5. Predicted Consequences of Climate Change at the Global Level

The United Nations and its member countries have resolved to prevent global average surface temperatures from rising by more than 2 degrees Centigrade over pre-industrial levels. Increases above this amount are judged to pose unacceptable dangers.

A global average temperature increase of about 0.78 degrees Centigrade above pre-industrial levels has already occurred. While this does not seem large to us here in Saskatchewan, where we experience a wide variation in temperatures over the course of the year, it is in fact, a very significant increase. Peter Prebble likened it to a temperature increase in the human body, where a series of small temperature rises can soon produce a fever.

Moreover, because there is a delayed response to recent increases in atmospheric greenhouse gas concentrations, a further global average temperature increase in the range of 0.2 degrees Celsius over the next 2 decades is almost certain to occur, even if all greenhouse gas emissions were to stop today. (For further detail on this point refer to IPCC 2007, *The Physical Science Basis*, starting at page 12 of the Summary for Policy Makers.) Beyond this, future temperature increases in the lower atmosphere and on the surface of the Earth will be highly dependent on future trends in manmade emissions of greenhouse gases worldwide.

Several speakers at the Citizen Hearings' discussed projections by the Intergovernmental Panel on Climate Change (IPCC) for global average surface temperature, sea ice extent in the Northern Hemisphere, and ocean acidity. Kirsten Zickfeld noted the IPCC projections are based on four different greenhouse gas emission scenarios referred to as Representative Concentration Pathways. These scenarios also take account of aerosols and other climate drivers. Each scenario is identified by its approximate total radiative forcing in 2100, relative to 1750.

Each of these four scenarios results in different future concentrations of greenhouse gases in the atmosphere. Each is also a reflection of different choices in climate change policies and in fossil fuel consumption.

Atmospheric greenhouse gas concentrations currently sit at approximately 435 parts per million CO_2equivalent, a measurement that takes account of carbon dioxide levels, as well as methane and nitrous oxide levels. This concentration has been rising at an average of over 2 parts per million each year.

Projecting into the future, the lowest IPCC Representative Concentration Pathway (RCP 2.6) is based on the assumption that future manmade greenhouse gas emissions decline sharply (i.e.: fossil fuel use declines very rapidly). Radiative forcing therefore also declines. Under this scenario, the rise in greenhouse gas concentration in the atmosphere is limited to 475 parts per million CO_2equivalent by 2100.

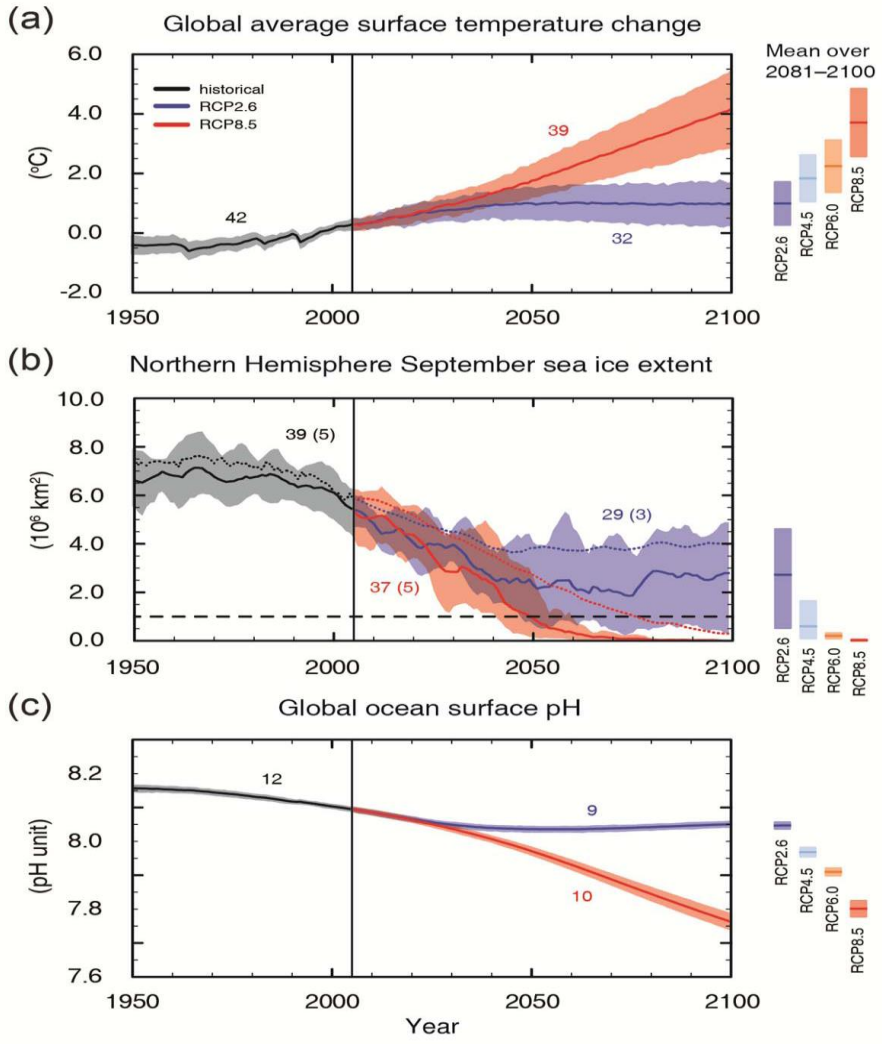
The other three greenhouse gas emission scenarios each presume progressively higher levels of fossil fuel use. Under RCP 4.5 greenhouse gas emissions and radiative forcing have stabilized by 2100. Nevertheless, greenhouse gas concentrations in the atmosphere have reached 630 parts per million by 2100. Under scenario RCP 6.0 fossil fuel use has been higher still, and has therefore resulted in greater radiative forcing.

The Difference between CO_2 and CO_2equivalent:

When scientists refer to CO_2 concentrations in the atmosphere, they are referring only to how much carbon dioxide is in the atmosphere. This is expressed in parts per million, and in 2013 averaged 396 parts per million over the course of the year. When scientists refer to CO_2e, they are referring to the combined concentration in the atmosphere of: carbon dioxide, nitrous oxide, methane and other greenhouse gases monitored under the Kyoto Protocol. This number will naturally be higher than CO_2 alone. The other gases are being weighted by their global warming potential relative to CO_2, and are being added to CO_2 levels.

Greenhouse gas concentrations in the atmosphere sit at 800 parts per million by 2100. In the fourth and highest fossil fuel use scenario, greenhouse gas concentrations in the atmosphere have reached 1,313 parts per million COe_2quivalent by 2100.

As can be seen from the chart below, **all three of the higher greenhouse gas emission scenarios are likely to result in a global average surface temperature increase of close to or well above 2 degrees Centigrade by the end of the century. This would put global average surface temperatures close to or well above the range judged to be dangerous and unacceptable by the United Nations and its member countries (including Canada).**



GRAPHS FROM THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2013)
PRESENTED TO THE CITIZENS' HEARINGS BY DR. KIRSTEN ZICKFELD

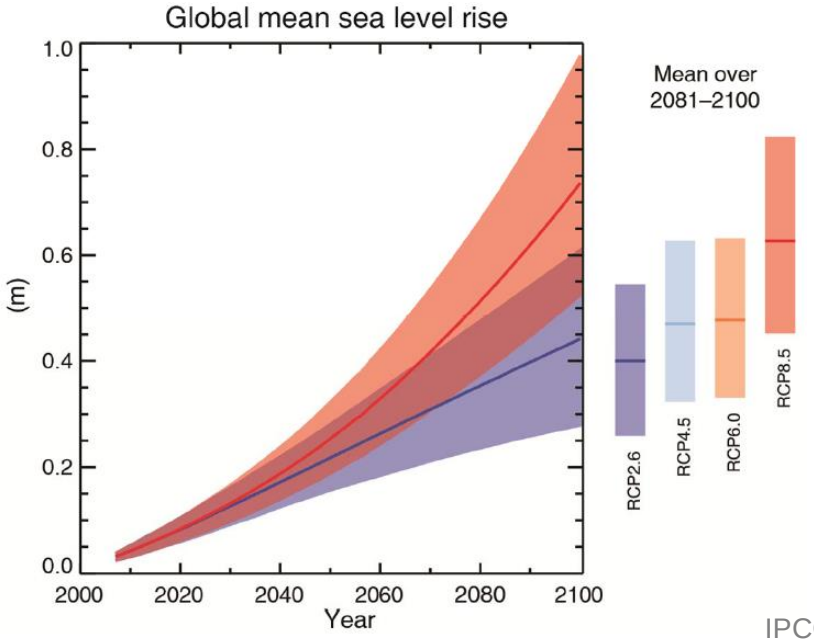
Kirsten Zickfeld explained that the three higher greenhouse gas emission scenarios are also forecast to cause the loss of most or all of the summer sea ice in the Northern Hemisphere by 2100, a profound change for the planet, since far more of the sun's energy would consequently be absorbed by open Arctic waters that will have lost much of their reflective property. That would in turn accelerate further planetary warming.

Similarly, **the three higher greenhouse gas emission scenarios are each predicted to result in a steady decline in ocean surface pH**. In other words, these emission scenarios will trigger increasing acidity of the oceans, with consequent negative effects for coral reefs and many forms of marine life.

Only the fourth and lowest greenhouse gas emission scenario avoids the above mentioned consequences with high confidence. Achieving this emission scenario requires large, rapid and sustained reductions in manmade greenhouse gas emissions. In effect, **worldwide fossil fuel extraction and consumption would need to be phased out nearly entirely by mid-century, and a very rapid reduction in use would be required in the decade ahead.**

Even this low emission scenario cannot stop ongoing sea level rise during this century, but sea level rise is forecast to be more serious under the three higher emission scenarios. Similarly, the low emission scenario cannot stop further temperature rise, but is expected to limit it to a global average increase of 1.7 degree Centigrade above the pre-industrial average. **Importantly, the low emission scenario avoids the dangers of a 2 degree Centigrade, 3 degree Centigrade or 4 degree Centigrade temperature rise**. Very importantly, it also avoids the prospect of ongoing surface temperatures increases in the centuries ahead.

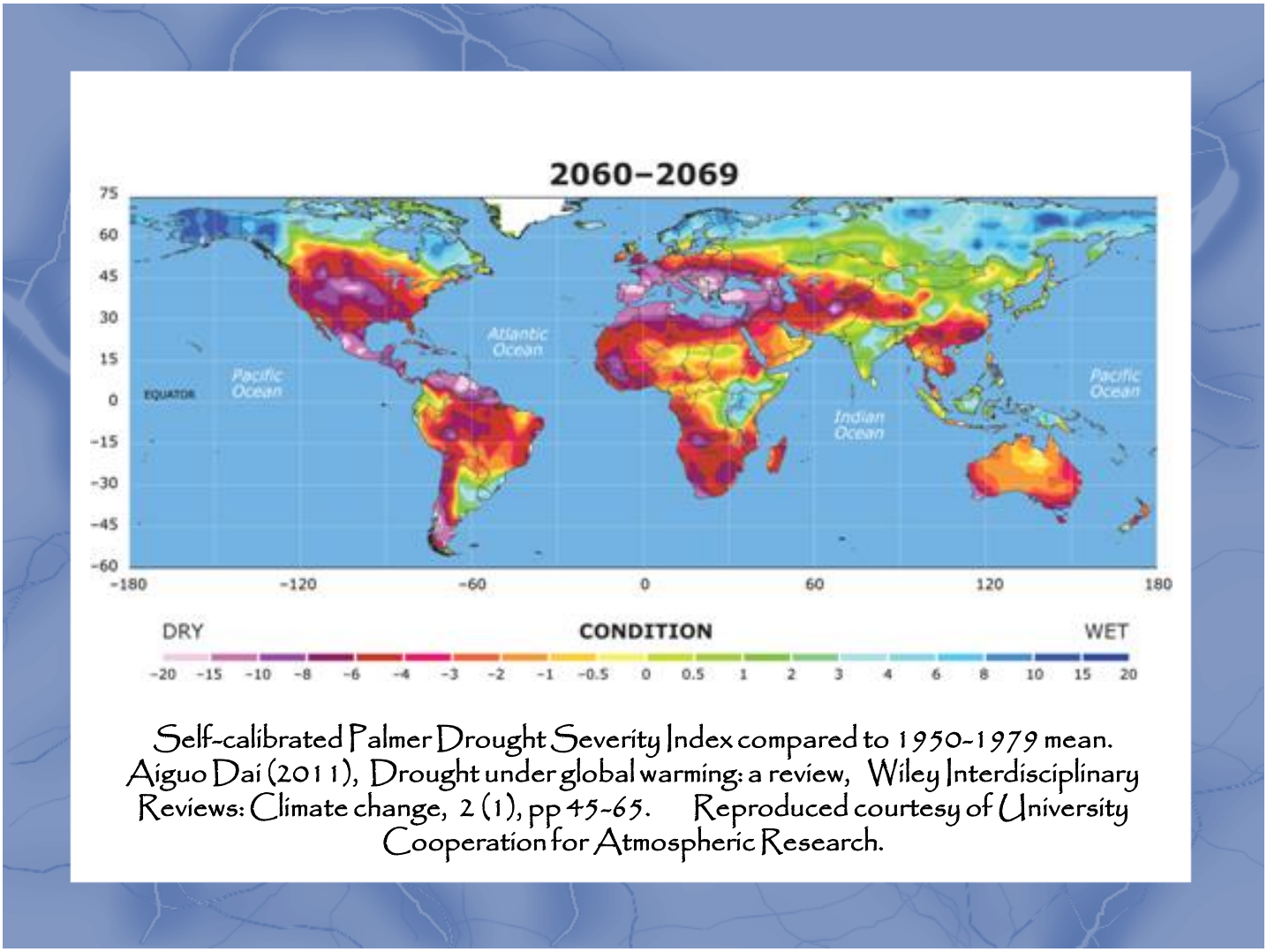
Sea Level Rise in the 21st Century



IPCC (2013)

IPCC GRAPH PRESENTED AT THE HEARINGS BY DR. KIRSTEN ZICKFELD

Mark Bigland-Pritchard of Climate Justice Saskatoon outlined the projected impact that rising greenhouse gas emissions will have on drought conditions across the globe. **Droughts are expected to become more widespread and more severe over the course of this century**. Mark presented data projecting much drier climatic conditions over much of southern and central Europe, the Midwest and Southwest of the United States, Mexico, Central America, Brazil, Chile, Australia, the Middle East, parts of Pakistan and China, southern Africa, and large parts of northern and western Africa. He noted this projected trend has serious implications for reduced crop production and increased hunger and malnutrition.



Self-calibrated Palmer Drought Severity Index compared to 1950-1979 mean. Aiguo Dai (2011), Drought under global warming: a review, Wiley Interdisciplinary Reviews: Climate change, 2 (1), pp 45-65. Reproduced courtesy of University Cooperation for Atmospheric Research.

SLIDE PRESENTED AT THE CITIZEN HEARINGS BY DR. MARK BIGLAND-PRITCHARD

Dr. Christian Holz of Climate Action Network Canada discussed several critically important predictions the United Nations Intergovernmental Panel on Climate Change has reached consensus on, **should average global surface temperature on our planet rise by 2 degrees Centigrade or more above pre-industrial levels**. He emphasized that if this is allowed to happen, millions of people will experience coastal flooding. **Hundreds of millions of people will be exposed to more water stress.** There will be increasing morbidity and mortality from heat waves, floods and droughts. Production of cereal crops at low latitudes will decrease, with many subsistence farmers suffering crop losses. There will be a large rise in malnutrition, and in cardiovascular, infectious and diarrheal diseases. Moreover, **up to 30% of the species that humans share the planet with will be placed at increased risk of extinction**. Most coral reefs in the world will be bleached, putting their future at grave risk.

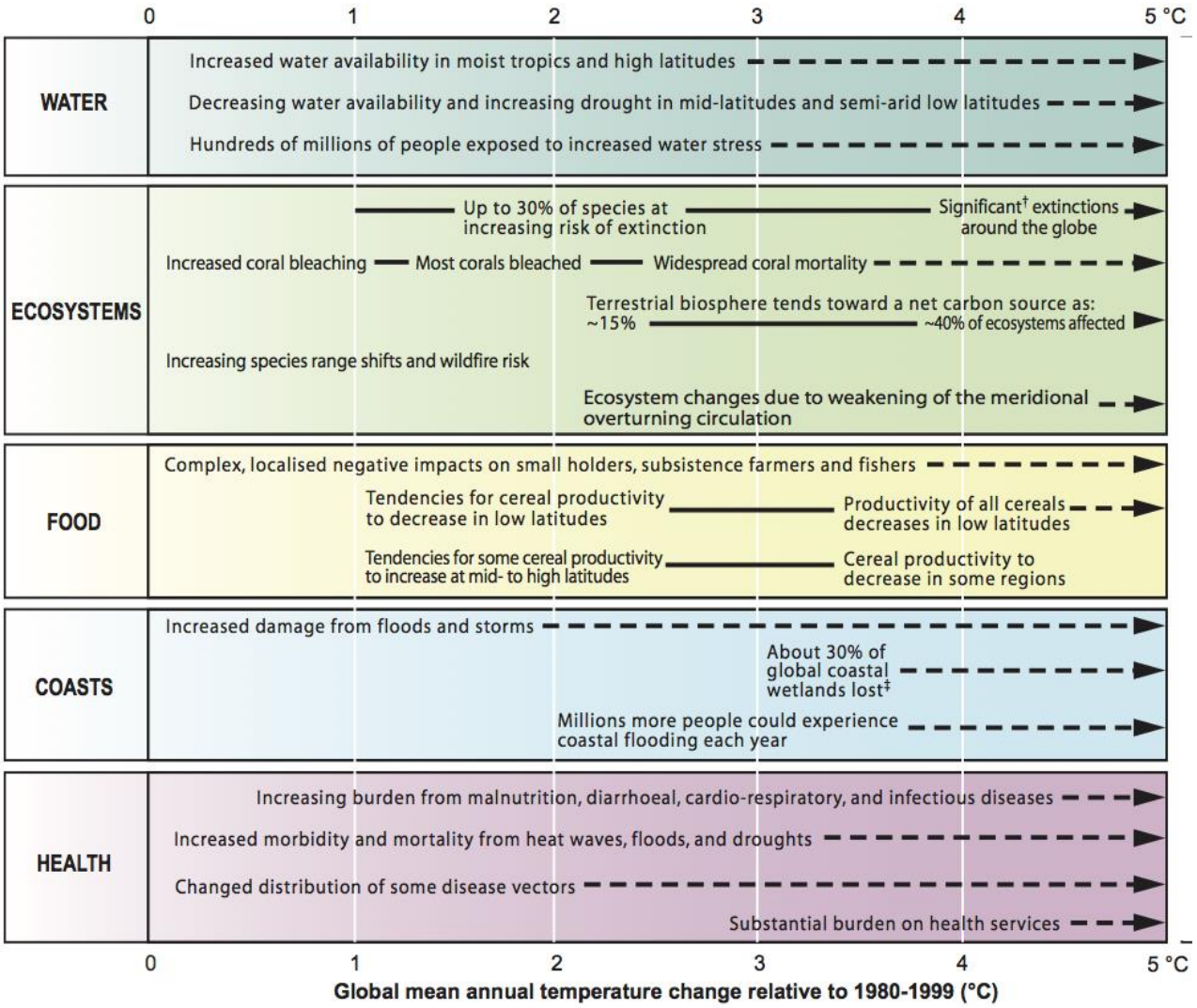


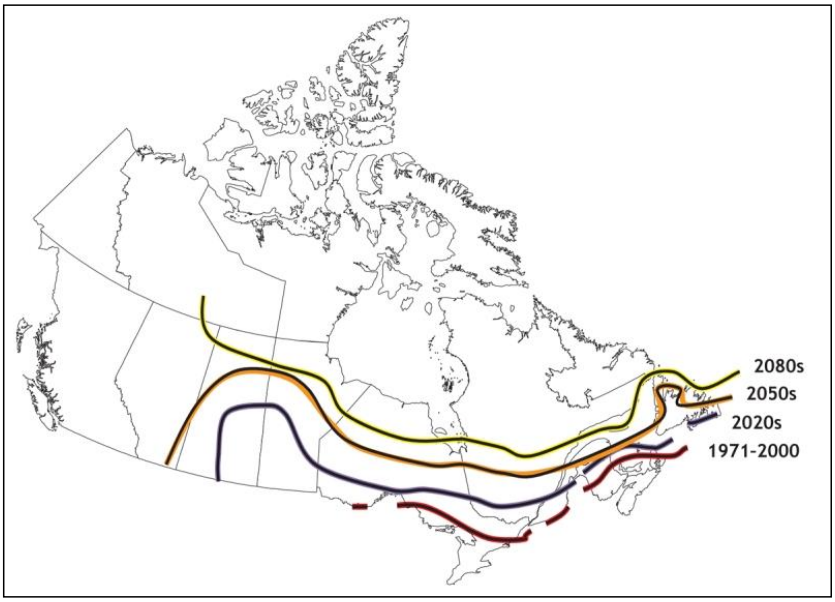
CHART FROM IPCC 2007 REPORT PRESENTED AT THE HEARINGS BY DR. CHRISTIAN HOLZ

Michael Swandt noted **that the worst health consequences from climate change will often be experienced in lower income countries that have the least to do with emitting greenhouse gas pollution in the first place**. These countries also tend to have the least monetary resources for adaptation to climate change. Meanwhile, many wealthier countries, which are disproportionately more responsible for greenhouse gas pollution, will not experience the health consequences as severely, by virtue of their more northerly geographical location.

This does not mean Canada will be unaffected. For instance, Michael Swandt presented data demonstrating that heat related deaths in Canadian cities such as Montreal will rise at least three fold by 2050 (assuming no adaptation or mitigation measures are taken), and perhaps much higher. He also presented projections for the spread of Lyme disease, which is expected to become more widespread in Saskatchewan, Manitoba and eastern provinces, as the climate warms.

Infectious disease

Projected distribution of *Ixodes scapularis* deer tick, vector for Lyme disease-causing *Borrelia burgdorferi* parasite (assuming constant greenhouse gas emissions)



Greer et al. Climate change and infectious diseases in North America: the road ahead. *CMAJ* 2008.

SLIDE PRESENTED AT THE HEARINGS BY MICHAEL SWANDT