



# IMPACTS OF CLIMATE CHANGE

*Sunlight is reflected from the Earth's surface in the form of heat. "Greenhouse gases" are components of the atmosphere that form a layer above the Earth and limit the amount of heat that can escape from the Earth's surface and lower atmosphere, much in the same way that glass in a greenhouse traps heat.*

**1. Maintaining a stable concentration of greenhouse gases in the atmosphere is central to human wellbeing and the wellbeing of millions of other species.** That's because these gases – particularly carbon dioxide, methane and nitrous oxide - play a critical role in regulating the Earth's climate. Their relative stability over the past several thousand years has in turn kept Earth's climate relatively stable, allowing human civilization to thrive.

However, over the past 60 years society has taken a large gamble. **By extracting and burning fossil fuels at an unprecedented rate, we have released large additional volumes of greenhouse gases into the atmosphere.** These have been added to the gases that exist in nature, thus pushing the atmospheric concentration of CO<sub>2</sub>, nitrous oxide and methane to levels unprecedented during the past 800,000 years.<sup>1</sup> CO<sub>2</sub> for instance, has risen from 280ppm (parts per million) in 1750 to 325ppm in 1970 to 396ppm in 2013.<sup>2</sup>

Average global temperature has responded by going up, although the effect is not immediate. There is a delay of at least 20 years between the time the concentration of greenhouse gases goes up and the temperature response. Accurate global temperature records began to be kept around 1850. Since then, **the 13 warmest years on Earth have occurred in just the past 14 years.**<sup>3</sup> The decade 2001-2010 is the hottest decade on record.<sup>4</sup> Warming has occurred over land and sea, as well as in the lower atmosphere. So far, the oceans are absorbing over 90% of the extra heat.<sup>5</sup>

**2. Just as a small rise in our body temperature matters a lot, so does a small rise in average global temperature.** It's easy to miss the full consequences, when living in Canada, the second coldest country on Earth. It's easier to see in a country like Kuwait, where the temperature hit a record 53.5 degrees Centigrade in 2011.<sup>6</sup> **Heat waves are becoming more problematic and more deadly.**<sup>7</sup> **Dangerous wildfires are also on the rise in many parts of the world.**<sup>8</sup>

**3.** Higher temperatures are also causing the spread of infectious diseases, such as dengue fever and malaria. Climate change is altering the geographical and seasonal distribution of carrier insects, and lengthening the transmission season. Saskatchewan has already faced the arrival of West Nile Virus.<sup>9</sup> **Soon human-induced climate change will cause Lyme disease to spread across our province.**<sup>10</sup>

4. As the atmosphere warms, it can hold more water vapour. **Climate change is causing more intensive rainfall events, which in turn can create massive floods like the one that hit southern Alberta in June 2013.** Within weeks of the Alberta floods, similar unprecedented flooding occurred in Colorado, Central Europe, Russia & the Himalayas.<sup>11</sup>

5. **The combination of warmer ocean waters and a warmer atmosphere is making hurricanes more powerful.** Hurricanes Katrina (2005) and Sandy (2012) in the USA are well known examples. In 2013 the Philippines faced a typhoon with the highest wind speed ever recorded on land (380km/hour).<sup>12</sup> It killed 5,700 people & displaced 4 million. The Philippines is pleading with other nations to cut their greenhouse gas emissions.<sup>13</sup>

6. **Climate change is reducing world food security.** Already, global wheat and maize production have been negatively impacted.<sup>14</sup> The number of people living in water stressed regions is expected to double by 2050.<sup>15</sup> Southern Saskatchewan is one location likely to face more intense droughts in the latter half of this century.<sup>16</sup>

7. **Another effect of rising greenhouse gas emissions is accelerated melting on Greenland, Antarctica and the world's mountain glaciers.** This melt water makes its way to the oceans, pushing up sea levels. **Sea levels are now rising at 3.2mm per year,** a trend that threatens to displace tens of millions of coastal residents, ruin large swaths of farmland near the ocean, and make coastal surges during storms very dangerous.<sup>17</sup>

8. **As climate change creates warmer ocean temperatures, coral reef ecosystems are increasingly stressed.** Reef bleaching has become widespread in the Great Barrier Reef and the Caribbean.<sup>18</sup> **A further global average temperature increase of 2 degrees C would kill virtually all coral reefs, and place 20-30% of all species on our planet at high risk of extinction.**<sup>19</sup>

9. The World Health Organization estimates that **150,000 people now lose their lives each year as a result of climate change.**<sup>20</sup> Women and children are particularly vulnerable.<sup>21</sup>

10. **All of the above-mentioned trends will get far worse unless greenhouse gas concentrations in the atmosphere are quickly stabilized. That won't be easy. It will require a 70% reduction in fossil fuel use worldwide by mid-century, and a complete phase-out of fossil fuels by 2070.**<sup>22</sup> It also necessitates an end to deforestation & unsustainable forest practices.

11. The International Energy Agency & the Intergovernmental Panel on Climate Change have advised governments that in order **to avoid catastrophic effects from climate change we must keep the majority of the world's known fossil fuel reserves in the ground.**<sup>23</sup>

## Acknowledgements

This information sheet was authored by Peter Prebble and Ann Coxworth of the Saskatchewan Environmental Society, with advice from the Society's Climate Change Working Group. Layout and web site design were done by Megan Van Buskirk.

## References

1. Intergovernmental Panel on Climate Change (IPCC), 2013: Summary for Policy Makers, in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, et al (eds), Cambridge University Press, Cambridge, United Kingdom and New York, USA, page 11 and page 17. Refer to section B5 entitled 'Carbon and Other Biogeochemical Cycles' and section D3 entitled 'Detection and Attribution of Climate Change'.
2. The National Oceanic and Atmospheric Administration Annual Greenhouse Gas Index 2014, NOAA Earth System Laboratory, National Oceanic & Atmospheric Administration. Updated in the Spring of 2014. Refer to Figure 2: Global Average Abundance of Long Lived Greenhouse Gases.
3. World Meteorological Organization, Press Release No. 985 entitled: "WMO Annual Climate Statement Highlights Extreme Events", March 24, 2014.
4. World Meteorological Organization, Press Release No. 985 entitled: "WMO Annual Climate Statement Highlights Extreme Events", March 24, 2014.
5. Intergovernmental Panel on Climate Change (IPCC), 2013: Summary for Policy Makers, in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, et al (eds), Cambridge University Press, Cambridge, United Kingdom and New York, USA, page 5. IPCC notes that *"more than 60% of the net energy increase in the climate system is stored in the upper ocean (0-700 m) during the relatively well-sampled 40 year period from 1971 to 2010, and about 30% is stored in the ocean below 700 m."*
6. *"Arab countries to be hit hardest by global warming"*, Saudi Gazette, January 5, 2013. <http://www.saudigazette.com.sa/index.cfm?method=home.regcon&contentid=20130105148135> This article refers to a 2012 World Bank report entitled *"Adaptation to a Changing Climate in the Arab Countries: A Case for Adaptation Governance and Leadership in Building Climate Resilience"*.

*Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, *ibid*, age 218. IPCC states: *"most global land areas with available data have experienced more heat waves since the middle of the 20th century."*

7. *Climate Change 2014: Impacts, Adaptation and Vulnerability: Contribution of Working Group 2 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Chapter 26, page 3. IPCC notes that *"Observed climate trends in North America include an increased occurrence of severe hot weather events over much of the US."* (The IPCC 2013 referenced cited in this footnote points out that the southeast part of the USA is an exception to this trend.)

**8.** Wildfire activity and fire frequency and duration have increased in the boreal forests of Canada and the forests of the western United States. (Refer to IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Impacts, Adaptation and Vulnerability: Contribution of Working Group 2 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, page 33.)

**9.** "Record year for cases in 2007", Saskatoon Star Phoenix, April 28, 2008, p. A4. There were over 1,400 reported cases of West Nile Virus in Saskatchewan in 2007.

**10.** "Climate change and infectious diseases in North America: the road ahead" by Amy Greer, Victoria Ng and Dr. David Fisman, CMAJ, March 11, 2008, Vol. 178, No. 6, 2008. Refer to Figure 2.

Synthesis; in Canada a Changing Climate: Sector Perspectives on Impacts and Adaptation, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada (Natural Resources Canada), 2014, p. 1-18. The authors discuss how: "climate-sensitive diseases (e.g. Lyme disease) and vectors are moving northward into Canada and will likely continue to expand their range." Refer to Chapter 7 of the publication for further details.

**11.** "Heavy rains in southern Alberta force mandatory evacuations in areas of Calgary and surroundings", National Post, June 20, 2013.

"German flood waters reach 500 year-high", The Associated Press, June 4, 2013.

"Rain slows rescue efforts amid deadly Colorado floods", CNN, September 16, 2013.

"Perilous floods prompt tens of thousands to scramble in Russia's Far East", CNN, August 18, 2013.

The Guardian, June 20, 2013. *In the Himalayan state of Uttarakhand some areas received more than 220mm of rain (8.6 inches) in a single day resulting in landslides. More than 5,000 people died. The flooding was described as a 'Himalayan tsunami'.*

Map showing total rainfall in India, Nepal and Neighbouring Countries in the Week of June 14 to June 20, 2013. Refer to: <http://earthobservatory.nasa.gov/IOTD/view.php?id=81450>

"Flooding in the Balkans", The Globe and Mail, May 20, 2014. *Approximately 1,000,000 Bosnians and 600,000 Serbians have been affected by the flooding.*

**12.** "Typhoon Haiyan: How does it compare with other tropical cyclones"? The Guardian, November 8, 2013. *Typhoon Haiyan recorded the most powerful wind speed over land. Three other cyclones reached more powerful wind speeds over the ocean.*

*The Philippines was also hit by Typhoon Bopha in 2012, which was the most powerful typhoon in the history of the southern Philippines. Over 1,000 people died and 216,000 homes were damaged or destroyed. (Refer to: The Guardian, December 5, 2012 and February 17, 2013. In addition, refer to: "Filipino super-typhoon an ominous warning of climate change impact", The Guardian, February 17, 2013.)*

**13.** <http://world.time.com/2013/11/11/watch-this-philippine-climate-negotiator-warned-us-last-year-and-we-ignored-him/> The article quotes Naderev Sano, the Philippine climate negotiator. In November 2012 Sano had addressed leaders gathered at the United Nations Convention on Climate Change, a year before Typhoon Haiyan struck his country, and just after another powerful typhoon, Bopha, had hit the Philippines. In November 2012 he said: "Madam Chair, we have never had a typhoon like Bopha, which has wreaked havoc in a part of the country that has never seen a storm like this in half a century. And heartbreaking tragedies like this are not unique to the Philippines, because the whole world, especially developing countries struggling to address poverty and achieve social and human development, confront these same realities...I appeal to the whole world, I appeal to leaders from all over the world, to open our eyes to the stark reality that we face. I appeal to ministers. The outcome of our work is not about what our political masters want. It is about what is demanded of us by 7 billion people."

**14.** IPCC, 2014: Summary for Policy Makers, in *Climate Change 2014: Impacts, Adaptation and Vulnerability: Contribution of Working Group 2 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, page 7.

**15.** "Predicting the future of global water stress: MIT researchers find that by 2050 more than half the world's population will live in water-stressed areas and about a billion or more will not have sufficient water resources". January 9, 2014. <http://newsoffice.mit.edu/2014/predicting-the-future-of-global-water-stress>

**16.** <http://www.parc.ca/saskadapt/adaptation-options/theme-assessments/water-drought#figure-3> Refer to the heading 'Water and Drought'. The abbreviation PARC stands for the Prairie Adaptation Research Collaborative based in Regina. Figure 3 is titled: 'Maps of the Aridity Index using climate data for 1961-90 and output from the CGCM1 for 2040-2069.'

The New Normal: The Canadian Prairies in a Changing Climate, David Sauchyn, Harry Diaz and Suren Kulshreshtha (eds), Chapter 5. "Prairies, Water and Climate Change" by James Byrne, Stefan Kienzle and David Sauchyn.

**17.** IPCC. 2013, Summary for Policy Makers, in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, et al (eds), Cambridge University Press, Cambridge, United Kingdom and New York., page 6.

**18.** IPCC, 2014: Summary for Policy Makers, in *Climate Change 2014: Impacts, Adaptation and Vulnerability: Contribution of Working Group 2 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, pages 33 and 34.

**19.** IPCC, 2014: Summary for Policy Makers, in *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group 3 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, page 13. *The Intergovernmental Panel on Climate Change emphasizes that coral reef systems worldwide are at "very high risk" if global temperatures are allowed to rise two degrees above the 1986-2005 temperature average.*

Technical Summary in *Climate Change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group 2 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Refer to Figure TS6 on page 37. *At a global average temperature of approximately 3 degrees C above pre-industrial, scientists project that globally 20-30% of species will be committed to extinction. The globe is currently 0.8 degrees C above the pre-industrial temperature.*

References for the document, titled:  
"Impacts of Climate Change"  
[www.climatefriendlyzone.ca](http://www.climatefriendlyzone.ca)

**20.** <http://www.who.int/heli/risks/climate/climatechange/en/> This WHO web site attributes 150,000 deaths each year worldwide to climate change.

Other WHO web site pages use the figure 140,000 deaths annually. Refer to: World Health Organization, "Health, Climate Change and WHO" (Public Health and Environment Department, WHO, Geneva). This is a slide show that can be accessed at: [http://www.who.int/globalchange/Final-DonorReport2011.pps#830,12,Slide 12](http://www.who.int/globalchange/Final-DonorReport2011.pps#830,12,Slide%2012). Also refer to: World Health Organization, Fact Sheet No. 266, Reviewed Nov 2013, <http://www.who.int/mediacentre/factsheets/fs266/en/> This WHO fact sheet states: "Global warming that has occurred since the 1970s caused over 140 000 excess deaths annually by the year 2004."

**21.** Gender, Climate Change and Health, World Health Organization (36 pages), <http://www.who.int/globalchange/GenderClimateChangeHealthfinal.pdf?ua=1>

**22.** Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, *ibid.* Chapter 12, page 1114. Refer to Figure 12.46(a) for the scale of reduction required. *Three emission pathways for achieving the goal are provided.*

IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group 3 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, pages 9 and 11. On page 11 the authors note: *Mitigation scenarios in which it is likely that the temperature change caused by anthropogenic GHG emissions can be kept to less than 2 degrees C relative to pre-industrial levels are characterized by atmospheric concentrations in 2100 of 450ppm CO<sub>2</sub> equivalent (high confidence)".* On page 9 the authors note *the CO<sub>2</sub> equivalent in 2011 was estimated to be 430ppm. At current annual emission rates, the CO<sub>2</sub> equivalent concentration in the atmosphere has been rising at approximately 2ppm per year.*

**23.** Carbon Tracker and the London School of Economics and Political Science's Grantham Research Institute on Climate Change and the Environment, Unburnable Carbon 2013: Wasted Carbon and Stranded Assets. Refer to the Executive Summary which states: *"In 2010 governments confirmed in the Cancun Agreement that emissions should be reduced to avoid a rise in global average temperature of more than 2 degrees C above pre-industrial levels, with the possibility of revising this down to 1.5 degrees C. The modeling used in previous analyses by Carbon Tracker and the IEA (International Energy Agency) showed that the carbon budget for a 2 degree C scenario would be around 565 to 886 billion tonnes (Gt) of carbon dioxide (CO<sub>2</sub>) to 2050...This budget, however, is only a fraction of the carbon embedded in the world's indicated fossil fuel reserves, which amounts to 2,860 GtCO<sub>2</sub>. A precautionary approach means only 20% of the total fossil fuel reserves can be burnt to 2050."*