some ideas survive and others die*. New York. Random House.
- Maibach, Nisbet and Weathers. 2011. *Conveying the Human Implications of Climate Change: A Climate Change Communication Primer for Public Health Professionals*.
- Climate Outreach and Information Network (COIN). 2015. *Talking Climate: The gateway to research on climate change communication*. http://talkingclimate.org/about/.

Module 16: Communicating climate change & health

To set up to deliver this module, ensure you have: 5 large tables at the back/sides of the room with a pad of flip chart paper and markers on it. You'll also need a blank wall large enough for 10 flipchart pages to be put up, blu tak (ideally already divided into small balls) to stick the pages up with, and a pile of markers nearby (enough for one for each person). For the closing exercise you'll need a small pile of wide post it notes on each table (enough for 3 post its per person) and one marker pen per person. You'll also need a clear patch on a wall someone in the training room for people to post their post its.

Our last module for this training package is on communicating climate change and health. We haven't left this till last because it's least important. In fact, we think that learning to communicate on health and climate is critical. It's all very well to have new knowledge on the ways that climate change affects health, and what we can do to manage and reduce the impacts. But acting on that knowledge is what's then important, in order to create change in the communities, regions and countries we work in.

2

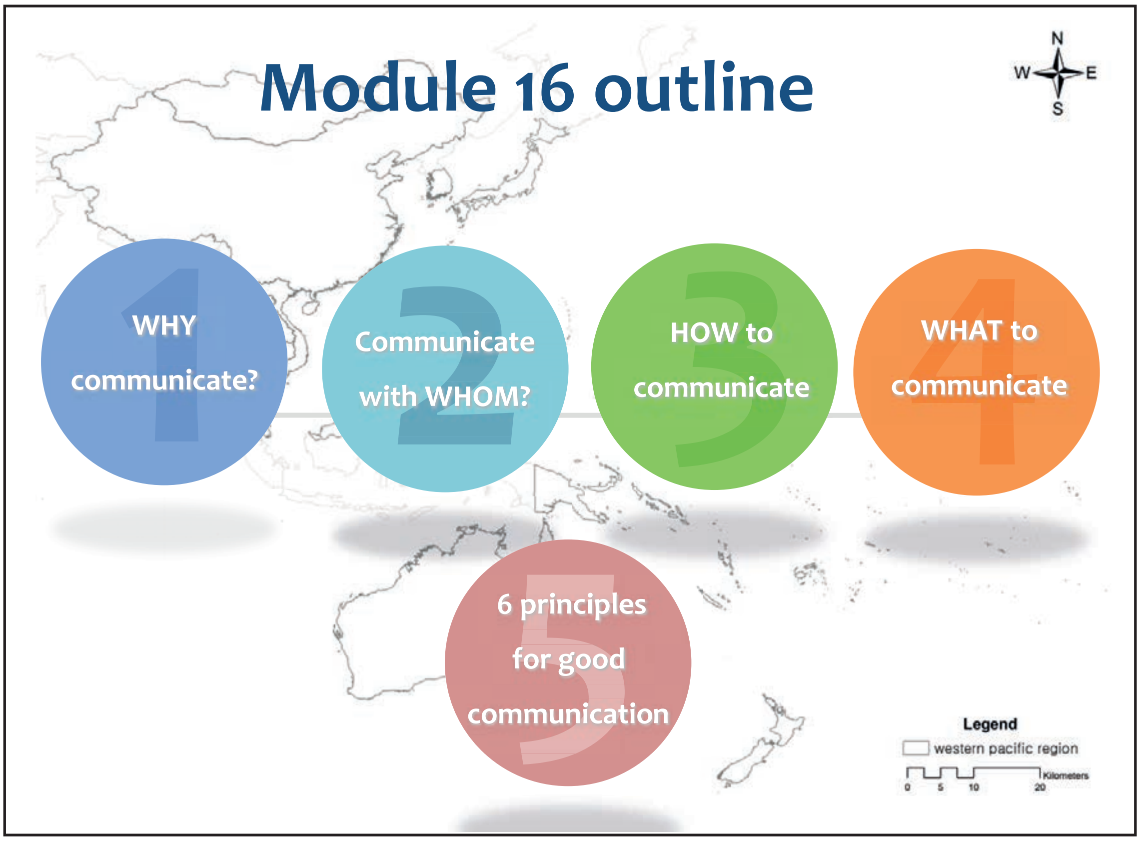
Key messages in Module 16

- Communicating the main messages of climate change & health is one of the health sector's responsibilities
- It is important to know the fundamentals of good communication
- Clarifying the message will help to advocate for appropriate responses to the health risks posed by climate change

There are three key messages from this short module on communication:

1. The importance of professionals within the health sector strengthening their skills to communicate the main issues around health and climate change. No one else is necessarily going to do this for us, so we need to become more visible and 'front-and –centre' of this discussion.
2. We are very rarely taught the basics of good communication, and it is vital that we understand what these are in order to continue our advocacy and research work.
3. If we are clearer about our messages, and how to relay these, then this will assist our ability to advocate.

3



This is a short module, and will be centered around two main areas – the first is the basics of communication. That is, why do we communicate? With whom do we communicate (i.e. our audience)? How do we communicate? And what do we communicate?

We will end the module by illustrating the 6 main tenets of good communication, which is based on a framework developed by Heath and Heath (2007). You'll have to wait until the end to find out what this acronym stands for!

4

Communicating climate change & health messages

1. Why?
2. With whom?
3. How?
4. What?

We start with the four main areas that we need to assess in order to properly develop our message. This is relevant for any subject that we are developing communication messages on, not just climate change and health.

So, firstly, we want to be clear about why we want to communicate this message – the 'why'. Is this because the message is unclear? Or that it is just not being heard by those who we think need to hear it? We need to make sure that there is a need for the communication, before we go ahead and spend time and money on developing our messages.

Secondly, we need to identify our audience. Who do we think needs to hear our message? Identifying our audience will assist us to target our message. I.e. if our audience is policy makers, then we know that the message needs to (for example) outline the problem, the possible solutions and how much this might cost – it all needs to be very brief and succinct. If we are communicating to community members, we might have a bit more flexibility in terms of the amount of material we communicate, and we may need to communicate this in a simpler manner that can cut across a variety of experiences and backgrounds.

Next, is the 'how'. We will talk about 'framing' in this section, to illustrate how powerful the 'framing' or setting the issue in an appropriate context, is.

And finally the 'what'. What is it that we actually want to communicate with our messages? We will have an interactive discussion around the main points that we feel are the key ones to include in our messages.

We'll now go through each of these in more detail.

This tip sheet to be printed as a visual guide to these sections: http://climateaccess.org/resource/tip-sheet-communication-tips-public-health-professionals

5

6

"Why do you think we need to communicate around climate change and health?

What are the first thoughts that jump into your head to justify communicating the health impacts of climate change? Raise your hand if you have a reason why. A few words is fine."

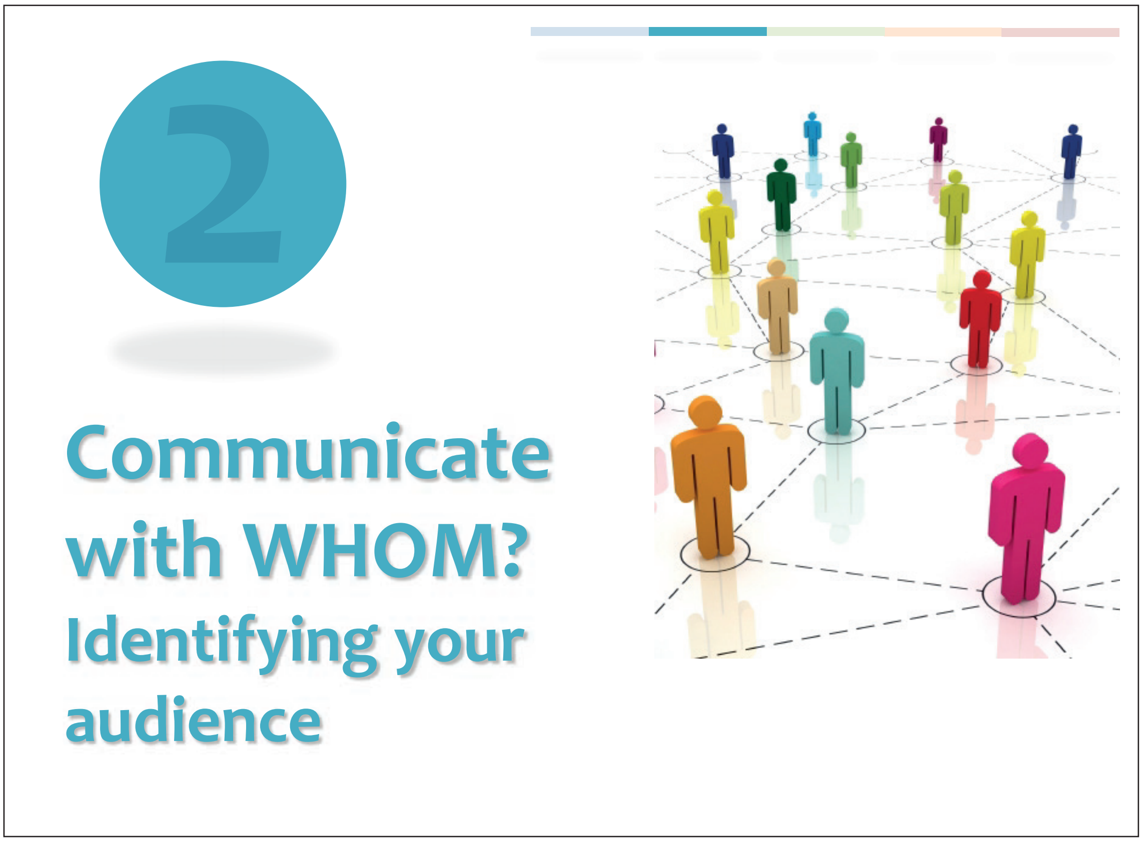
Facilitate responses, getting a wide range of reasons from across the room. Acknowledge people's responses, and continue to ask "Why else do we need to communicate?"

Answers might include:

- Because CC is a threat to human health and wellbeing
- Climate change will affect us all
- People in SE Asia and the Pacific will be impacted particularly by climate change
- Impacts are already being experienced
- Many people currently have low levels of understanding
- We need to prepare for the health impacts of climate change
- Everyone needs to be involved in reducing our contribution to climate change
- Public health professionals have an obligation to do their best to prevent CC from harming human health – therefore it is important that we are involved in effectively informing the public and decision-makers about the risks and potential responses. etc.

Wrap up the input that's been provided with a quick summary, thanking people for their input and adding in your own or ideas above if any of these are not covered.

7



So I think we have a good understanding of why communication around health and climate change is important.

Let's now look at who we are likely to need to communicate with.

8

Whom do you want to communicate with on climate change?

I'd like you in a minute to define who your audience is in your work in communicating messages around the climate change and health. Whom do you need to reach?

Your audiences will vary, depending on the reasons for communicating messages. You might be interested in communicating broadly, including with other health professionals, professionals in areas related to health (e.g. water, agriculture, disaster management), the general public, media agencies, and decision-makers (including bilateral and multi-lateral donors). Or in your area of responsibility, you might be responsible for reaching a particular target group such as women and children.

I'll give you **4 minutes** now to list down or map out your key audiences that you want to reach in the notes space next to this slide, or on another piece of paper if you need more space. Please be specific about the departments, groups, and representative organisations you may need to influence.

Give a time warning: **3 minutes** "Ok I'll give you another minute to finish off your audience mapping." **4 minutes** "And I'll get you to finish off now, thanks."

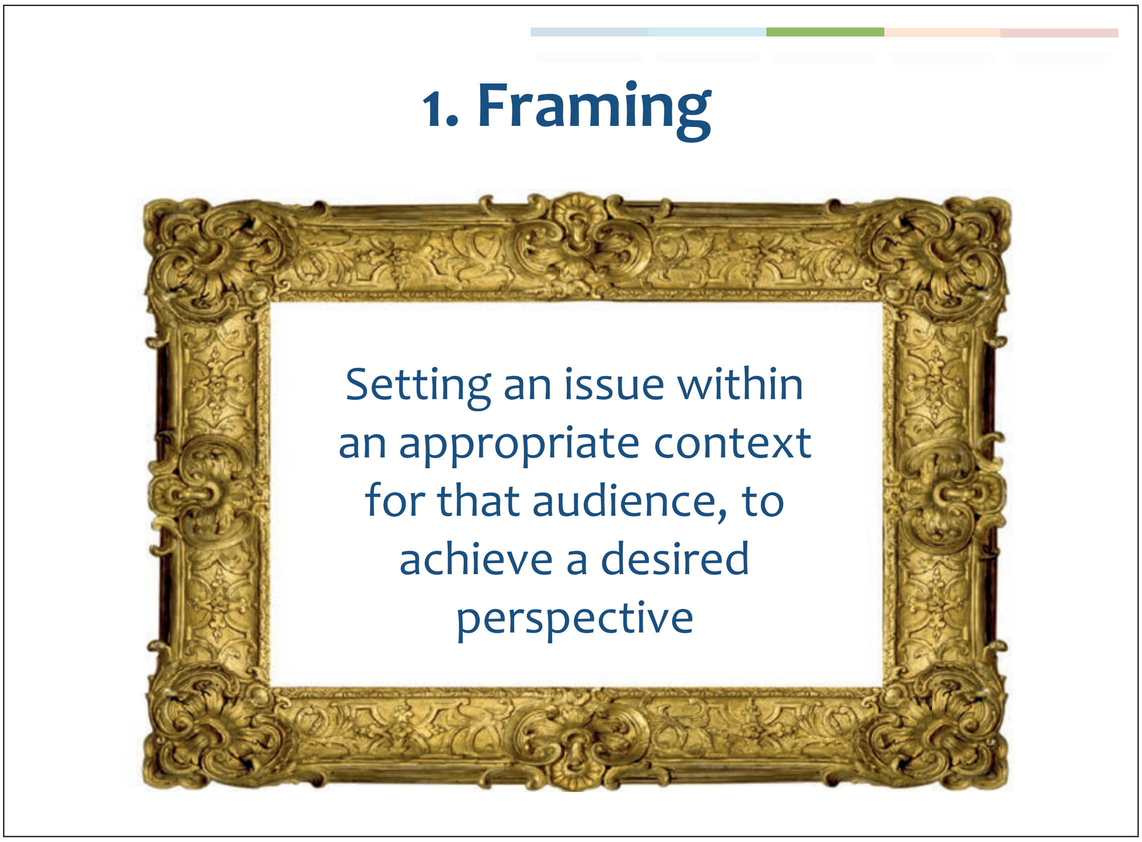
I hope that gave you some specific ideas about who you're likely to need to communicate with when you're back home. This will likely entail forming a relationship and learning more about the needs and priorities of these different audiences. Because we need to target our messages differently depending on who our audience is, as we will discuss next.

9

Once you've determined whom you need to communicate with, you then need to decide how to communicate. Communicating automatically as we would tend to usually is unlikely to work. We are not our audience, and we need to factor in who specifically we're communicating to in designing our message.

On the next slides are some steps that make for more effective communication design.

10



The first step is framing your message.

Framing is setting an issue within an appropriate context for that audience, to achieve a desired interpretation or perspective. Frames can also help communicate why an issue might be a problem, who or what might be responsible, and, in some cases, what should be done.

- Framing is not intended to deceive or manipulate people, but to make credible climate change information more accessible to the public.
- Framing can be a subtle art—even the choice of a single word can make the difference between winning and alienating an audience.

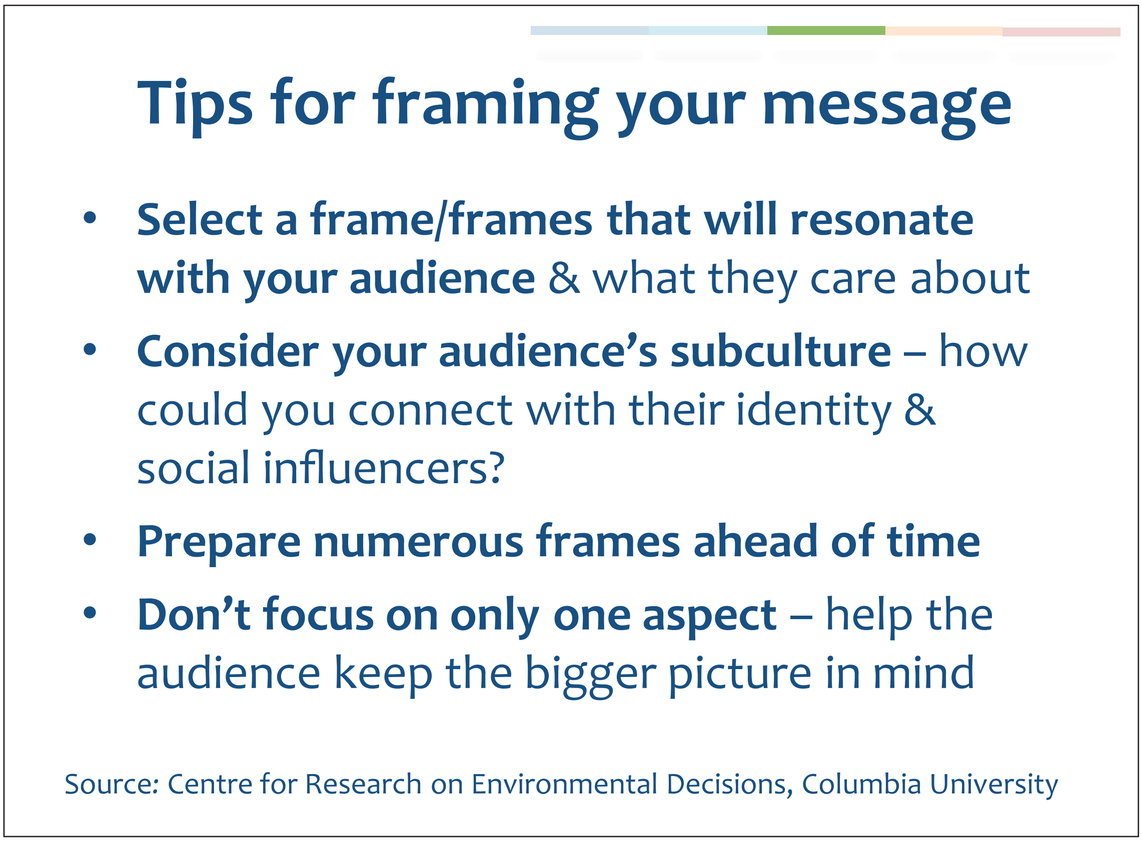
While they may not be aware of it, people feel better and more positive about achieving their goals and are more likely to sustain their behavior when their goals are framed in a manner that feels naturally comfortable to them.

Trainer notes.

For future development, the following could be inserted/added here:

- Insert a climate change and health example of framing showing the message before and after framing (as slide 11) to make it clear what framing is.
- Print off a health frame example for reference, turning this into a mini exercise by getting pairs to read and discuss the example.

11



Tips for framing how you communicate include: (**CLICK** for each of the four tips)

- Select a frame/frames that will resonate with your audience. What do they care about? What do they already know about and have familiarity with?
- Consider the audience's membership of specific subcultures (groups of people with distinct sets of beliefs, or based on race, ethnicity, class, age, gender, religion, occupation, etc.).
- Prepare numerous frames ahead of time (i.e., climate change as a health, religious, youth, or economic issue).
- When framing climate change, be careful not to focus so intently on one particular aspect that the audience loses sight of the bigger picture.

Source: *Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public', Centre for Research on Environmental Decisions, Columbia University: http://guide.cred.columbia.edu/guide/principles.html*

12

Tips for framing your message

- Tap into people's **desire to avoid future losses** rather than realize future gains
- Focus on **potential current & future losses related to inaction** on climate change, instead of current & future gains
- Frame action on climate change as **'losing a little bit now instead of losing much more in the future'**

Source: Centre for Research on Environmental Decisions, Columbia University

Other helpful tips on how to frame your message around health and climate change are: (**CLICK** for each of the three tips)

- Tap into people's desire to avoid future losses rather than realize future gains.
- Present information in a way that makes the audience aware of potential current and future losses related to inaction on climate change instead of focusing on current and future gains.
- Remember that audiences may be more likely to make changes to their behavior if climate change information is framed as "losing a little bit now instead of losing much more in the future.

Source: *Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public', Centre for Research on Environmental Decisions, Columbia University: http://guide.cred.columbia.edu/guide/principles.html*

13

2. Localise the issue

The second tip on how to develop your message is to localise the issue - bring the message close to home. If we can highlight the current and potential impacts of climate change not only globally, but also locally then this will increase the audience's sense of connection with the issue.

One way to do this is to leverage local extreme weather events, using them as "teachable moments" during which to relate climate change to the experience of your audience. (However, keep in mind that although climate change may increase the chance that a particular event will occur, it does not cause an event to take place.)

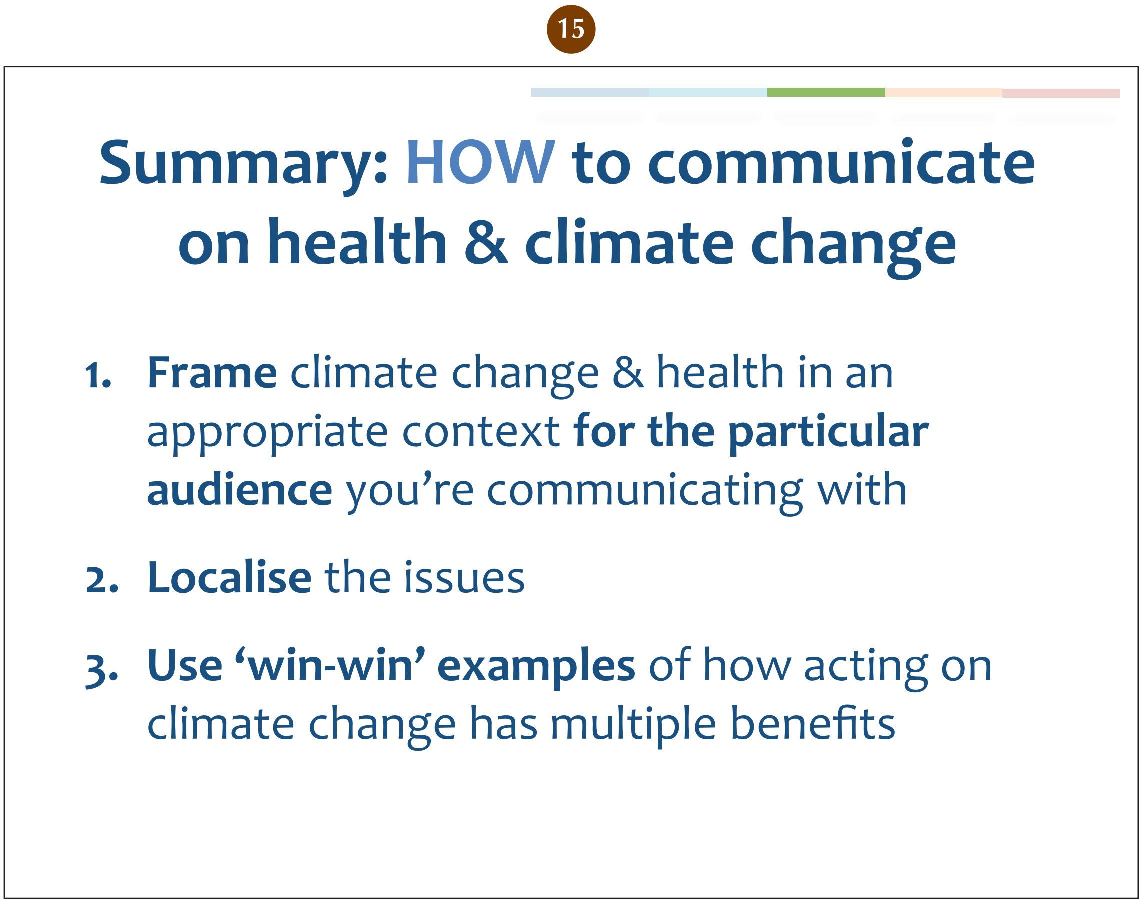
14

3. Use 'win-win' examples

Using examples of 'win-win' scenarios is a powerful way for the health community to link itself with the broader climate change community, as well as illustrate the savings that can be made (financial and GHG) in order to appeal to those segments of the audience that need to know the 'business case' for change.

We have discussed 'win-win' opportunities for health and climate change, so just a reminder here of some examples. These include:

1. Active transport such as bike riding, which benefits healthier lifestyles and reduction in GHG emissions via car use
2. Green spaces, leading to cleaner air, more room for physical activity and community connection
3. Reducing meat consumption, contributing to healthier lifestyles and a reduction in methane emissions.



So a reminder of these three steps in HOW to communicate effectively with your chosen audience on health and climate change:

1. **Frame** climate change & health in an appropriate context for the particular audience you're communicating with
2. **Localise** the issues
3. Use **'win-win' examples.**

16

4

WHAT to communicate on climate change & health

We've looked at why, with whom, and how we communicate effectively on climate change and health. Next up, WHAT should we communicate to get the message across around health and climate change most effectively?

There are lots of specific messages you will build up over time in your work, but let's look at 5 general messages that are valuable foundations for communication around climate change and health.

17

5 key points to communicate

1. Climate change is **real & human-induced**
2. Climate change has **negative effects for us & our communities** in a number of ways
3. We **need to start taking acting now to protect our health** (& the health of the planet)
4. We **have enough evidence** to act now
5. **'Win-win' actions will benefit our health, our economy & the environment**

These 5 points that are valuable foundations for communication around climate change and health are: (**CLICK** to animate each of the 5 points)

1. Climate change is real & human-induced
2. Climate change has negative effects for us & our communities in a number of ways
3. We need to start taking acting now to protect our health (& the health of the planet)
4. We have enough evidence to act now
5. 'Win-win' actions will benefit our health, our economy & the environment.

18

NB: This exercise will require 5 empty tables for groups to stand around (free of chairs) with either a pad of flipchart paper or a stack of A4 paper on it and a packet of markers.

"I now want to give you some time to go further into these points and come up with some specific examples. Remember that when we're generating the content of our communication we need to do this for a specific target group in a particular location, which we won't have for this exercise. So please assume you're creating specific communication messages for the general public in a country in the Asia Pacific.

So for this exercise, in a minute I'll ask you to divide into 5 groups. Table 1 will be over there (point), table 2 there – point out the five different empty tables in number order around the room. Please divide yourselves fairly evenly, so if one table is full you head to another one." (You may need to have a few helpers circulate to help make this happen.)

"When you get to your table, write your key point at the top of a flipchart page – table 1 will write on communication point one (Climate change is real & human-induced), table 2 point 2 etc. I'll show the slide with the 5 communication points again in a minute.

I then want you to list down some examples of what that key communication point could sound like when communicated to the public. For example, if you had point 1, 'Climate change is real & human-induced', you might list as a specific communication example: '97% of climate scientists around the world agree that climate change is happening and that it is human induced.' Please write clearly so that others can read the examples you come up with.

Are there any questions?"

"Ok, please find your way to one of the 5 tables – point out 1 – 5 again – where you'll have **7 minutes** to come up with some specific examples of this key communication point."

Project the next slide so the 5 communication points are visible and set timer

19

5 key points to communicate

1. Climate change is real & human-induced
2. Climate change has negative effects for us & our communities in a number of ways
3. We need to start taking acting now to protect our health (& the health of the planet)
4. We have enough evidence to act now
5. 'Win-win' actions will benefit our health, our economy & the environment

Give time reminders: At **4 minutes** – "Ok, you have another 3 minutes to come up with some more specific examples of how to communicate this point". **6 minutes** - "You have one minute left. Finish off your last example and then please take your page or pages to the wall (name specific location) where we'll display them."

7 mins – "Please finish up now. If you haven't done so already please bring your page to the wall and stick it up in the gallery so we can see some of the great examples you've come up with. Please also bring a marker or pen with you."

Once pages are up in a long gallery – "Now that these great examples are up, please spend the next four minutes exploring this gallery and looking at the examples that others have come up with. As well as looking, you'll also have the chance to vote – please place a tick or mark on the examples that you think are particularly strong messages to use around climate change and health, using a marker near the wall."

Give a time countdown – At **2 mins**: "Make sure that you're getting around to all five pages, and leaving a mark on what you think are the strongest communications examples." At **3 mins** "Ok you have another minute. Make sure you read over as many of the other examples as you can, and leave your mark on those that you think are particularly strong."

"Thanks everyone. I'll get you to take a few big steps back from the wall. Looking across the pages, where can you see the most marks?"

Get participants to help you find some of the strongest communication messages (as voted by the group) and read them out, stating the key communication point first (1, 2, 3, 4 or 5).

"Great. Well done everybody – you've come up with some strong examples on what to communicate around climate change and health. I hope you'll bring some of these messages into your future communication. You're welcome to photograph these to take away with you if you'd like to. (Or offer to photograph them and provide them to participants if relevant.) Please return to your seats."

20

In this last section of this module on communicating around health and climate change I'm going to introduce you to 6 principles that make for good communication.

21

SUCCES: 6 principles for good communication

- **S** – Keep it ***simple***
- **U** – Make your point in an ***unexpected*** way
- **C** – Give ***concrete*** examples
- **C** – Use ***credibility*** to your advantage
- **E** – Allow ***emotion*** to accentuate the message
- **S** – Use a ***story*** to bring the message to life

Source: Heath & Heath (2007). 'Made to stick: Why some ideas survive & others die'.

The fundamentals of good communication can be represented by an acronym of six features that spell 'SUCCES'. These each stand for: (CLICK to display each)

S – Keeping it simple

U – Making your point in an unexpected way – preferably not with lots of detailed data in complex tables or graphs, that people might expect

C – Give concrete examples – this way people can relate to what can be quite complex and overwhelming ideas, and not have to use their imagination

C – Use credibility to your advantage. An example of this is that 97% of climate scientists agree on the climate science, or that information you're sharing is from the World Health Organisation.

E – Using emotion is helpful, as this is how humans work – despite the fact that we think we are purely rational creatures! But make sure that you don't overuse emotion, as scaring people is also counterproductive, as they are then likely to disengage; and finally,

S – Stories bring messages to life. Is there an example of a community who has adapted to climate change whose story you can convey to someone who needs to be convinced on the importance of responding to the health effects of climate change? This is likely to be much more inspiring and empowering than just talking about the theoretical need for us to act.

Source: *Heath, C., & Heath, D. (2007). Made to stick: Why some ideas survive and others die. New York. Random House.*

22

Resources for further learning

Conveying the Human Implications of Climate Change: A Climate Change Communication Primer for Public Health Professionals
Maibach, Nisbet & Weathers (2011)

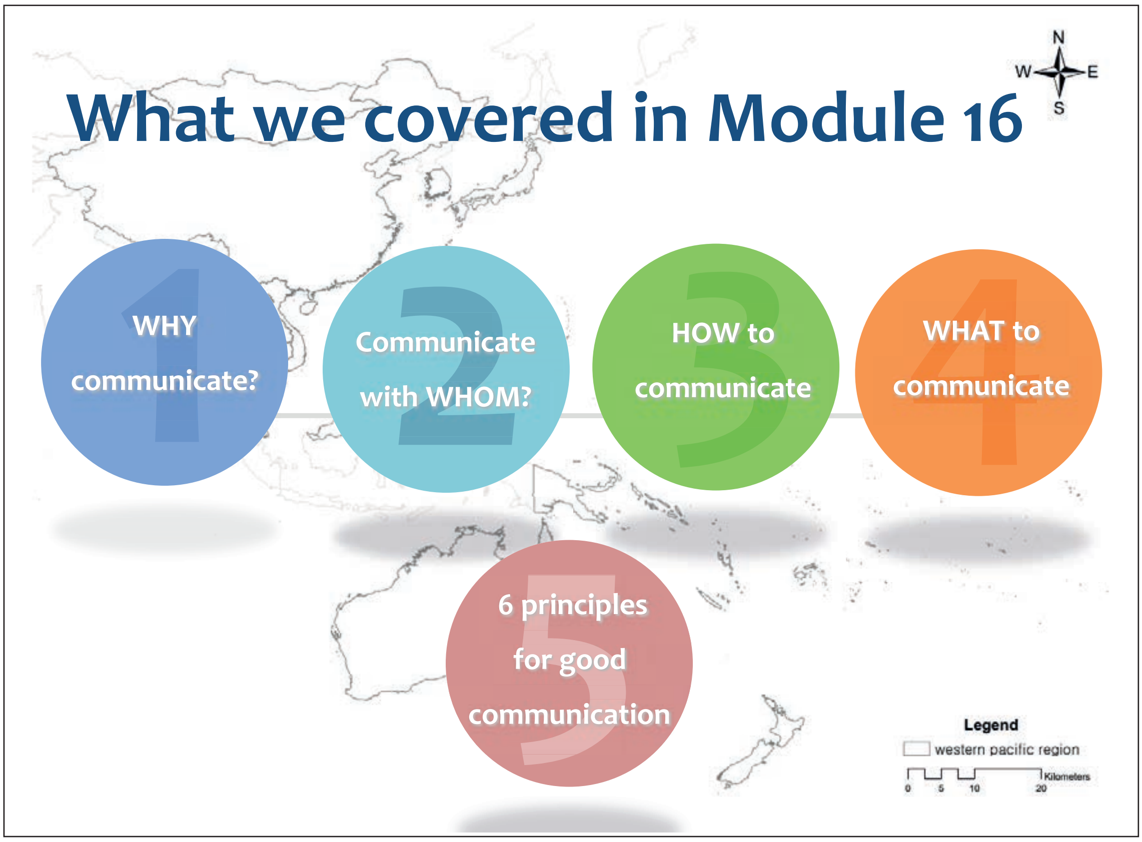
The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides & the Interested Public
Centre for Research on Environmental Decisions, Columbia (CRED) (2009)

http://talkingclimate.org/about/

The first two resources listed here have been drawn from in this module, so if you'd like to do further learning in this important area they are both great – very clear, easy to use and freely available, and also link to other resources within them.

The third resource is a general good guide for communicating about climate change (without a health focus), which you might also find useful.

23



A reminder that this is what we covered in Module 16:

Why do we communicate? With whom do we communicate (i.e. who is our audience)? How do we communicate? And what do we communicate around climate change and health?

We finished the module by illustrating the 6 principles of good communication, using the 'SUCCES' framework developed by Heath and Heath.

24

Learning from Module 16

- Communicating the main messages of climate change & health is one of the health sector's responsibilities
- It is important to know the fundamentals of good communication
- Clarifying the message will help to advocate for appropriate responses to the health risks posed by climate change

The learning take aways on communicating health and climate change are:

CLICK to animate each of the three points

1. The importance of professionals within the health sector strengthening their skills to communicate the main issues around health and climate change. No one else is necessarily going to do this for us, so we need to become more visible and 'front-and –centre' of this discussion.
2. We are very rarely taught the basics of good communication, and it is vital that we understand what these are in order to continue our advocacy and research work
3. If we are clearer about our messages, and how to relay these, then this will assist our ability to advocate for appropriate responses to the health risks posed by climate change.

25

Summary: HOW to communicate on health & climate change

1. **Frame** climate change & health in an appropriate context **for the particular audience** you're communicating with
2. **Localise** the issues
3. **Use 'win-win' examples** of how acting on climate change has multiple benefits

And just to make sure they stay with you, here is a summary of some of the key things we covered under HOW and WHAT to communicate around climate change and health.

26

WHAT to communicate?
5 key points

1. Climate change is real & human-induced
2. Climate change has negative effects for us & our communities in a number of ways
3. We need to start taking acting now to protect our health (& the health of the planet)
4. We have enough evidence to act now
5. 'Win-win' actions will benefit our health, our economy & the environment

27

6 steps for communication SUCCES

- **S** – Keep it ***simple***
- **U** – Make your point in an ***unexpected*** way
- **C** – Give ***concrete*** examples
- **C** – Use ***credibility*** to your advantage
- **E** – Allow ***emotion*** to accentuate the message
- **S** – Use a ***story*** to bring the message to life

Source: Heath & Heath (2007). *Made to stick: Why some ideas survive & others die.*

28

To finish off, I'll ask you now to reflect on three key learnings or take aways – things that will influence how or what you communicate on health and climate change in your work from now on.

This might be one of the suggestions from the slides on how to communicate, such as 'I will frame my message for the specific audience I'm communicating to, not write one communication and use it for everyone'. Or it could be a key point you'll emphasise, or one of the SUCCES steps, such as always giving concrete examples of the effect of climate change.

On your table you'll see a pile of post it notes. Once you've had time to gather your three take aways or learnings, please write each one on a separate post it note.

When you've finished, come and post your note on this wall over here (point)."

People should automatically move, so shouldn't require a time count down. Moving over to the wall yourself will help remind people of the next step. Encourage informal reading and discussion around the post its. If you have time, you can get people to group the post its into themes.

When time is up/people seem to have had enough, wrap up by thanking everyone and giving an instruction about the lunch break and the time to reconvene.

This training package on climate change and health was prepared initially in 2009 and substantially revised by a group of experts in 2014. It is a product of collaborative effort of WHO/SEARO, WHO/WPRO and GIZ, Bonn. The training package consists of 16 standalone modules covering a range of topics that will prove very useful to build capacity of public health professionals who are involved in management of public health programmes impacted by climate change. The modules are also designed for ease of use by professionals from other sectors such as the environment, transport, disaster preparedness, etc., enabling them to understand the intersectoral nature of the issue and to address health impacts jointly with other sectors. One or more modules can be used as advocacy material as well as to orient different target audiences such as policy-makers.

World Health Organization
Regional Office for South-East Asia
World Health House
Indraprastha Estate,
Mahatma Gandhi Marg,
New Delhi-110002, India
www.searo.who.int

SEA-EH-585