



# **Building an Environmentally Sustainable Future for Saskatchewan**

**Saskatchewan's Role in Global Climate Change  
and the Path to Sustainability**

**By Peter Prebble,  
David Henry, Murray Hidlebaugh  
and William Wardell**



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**Building an Environmentally Sustainable Future for Saskatchewan:  
Saskatchewan's Role in Global Climate Change  
and the Path to Sustainability**

**Saskatchewan's Role in Global Climate Change, Biodiversity Loss and Nuclear Weapons Proliferation,  
and the Policy Measures Needed to Change Course and Chart a Sustainable Future**

**By Peter Prebble, David Henry, Murray Hidlebaugh and William Wardell**

**March 2015**

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Key words: climate change, ocean acidification, biodiversity, uranium exports, nuclear weapons proliferation, environmentally sustainable policy measures

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# Contents

Introduction . . . . .	5
Global Environmental Problems that Saskatchewan Growth Policies Contribute To . . . . .	6
1 Saskatchewan’s Economic Growth Agenda is Disproportionately Exacerbating the Global Climate Crisis and the Disruption of the Hydrological Cycle. . . . .	7
2-a Saskatchewan’s Carbon Dioxide Emissions are Disproportionately Contributing to a Second Environmental Crisis: The Anthropogenic Acidification of the World’s Oceans . . . . .	16
2-b Saskatchewan’s Emissions Challenge in the Face of Climate Change and Ocean Acidification . . . . .	18
3 Saskatchewan Policies are Contributing to a Loss of Native Prairie and the Global Decline in Biodiversity . . . . .	28
4 Saskatchewan Uranium Exports have Contributed to the Buildup of an Immense Nuclear Weapons Stockpile on Our Planet, as Well as to the Spread of Atomic Bombs Around the World . . . . .	33
Summary . . . . .	37
The Economic Costs of Saskatchewan’s Policy Direction . . . . .	38
The Negative Impacts of Current Economic Growth Strategies on Saskatchewan’s Local Environment . . . . .	39
Building a More Sustainable Future for Saskatchewan . . . . .	41
Conclusion . . . . .	47
Endnotes . . . . .	48

# Introduction

Saskatchewan has given Canada a remarkable social legacy that demonstrates concern for collective well-being. For example, Saskatchewan is the birthplace of Medicare in Canada. Saskatchewan has exceptional levels of volunteerism in a wide array of not-for-profit organizations that work to serve families, local communities and the province. And Saskatchewan is home to the establishment of an impressive number of local and prairie based co-operatives, which work to advance the well-being of the collective, and to reduce the power of private corporate capital that often operates in the interests of a relatively narrow group of shareholders.

Yet the important concept of the public well-being is becoming lost when it comes to environmental practices in Saskatchewan, particularly economic practices with large environmental impacts that have their origins here, but extend far beyond our borders. These negative environmental impacts also have profoundly harmful social impacts. At the heart of the problem is the willingness of the provincial government and several corporations in Saskatchewan to pursue economic growth without regard for environmental consequences. This is most evident in Saskatchewan's resource extraction industries, particularly oil, coal, and uranium, but the trend is also displaying itself in other sectors of the Saskatchewan economy. The end result is that Saskatchewan's economic growth strategy is becoming a heavy burden for others around the world to carry. This paper seeks to illuminate the nature of these burdens,

and to identify more environmentally sustainable economic paths that our province could pursue.

Saskatchewan does a somewhat better job of mitigating environmental impacts that are of a more localized nature, and that more immediately affect local health and community well-being. Many of the projects in this category are industrial developments that need to be better regulated in order to prevent local ground and surface water contamination, air pollution, or transport accidents. However, even here the ground appears to be shifting. In order to pursue its economic growth agenda, the Saskatchewan government is displaying an increased willingness to accept economic development projects that will result in long lasting damage to important Saskatchewan lakes, aquifers, and ecosystems, or that will increase transportation risks through Saskatchewan communities.

In this paper we analyze the impact of Saskatchewan's economy on greenhouse gas pollution, ocean acidification, biodiversity loss and nuclear weapons proliferation—four global issues that must be urgently addressed if the quality of life on our planet is to be protected for future generations. We argue that the current direction Saskatchewan's economic growth agenda is taking is not environmentally sustainable, and is therefore not in the interests of the global community. In this context, we present a set of 30 policy proposals that when taken together would help to build a more environmentally sustainable future for Saskatchewan.

# Global Environmental Problems that Saskatchewan Growth Policies Contribute To

Saskatchewan's growth policies need to be examined in the context of critical global trends which threaten to impact all humanity, including all residents of Saskatchewan.

Four of the most important global trends are:

- 1.** Rapidly increasing greenhouse gas emissions and signs of worldwide climate breakdown, including major disruption of the hydrological cycle.
- 2.** Rising acidity of the oceans and a decline in the health of marine ecosystems.
- 3.** A worrisome decline in terrestrial species biodiversity across the globe.
- 4.** A weakening of the Treaty on the Non-Proliferation of Nuclear Weapons, and the rise of dangerous nuclear weapon nations.

At such a critical time in human history, Saskatchewan public policies should be formulated with the view to protecting Saskatchewan people's long term health and well-being, while at the same time doing our share to alleviate each of the above mentioned global environmental crises that we collectively face. Yet, instead, Saskatchewan public policies currently play a disproportionate role in exacerbating each of these immense environmental problems—in effect making them worse, because of our province's willingness to pursue financial wealth at the expense of global well-being. Let us examine each global trend and then consider Saskatchewan's impact on it.

# 1

## **Saskatchewan's Economic Growth Agenda is Disproportionately Exacerbating the Global Climate Crisis and the Disruption of the Hydrological Cycle**

Saskatchewan's annual greenhouse gas emissions are over 74 million tonnes, and are primarily made up of manmade carbon dioxide, methane and nitrous oxide.<sup>1</sup> Saskatchewan's annual per capita greenhouse gas emissions are well over 3 times the Canadian average, and are almost 10 times higher than the world average.<sup>2</sup> A large portion of those emissions reflect decisions Saskatchewan has made about how to develop its economy. However, their sustainability must be viewed in a global context.

There is a high price to be paid for society's reliance on fossil fuels to drive economic growth. The United Nations Intergovernmental Panel on Climate Change (IPCC) has concluded that greenhouse gas concentrations in the atmosphere are now higher than they have been at any time in the past 800,000 years, and that human activities have been the dominant cause of warming since the mid 20th century.<sup>a</sup> This has been reflected in the fact that average global temperature has been rising. Every one of the past 38 years has been consistently above the 20th century global temperature average.<sup>3</sup> The decade 2001-2010 is the hottest on record. In those 10 years more

national temperature records were broken than in any previous decade.<sup>4</sup>

Now the 12 month period January to December 2014 has gone on to be the warmest year in the 135 year period of record. The combined average global temperature over land and ocean surfaces in 2014 surpassed a previous calendar year high set in 2005 and tied in 2010.<sup>5</sup> As illustrated below, while Saskatchewan and much of North America did not experience warmer than average temperatures during this period, most of the world did.

Equally as significant as the increase in average global temperature over the past few decades, is the fact that the oceans have been steadily warming. The oceans are taking up more than 90% of the additional energy accumulated in the climate system as a result of rising greenhouse gas emissions.<sup>6</sup> This contributes to sea level rise, due to the thermal expansion of sea water. It also has important long term risk implications for future generations, since energy stored in the oceans will ultimately be released over the centuries ahead.

Footnotes have been used selectively to provide the reader with quick access to additional background information. All other references are in the end notes.

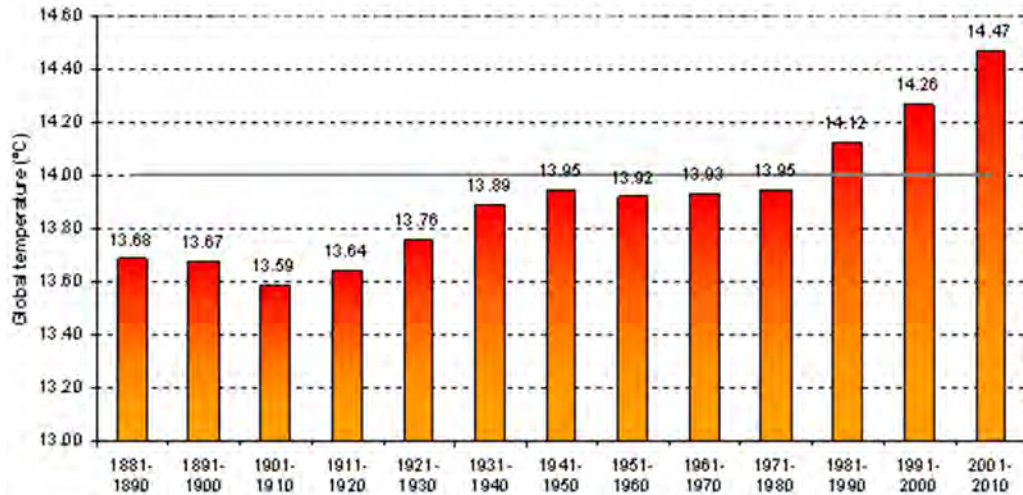
a IPCC, 2013: *Summary for Policy Makers, in Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, (Stocker, T.F., D. Qin, et al (eds), Cambridge University Press, Cambridge, United Kingdom and New York, USA., pages 11 and 17. Refer to section B5 entitled 'Carbon and Other Biogeochemical Cycles' and section D3 entitled 'Detection and Attribution of Climate Change'.

The three most important greenhouse gases driving climate change are carbon dioxide, methane and nitrous oxide. On December 3, 2014 the World Meteorological Organization reported that the globally averaged atmospheric concentration of carbon dioxide reached 396 parts per million in 2013 – 142% of the pre-industrial average. The increase in carbon dioxide levels in the atmosphere from 2012 to 2013 was 2.9 parts per million. The same WMO report noted that methane concentrations in the atmosphere reached a new high of 1824 parts per billion in 2013 – 253% of the pre-industrial level. Nitrous oxide concentrations reached 325.9 parts per billion in 2013 – 121% of pre-industrial levels. For further details refer WMO's Provisional Statement on the Status of the Climate in 2014 [www.wmo.int/pages/mediacentre/press\\_releases/documents/1009\\_Draft\\_Statement\\_2014.pdf](http://www.wmo.int/pages/mediacentre/press_releases/documents/1009_Draft_Statement_2014.pdf)

## Decadal Average Global Temperature Over Land and Sea

Average global temperature has been rising significantly over each of the past three decades due to fossil fuel burning and other man made sources of greenhouse gas emissions.

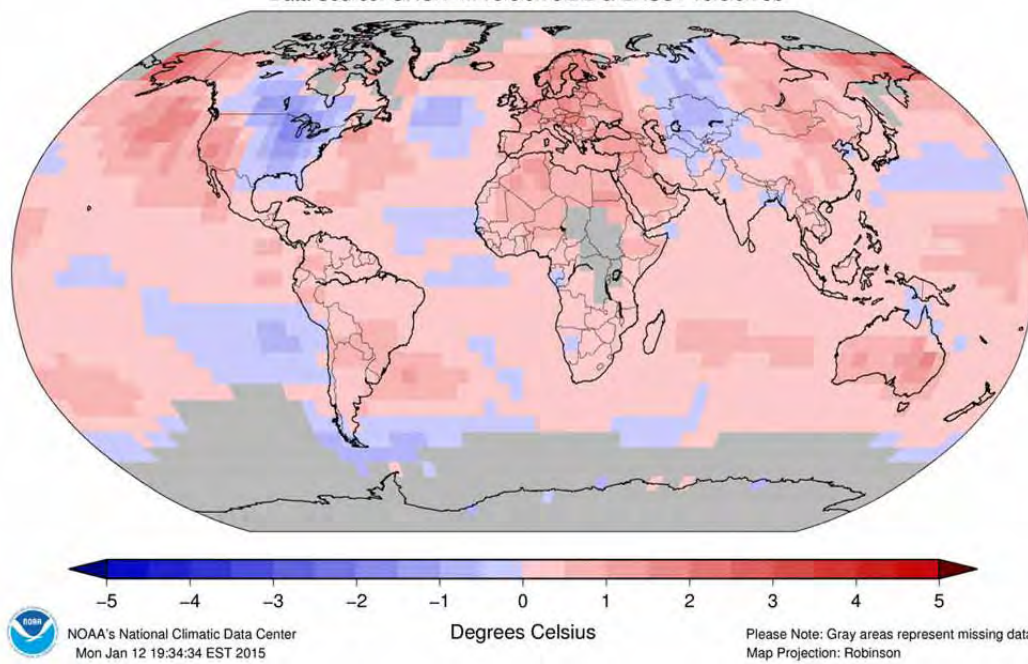
*Decadal global combined surface-air temperature over land and sea-surface temperature (°C) obtained from the average over the three independent datasets maintained by the HadCRU, NOAA-NCDC and NASA-GISS. The horizontal grey line indicates the long term average value (14°C).*



Source: World Meteorological Organization Press Release No. 976. [www.wmo.int/pages/mediacentre/press\\_releases/pr\\_976\\_en.html](http://www.wmo.int/pages/mediacentre/press_releases/pr_976_en.html)

## Land and Ocean Temperature Departure from Average Jan-Dec 2014 (with respect to a 1981-2010 base period)

Data Source: GHCN-M version 3.2.2 & ERSST version 3b



Source: [www.ncdc.noaa.gov/sotc/service/global/map-blended-mntp/201401-201412.gif](http://www.ncdc.noaa.gov/sotc/service/global/map-blended-mntp/201401-201412.gif) (National Oceanic and Atmospheric Administration)



## Observed Effects of Climate Change

There is a considerable lag period between higher atmospheric concentrations of heat trapping greenhouse gases and their climate impacts, but already those impacts are large. They include: more extreme heat waves, more frequent and intensive flood events, the accelerated melting of Arctic sea ice, more rapid melting on Greenland and western Antarctica, a steady rise in sea levels worldwide, increasing damage from coastal ocean surges, loss of productive agricultural lands from both drought and sea water intrusion, a sharp decline in the viability of coral reefs, and a major disruption of ecosystems as many land based animals and marine creatures move towards the poles.

Many of these negative climate change impacts are of growing concern, as illustrated by the following examples:

- Some global crop yields are already being impacted by climate change. Wheat and maize yields are now in decline in many regions of the world and in the global aggregate.<sup>7</sup>
- As ocean waters warm, there has been a rise in coral reef bleaching and a decline in coral reefs in the western Caribbean, on Australia's Great Barrier Reef, and in tropical Asian and African

waters.<sup>8</sup> The world is at serious risk of losing many of its coral reefs due to climate change.<sup>b</sup>

- Recent work by the Intergovernmental Panel on Climate Change has found significant evidence that the frequency and intensity of heavy precipitation events has increased in both North America and Europe since the middle of the 20th century.<sup>9</sup>
- The eight lowest years on record for extent of Arctic sea ice all occurred between 2007 and 2014.<sup>10</sup> Arctic air temperatures are rising at twice the rate of global air temperatures.<sup>11</sup>
- Greenland's ice sheets are melting at six times the pace they did in the 1990's. The current rate at which ice is being lost is 215 billion tonnes of ice per year.<sup>12</sup> Once stable glaciers in the northeast of Greenland are now shrinking.<sup>13</sup>
- Antarctica is shedding 160 billion tonnes of ice per year into the ocean.<sup>14</sup> This compares with an average ice loss rate of 30 billion tonnes over the period 1992-2001.<sup>15</sup> The collapse of the Western Antarctica Ice Sheet has begun.<sup>16</sup>
- The pace of global sea level rise has almost doubled. While ocean levels rose at a rate of 1.7 mm per year between 1901 and 2010, they rose at a rate of 3.2 mm per year between 1993 and 2010.<sup>c</sup> One example of the impacts

<sup>b</sup> Climate change interacts with other important factors that are also contributing to coral reef decline, notably human over-exploitation and pollution from agricultural runoff. Coral reefs are a critically important part of the marine ecosystem, serving as nurseries for younger fish. So widespread is environmental damage in the Caribbean, that the vast majority of coral reefs in that part of the world are on the verge of collapse. (Refer to: "Caribbean coral reefs face collapse", *The Guardian*, (United Kingdom), September 10, 2012).

If ocean temperatures go above a given threshold, they result in coral reefs bleaching and turning white. This is because the warmer ocean temperatures interrupt the ability of an algae—essential to the life of coral reefs—to conduct photosynthesis. If the elevated water temperatures continue for some time, a physical split actually occurs between the coral polyps and algae. Then without their algae, coral polyps in effect starve to death. (Refer to: *The Weather Makers: How We Are Changing the Climate and What it Means for Life on Earth*, by Tim Flannery, 2005, pp. 107-108.)

<sup>c</sup> 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*, *ibid.*, page 11. Refer to section B.4 entitled 'Sea Level'.

Sea level rise is being driven by a combination of melting mountain glaciers, melting ice sheets, and thermal expansion of sea water.

is the Atlantic coast of the United States, where many coastal communities are beginning to experience numerous tidal flooding events each year.<sup>d</sup> In the Sundarbans off the coast of India and Bangladesh some communities have already been completely flooded out by the rising ocean, and residents have been forced to relocate.<sup>17</sup> Millions of people face similar prospects in the century ahead.

- Temperatures on the 4,500 metre high Plateau of Tibet have increased by 0.4°C per decade since 1960. The plateau is the source of most of Asia's major rivers. Glaciers in this area are shrinking rapidly, and one-tenth of the permafrost has thawed in the past decade.<sup>18</sup>
- Warmer winter conditions have changed the range of some pests. For instance, the mountain pine beetle has ravaged British Columbia's pine forests over the past 12 years, destroying the livelihood of many interior BC towns. Since 2007 the pine beetle has crossed the Rockies and is now causing serious damage to a large segment of Alberta's forests.<sup>19</sup> There is clearly a significant risk it will move into Saskatchewan.
- The World Health Organization estimates that 140,000 people now die each year as a result of climate change.<sup>20</sup>
- One example of health impacts from climate change is the observed changes in disease vectors.<sup>e</sup> At a global level climate change is causing the spread of infectious diseases, such as dengue fever and malaria. It is altering the geographical and seasonal distribution of carrier insects and lengthening

the transmission season. At a national level, Saskatchewan and many other Canadian provinces have already faced the arrival of West Nile Virus. Now surveillance data indicates Lyme vectors (a proxy for Lyme disease risk) are spreading into Canada "at a rate of 35-55 km per year and are following climate-determined geographic trajectories".<sup>21</sup>

## Extreme Events

In addition to the major trends mentioned above, several recent unprecedented extremes appear to be consistent with predictions made by climate scientists, and are thus a warning of the risks society faces. Saskatchewan must take account of these global risks as it charts its policy course in cooperation with other jurisdictions. For example:

- 2012 marked the warmest year on record in the contiguous United States (48 states).<sup>22</sup> Large parts of the country faced severe drought conditions.<sup>23</sup>
- The American east coast, including New York City, was hit by Hurricane Sandy in October of 2012. That storm system left 159 people dead from Maryland to New Hampshire.<sup>24</sup> Seawater poured into New York's subway system and vehicle tunnels, underlining their vulnerability. The storm surge pushed water levels at the southern tip of Manhattan past 13 feet. Six months after the storm, tens of thousands of Americans were still displaced from their homes.

<sup>d</sup> *Encroaching Tides: How Sea Level Rise and Tidal Flooding Threaten U.S. East and Gulf Coast Communities Over the Next 30 Years*, Union of Concerned Scientists, 2014, [www.ucsusa.org/sites/default/files/attach/2014/10/encroaching-tides-executive-summary.pdf](http://www.ucsusa.org/sites/default/files/attach/2014/10/encroaching-tides-executive-summary.pdf) Tidal flooding can cover coastal roads and impact entire neighbourhoods. The publication reports that some east coast communities have seen a fourfold increase in tidal flooding since 1970. Charleston, South Carolina, for example, has gone from 2 or 3 days of tidal flooding per year in the 1970's to averaging 10 or more such days annually. By 2030, many east coast cities, including Washington DC, can expect more than 150 tidal flood events per year.

<sup>e</sup> In this context, the term vector is being used in its pathological meaning, where vector refers to an organism, such as a mosquito or tick that carries disease causing microorganisms from one particular host to another.

- 2013 marked the highest wind speeds ever recorded by a typhoon over land—when Typhoon Haiyan struck the Philippines.<sup>25</sup> Over 6,000 people died and more than 4 million people were displaced.<sup>26</sup> The hardship of Typhoon Haiyan added to major human impacts from other typhoons that have hit the Philippines in recent years. For instance, in December 2012 Typhoon Bopha was the most powerful typhoon in the history of the southern Philippines. Over 1,000 people died and approximately 216,000 homes were damaged or destroyed.<sup>27</sup> More powerful typhoons and hurricanes have long been predicted as one of the outcomes of climate change.
- 2013 was the hottest year on record in Australia, and the 24 month period ending with April 2014 was Australia’s hottest 2 year period on record.<sup>28</sup> So severe were the wild fires in Australia that by early 2013 states like New South Wales had instituted a new category to warn the public of fire risk that goes beyond extreme, naming this new category “catastrophic”.<sup>29</sup> Moreover, the October-November 2014 period (Australia’s spring) is now the warmest on record for that time of year. Both months set records for average temperature and maximum temperature,<sup>f</sup> setting the stage for another dangerous wild fire season.
- California experienced devastating drought in 2012-2014, a longer wildfire season, and for

the first time 3 consecutive years in the top 20 for dryness.<sup>30</sup> This is consistent with climate science projections for increased drought in the US southwest. An estimate by the University of California has put the economic cost of the drought to the state of California in 2014 at \$2.2 billion along with the loss of approximately 17,000 seasonal and part time jobs.<sup>31</sup> The extent and depth of the drought by the end of November 2014 is illustrated on the following page.<sup>32</sup>

- The UK has faced unprecedented floods in recent years, with 5 of its 6 wettest years on record occurring since the year 2000—a trend that scientists had predicted would occur because of climate change. This past winter (December 2013 to February 2014) was the wettest ever in the UK.<sup>33</sup> Climate change impacts in the United Kingdom are increasingly being viewed as an issue of national security.<sup>9</sup>

In 2013 a worrisome number of communities experienced unprecedented extreme rainfall events over a relatively short period of time. For example, southern Alberta faced unprecedented flooding in June of 2013.<sup>34</sup> Hundreds of thousands of Albertans were impacted. A dozen communities, including Calgary and High River needed to conduct emergency evacuations; 5 Albertans lost their lives, including 3 residents of High River. Significantly, just before the Alberta floods, central Europe and the Himalayas

f *Special Climate Statement 50 – Australia’s warmest spring on record*, Australian Bureau of Meteorology, December 2, 2014. Refer to sections 2 and 3. [www.bom.gov.au/climate/current/statements/scs50.pdf](http://www.bom.gov.au/climate/current/statements/scs50.pdf) The statement reports that the continent of Australia also experienced its warmest October day on record (36.39°C on October 25, 2014). Two significant heat waves in November brought record high November temperatures to Australia’s Northern Territory, to New South Wales, to Queensland and to South Australia.

Much of northeast Australia has been experiencing a so-called once in a century drought. (Refer to “Global warming scorches Aussie farmers”, *The Star Phoenix*, December 2, 2014).

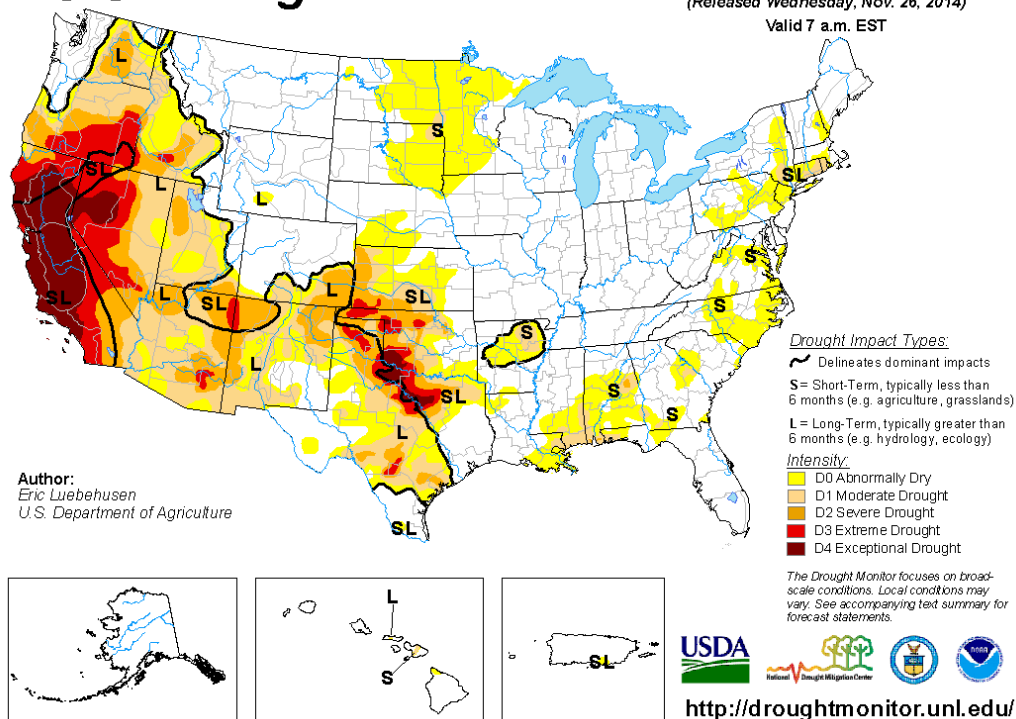
An example of the fire risk was seen when thousands were forced to flee their homes from wildfires in South Australia in the first days of January 2015. (“South Australia bushfires: thousands flee their homes as winds fan flames”, *The Guardian*, January 3, 2015.)

g “Climate change is an issue of national security warns Ed Miliband”, *The Observer*, February 16, 2014 The article reports on 22 severe flood warnings & 190 less severe flood warnings that had been issued for the UK at the time the article was written.

The Extent and Severity of Drought in the United States as of November 25, 2014

# U.S. Drought Monitor

November 25, 2014  
(Released Wednesday, Nov. 26, 2014)  
Valid 7 a.m. EST



Author:  
Eric Luebbehusen  
U.S. Department of Agriculture

faced similar kinds of rainfall events.<sup>35</sup> The June 2013 Himalayan floods breached a glacier and triggered many landslides.<sup>36</sup> More than 5,000 people died. Later that summer Colorado and parts of Russia were also hit by disastrous flooding.<sup>37</sup> These examples underline the high human costs associated with intensive rainfall events.<sup>h</sup> They are also part of a growing body of

evidence that hydrological stationarity has been lost. In other words, we can no longer accurately predict the future based on the range of precipitation patterns in the relatively recent past. This in turn has profound implications for much of the installed water-related community infrastructure around the world, which was built assuming those historical patterns of variability were reliable.<sup>i</sup>

h Extreme rainfall and flooding events were widespread around the world in 2014. As the following examples in the period March to September 2014 illustrate, many of these events had a very high human toll associated with them. For instance, in Pemba City, Mozambique in March of 2014 587mm of rain fell over 4 days, destroying over 3,000 homes. In Serbia, Bosnia-Herzegovina and Croatia May 2014 floods killed 79 people and displaced another 137,000. 41,000 people required temporary housing in Russia when flooding hit the republics of Aitai, Khakassia and Tuva in May and early June of 2014. In August 2014 flooding in Bangladesh displaced 57,000 families (the homes of 31,000 were totally destroyed). In September 2014, Hérault in southern France received over 400 mm of rain in 5 days causing severe flooding and mudslides. The most serious impacts of flooding during September 2014 were felt in India and northern Pakistan where 250 people drowned and over 100,000 were displaced. (Source: World Meteorological Organization "Provisional Statement on the Status of the Climate in 2014", December 2014.)

i "Stationarity Is Dead: Whither Water Management" by P.C.D. Milly, Julio Betancourt, Malin Falkenmark, Robert M. Hirsch, Zbigniew W. Kundzewicz, Dennis P. Lettenmaier and Ronald J. Stouffer, *Science*, Volume 319, February 1, 2008. The authors note that "stationarity—the idea that natural systems fluctuate within an unchanging envelope of variability—is a foundational concept that permeates training and practice in water-resource engineering." They then go on to make the case that "stationarity is dead" because "substantial anthropogenic change of Earth's climate is altering the means and extremes of precipitation, evapotranspiration and rates of discharge of rivers. Warming augments atmospheric humidity and water transport. This increases precipitation and possibly flood risk, where prevailing atmospheric water-vapor fluxes converge."

## Saskatchewan Extreme Precipitation Events

Saskatchewan’s recent experience also illustrates a loss of hydrological stationarity. Southeast Saskatchewan and southwest Manitoba suffered unprecedented flooding in 2011 caused by a combination of exceptionally heavy rainfall and soils already saturated with moisture. It was a so-called “one in a hundred year” flood. Then in late June 2014 southeast Saskatchewan, parts of east central Saskatchewan and much of southwest Manitoba were hit again by another round of equally devastating floods. Seventy-five Saskatchewan municipalities declared a state of emergency, while Manitoba declared a provincial state of emergency.<sup>38</sup> Many Saskatchewan farms suffered flooding and soil degradation. In Saskatchewan, as of July 31, 2014, 167 municipalities had been approved for designation under the Provincial Disaster Assistance Program.<sup>39</sup> The full cost of the flooding has yet to be determined, but the Government of Saskatchewan has now budgeted \$150 million for Provincial Disaster Assistance spending in fiscal year 2014-15. These funds will be supplemented by significant federal financial assistance as well.

### Flooding in Melville, Saskatchewan on June 30, 2014



Source: This photo was released by the Government of Saskatchewan.<sup>40</sup>

As the chart below illustrates, over the past decade Saskatchewan has experienced a growing number of extreme weather events—many of which involve flooding due to intensive rainfall. This has required unprecedented levels of spending under the Provincial Disaster Assistance Program.

### Saskatchewan’s Provincial Disaster Assistance Program (PDAP) Spending

Fiscal Year Ending March	Total Spending
2002	\$ 1,500,000
2003	\$ 1,675,000
2004	\$ 618,000
2005	\$ 276,000
2006	\$ 15,154,000
2007	\$ 9,866,000
2008	\$ 31,378,000
2009	\$ 14,486,000
2010	\$ 10,440,000
2011	\$ 48,150,000
2012	\$ 157,115,000
2013	\$ 72,597,000
2014	\$ 46,815,000
2015	\$ 150,000,000*

\*(budgeted after June/July 2014 floods)

Source: Annual data was compiled using Volume 2 of the Saskatchewan Government Public Accounts for each of the fiscal years 2001-2002 through to 2012-14. Compiled by Peter Prebble.

Note: Modest improvements in PDAP eligibility levels were made in 2010, but this is not the primary reason for spending increases, which were driven largely by increased flooding, much of it caused by heavy precipitation events. The figure for the fiscal year ending March 31, 2015 is based on the amount the Government of Saskatchewan has budgeted for PDAP following major flooding events in June and July of 2014.

## Future Global Impacts of Climate Change

The greatest concern—and a great responsibility for all governments in the world—is that all of the above-mentioned trends, and other negative climate change-related impacts, will worsen and pose grave risks to the quality of life on Earth over the course of this century and the next. These risks are directly related to fossil fuel consumption and production. In their November 1, 2014 report to the United Nations and its member governments, the Intergovernmental Panel on Climate Change diplomatically puts it this way: “Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems.”<sup>41</sup>

Three of the most serious projected impacts for people are: (1) a further increase in extreme weather events, (2) a decline in reliable global food supplies, and (3) a decline in water supplies in many dry areas of the world.

With respect to extreme weather, the Intergovernmental Panel on Climate Change (IPCC) stresses that “climate-change-related risks from extreme events, such as heat waves, extreme precipitation, and coastal flooding, are already moderate (high confidence) and high with 1°C additional warming (medium confidence)”.

On the matter of a decline in reliable global food supplies, IPCC warns that food security will be undermined by climate change. For example, IPCC predicts: “Due to projected climate change by the mid-21st century and beyond,

global marine species redistribution and marine biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services (high confidence). For wheat, rice, and maize in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more above late-20th century levels, although individual locations may benefit (medium confidence). Global temperature increases of 4°C or more above late-20th century levels, combined with increasing food demand, would pose large risks to food security globally (high confidence).”<sup>42</sup>

On the matter of a decline in water supplies in many dry areas of the world, the IPCC states: “Climate change is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions (robust evidence, high agreement), intensifying competition for water among sectors (limited evidence, medium agreement).”<sup>i</sup>

The IPCC emphasizes that if greenhouse gas emissions are not addressed quickly, disadvantaged persons and disadvantaged communities in all countries will suffer a disproportionate share of the above-mentioned risks, making climate change an issue of fundamental social justice.

As noted above, the IPCC also predicts many serious impacts on ecosystems and ecosystem services. For instance, the Panel warns that “most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes”.<sup>43</sup> Moreover “a large

<sup>j</sup> IPCC, 2014: *Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 2.3.

A growing body of evidence suggests that if the world warms by 2°C, up to one fifth of the global population could suffer severe water shortages. Key regions at risk from water scarcity include the Mediterranean, the Middle East and parts of the southern USA. (“Water risk as world warms: First comprehensive global-impact project shows that water scarcity is a major worry”, by Quirin Schiermeier, *Nature*, January 2, 2014, page 10-11.)

fraction of species face increased extinction risk due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors (high confidence)".<sup>44</sup>

The IPCC defines these risks more precisely by noting: "Many species and systems with limited adaptive capacity are subject to very high risks with additional warming of 2°C" (when compared to the 1986 to 2005 temperature average). The Panel stresses that: "Coral reefs and polar ecosystems are highly vulnerable. Coastal systems and low-lying areas are at risk from sea-level rise, which will continue for centuries even if the global mean temperature is stabilized (high confidence)".<sup>45</sup>

Given the multiple risks that greenhouse gas emissions pose, it is imperative that society limit the magnitude and rate of climate change while there is still time to do so. In the authors' judgment, the situation is now sufficiently severe that if action is not taken, we face the prospect that some populated areas of our home planet are likely to become uninhabitable. For instance, some island nations will be forced to abandon their country due to sea level rise, while some areas of the globe that are already subject to severe heat and drought will reach the point where outdoor work becomes exceedingly difficult, if not impossible. In summary, unless we

act decisively to phase out fossil fuels and other anthropogenic sources of greenhouse gases, the world will face: a growing number of extreme weather events, more drought, more intensive flooding, more severe heat waves, a sharp decline in food and water security, multiple increased health risks, widespread loss of species, major loss of coral reef ecosystems, an accelerated rise in sea levels that will continue for centuries, more dangerous coastal storm surges, serious coastal flooding, and a critical loss of ecosystem services.

Central to minimizing these impacts is moving quickly and decisively on greenhouse gas emissions reduction, rather than waiting for another 5-10 year period before taking serious action.<sup>46</sup> The international community has already delayed for a dangerously long period of time, and some prosperous jurisdictions like Saskatchewan are not only adding unduly to the emissions burden, but by failing to achieve any net greenhouse gas emission reductions, are setting a most unfortunate example for other countries. The reality now is that every province, state and country in the world must make substantial cuts to greenhouse gas emissions.

We shall examine Saskatchewan's greenhouse gas emission responsibilities in more detail in a moment, but before doing so let us turn to a second major global risk—ocean acidification.

## 2-a Saskatchewan's Carbon Dioxide Emissions are Disproportionately Contributing to a Second Environmental Crisis: The Anthropogenic Acidification of the World's Oceans

Saskatchewan released 45,600,000 tonnes of carbon dioxide into the atmosphere in 2012, the most recent year for which data is available.<sup>47</sup> Not only will that carbon dioxide have negative heat trapping effects in the atmosphere, but about 30% of it will be taken up by the sea, where it will react with water molecules to form carbonic acid.<sup>48</sup>

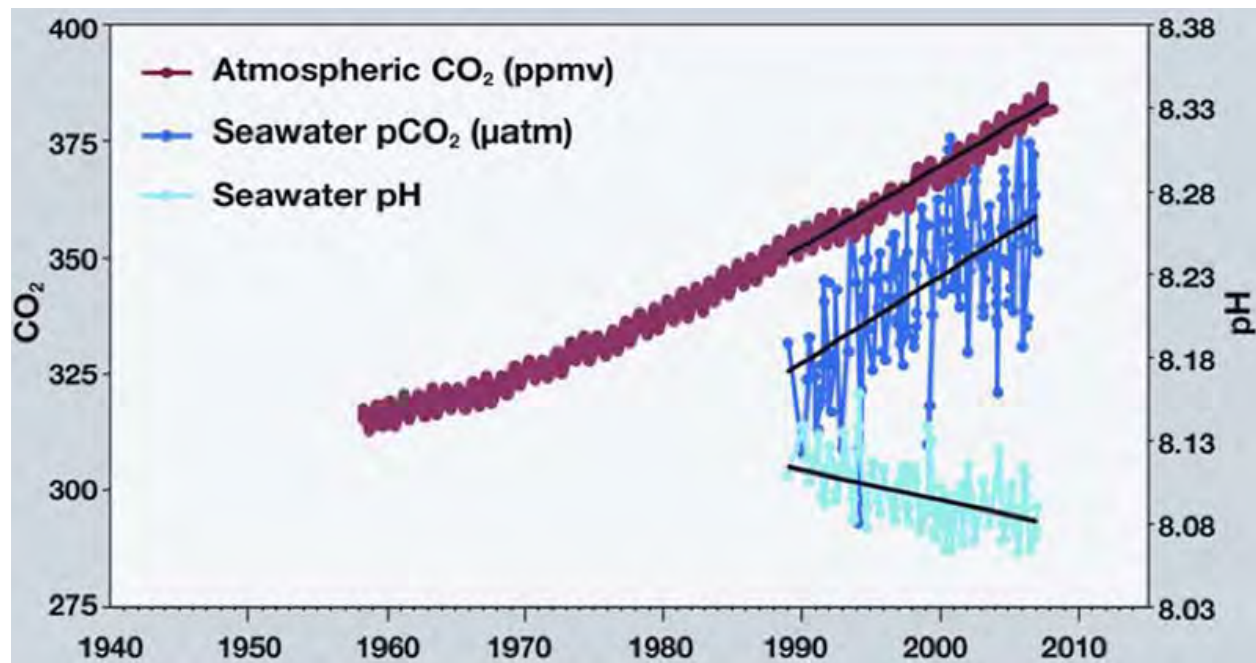
At a global level, approximately half of all the manmade carbon dioxide emissions between 1750 and the present time have occurred in the past 40 years.<sup>49</sup> This has resulted in the uptake

of increasing amounts of carbon dioxide by the oceans from the atmosphere, and that in turn is changing the chemical balance of sea water. Open ocean pH has declined by at least 0.1 (from 8.2 to 8.1) since the beginning of the industrial era, which corresponds to a 26% increase in the hydrogen ion concentration of seawater.<sup>50</sup> In other words, the ocean is becoming significantly more acidic.

That trend is certain to continue as the oceans absorb excess carbon dioxide that human activities have pumped into the atmosphere. The

### Observed Changes in the Concentration of CO<sub>2</sub> in Seawater and the Corresponding Change in the pH of Seawater

The chart below shows the observed changes in the concentration of carbon dioxide in seawater, and in ocean acidity (pH). The increasing acidity of the oceans (decline in pH) has negative implications for marine life.



Source: November 2012 World Bank Report, Turn Down the Heat, Figure 11.



oceans are estimated to have taken up in the range of 600 billion tonnes of carbon dioxide from cumulative human-induced emissions between 1750 and 2011.<sup>k</sup>

Accumulation of carbon dioxide and the resulting increased acidity can affect many functions of marine organisms including plant photosynthesis, membrane transport, growth, reproduction and calcification.<sup>51</sup> The steady drop in the pH of sea water poses significant risks for marine ecosystems, and will inevitably lead to a decline in the health and biodiversity of the oceans.<sup>52</sup> By 2100 the average surface ocean pH could well be 0.2 to 0.4 lower than it is today.<sup>53</sup> The extent of the decrease will depend on how much carbon dioxide is released into the atmosphere by fossil fuel burning and deforestation in the decades ahead.

The concern with ever higher ocean uptake of carbon dioxide is not only the magnitude of CO<sub>2</sub> levels, but also the unprecedented rate of change. The scientific community is emphasizing that the present rate and scale of ocean acidification is at least 10 times faster than at any time in the past 65 million years.<sup>54</sup>

The changes will have particularly negative impacts on marine organisms that must build shells for their survival. Examples include scallops, clams, oysters and some species of plankton. That is because as ocean waters become more acidic, the extra carbonic acid reacts with dissolved carbonate ions in those waters to decrease their overall concentration. In order to build shells, marine organisms biochemically combine carbonate with dissolved calcium ions.<sup>55</sup> Thus, as

carbonate ions decline, it becomes increasingly difficult for marine invertebrates to build shells.

Natural Resources Canada (NRC), in a climate change update published in 2014 reports that observations in the Arctic and Atlantic waters off Canada indicate decreasing pH at rates similar to those observed globally. Widespread ocean acidification has also been detected in the North Pacific Ocean, as early as 2008. Referring to Canada's coastlines, the NRC update observes: "In some areas of all three coasts, waters are considered to be 'corrosive' to some calcareous organisms, i.e. capable of dissolving their shells and skeletons."<sup>56</sup>

Already the shellfish industry in British Columbia is sounding alarm bells. For example, Island Scallops, a major producer of shellfish seed stock near Nanaimo, for years grew scallop larvae using ordinary sea water. Now it must remove carbon dioxide from the sea water before utilizing it in its tanks.<sup>57</sup>

Ocean acidification also poses a significant threat to the world's coral reefs, impairing calcification and reef growth.<sup>58</sup> This, when combined with other stressors such as ocean warming, higher sea levels, increased storm intensity, and overfishing puts the future of coral reefs in grave danger over the coming century.

It is now clear that ocean acidification is happening more rapidly than scientists initially expected and is a very urgent issue. Former National Oceanic and Atmospheric Administration chief Jane Lubchenco rightly described it as the "osteoporosis of the sea".<sup>59</sup> Fossil fuel burning and deforestation are the two root causes of the problem that must be addressed.

<sup>k</sup> IPCC notes that between 1750 and 2011 cumulative manmade carbon dioxide emissions to the atmosphere were 2040 GtCO<sub>2</sub>, with a potential range above or below that of 310 Gt. The oceans have to date absorbed about 30% of that emitted carbon dioxide. If 30% of the 2040 Gt figure is used to arrive at an estimate for carbon dioxide uptake by the oceans, a figure of 612 GtCO<sub>2</sub> is obtained. ( For further detail see: *IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 1.2.)

## 2-b Saskatchewan's Emissions Challenge in the Face of Climate Change and Ocean Acidification

Saskatchewan's economy accounts for about 1/700 of the annual man made global greenhouse gas emissions that are causing climate change.<sup>60</sup> Yet we constitute approximately 1/6,400 of world population.<sup>61</sup> In a world that urgently needs to address climate change, this is not a differential between emissions and population that a responsible democratic society can continue to tolerate.

Member countries of the United Nations agreed in the 2009 Copenhagen Accord to work to prevent average global temperature from increasing to 2°C above pre-industrial levels or more.<sup>1</sup> Even that increase was judged to be too high and too dangerous by representatives of many developing countries, particularly leaders of small island nations that feared a 2 degree increase would raise sea levels to a point that would jeopardize their country's security, and create severe weather events that would be very difficult to recover from.

To underline the scale of the challenge that now lies ahead if the global community is to avoid a

2 degree Centigrade increase in average global temperature (i.e. avoid the worst dangers of climate change), it must by mid-century reduce collective greenhouse gas emissions from its current level of approximately 7 tonnes per person annually down to an annual average of between 1 and 2 tonnes per person.<sup>62</sup> And to be able to avoid a 2°C increase with relatively high confidence, global greenhouse gas emissions will need to be zero by 2070, as illustrated in the chart below.<sup>63</sup>

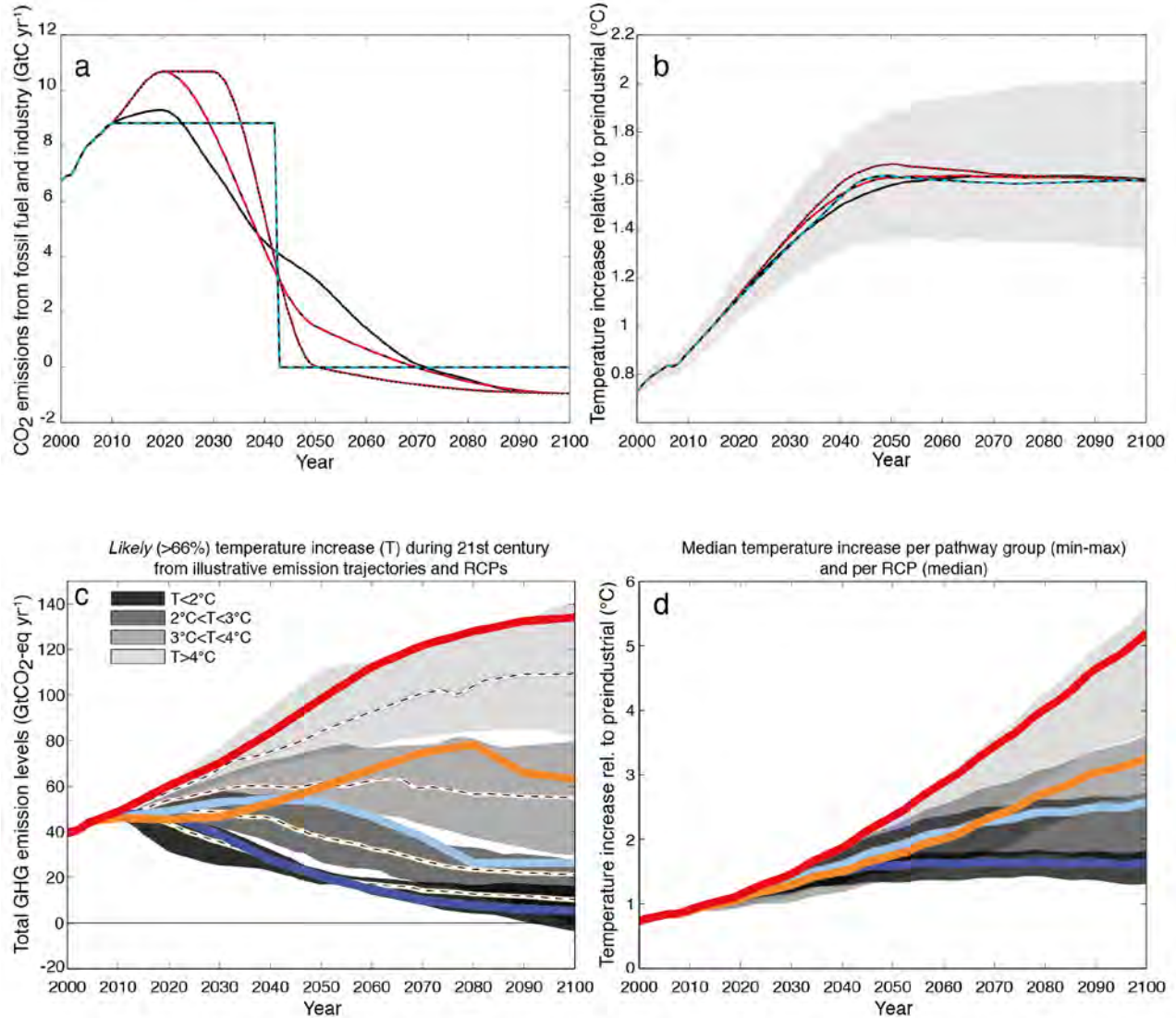
Saskatchewan's annual greenhouse gas emissions are at present approximately 67 tonnes per person.<sup>64</sup> If Saskatchewan is to participate in a responsible fashion in a global effort to avoid dangerous climate change, our manmade carbon dioxide emissions and our other manmade greenhouse gas emissions will also need to be reduced to zero by 2070. Of equal importance, Saskatchewan's carbon dioxide emissions will need to be reduced to zero as part of a global effort to prevent serious acidification of the oceans.

<sup>1</sup> [http://unfccc.int/meetings/copenhagen\\_dec\\_2009/items/5262.php](http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php)

In clause 1 of the Accord participating nations agreed: "To achieve the ultimate objective of the Convention to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, we shall, recognizing the scientific view that the increase in global temperature should be below 2°C, on the basis of equity and in the context of sustainable development, enhance our long-term cooperative action to combat climate change."

Clause 2 goes on to include the following statement on limiting average global temperature: "We agree that deep cuts in global emissions are required according to science, and as documented by the IPCC Fourth Assessment Report with a view to reduce global emissions so as to hold the increase in global temperature below 2°C, and take action to meet this objective consistent with science and on the basis of equity ..."

**The Depth of Greenhouse Gas Emission Reduction Required to Avoid a 2 Degree Centigrade Average Global Temperature Increase with at Least 66% Confidence and the Resulting Average Global Temperature Increase in the Event that Three Higher Greenhouse Gas Emission Paths are Followed**



### Authors Explanatory Note for Panel (a) and (b):

The figure is drawn from the 2013 report of the Intergovernmental Panel on Climate Change focusing on the physical science of climate change. (*Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Chapter 12, page 1114, Figure 12.46) Panel (a) demonstrates the scale of manmade carbon dioxide reduction required worldwide in order to avoid a 2 degree Centigrade increase in average global temperature, when compared with average global temperature in the preindustrial era. It is widely agreed by climate scientists that exceeding a 2 degree increase puts the world at risk of very serious dangers from climate change. In order to have a better than 66% chance of achieving this target, carbon dioxide emissions from fossil fuel burning, deforestation and other industrial activities will have to be phased out completely by no later than 2070.

Panel (a) in the Figure presents three illustrative greenhouse gas emission reduction pathways that achieve this end point. The options underline that delaying greenhouse gas emission reduction any longer means that manmade carbon dioxide emissions then have to be reduced at an even more rapid pace later in the century. Panel (b) in the Figure shows the impact that each of the emission reduction pathways in (a) will have on global average temperatures relative to preindustrial. The increase in average global temperature is expected to level out in the 1.6°C range (over pre-industrial), but could go as high as almost 2°C, as the grey area illustrates.

The reference to RCP 2.6 in the IPCC explanation of the Figure is a reference to Representative Concentration Pathway 2.6. It represents the most stringent of the greenhouse gas emission reduction scenarios presented by the Intergovernmental Panel on Climate Change in its 2013-2014 reports, and the only one with a serious chance of avoiding a 2°C temperature increase in the future.

### Intergovernmental Panel on Climate Change explanation of the Figure above:

(a) CO<sub>2</sub> emissions for the RCP2.6 scenario (black) and three illustrative modified emission pathways leading to the same warming. (b) Global temperature change relative to pre-industrial for the pathways shown in panel (a). (c) Grey shaded bands show Integrated Assessment Model (IAM) emission pathways over the 21st century. The pathways were grouped based on ranges of likely avoided temperature increase in the 21st century. Pathways in the darkest three bands likely stay below 2°C, 3°C, 4°C by 2100, respectively (see legend), while those in the lightest grey band are higher than that. Emission corridors were defined by, at each year, identifying the 15th to 85th percentile range of emissions and drawing the corresponding bands across the range. Individual scenarios that follow the upper edge of the bands early on tend to follow the lower edge of the band later on. Black-white lines show median paths per range. (d) Global temperature relative to pre-industrial for the pathways in (c). (Data in (c) and (d) based on Rogelj et al. (2011).) Coloured lines in (c) and (d) denote the four RCP scenarios.<sup>65</sup>

To further clarify the scale of greenhouse gas emission reduction required in the decades ahead, it is useful to view the issue through the lens of the world's total carbon budget, and how much of it has been used up. The 2013 report of the Intergovernmental Panel on Climate Change focused on this carbon budget, noting that, if global warming is to be held below the 2°C limit and once the global warming impacts of methane, nitrous oxide and other non-CO<sub>2</sub> greenhouse gas releases are accounted for, the maximum amount of manmade carbon dioxide that can be released into the atmosphere is 2,900 Gt. Since the late 19th century an estimated 1,890 Gt of carbon dioxide has already been released, much of it in the past 40 years, leaving no more than 1,010 Gt left to release in the future—as of the year 2011.<sup>66</sup> Given that annual average manmade carbon dioxide emissions are now in the range of 40 Gt per year,<sup>67</sup> it is obvious that the time period during which the world can continue to release manmade carbon dioxide—if the worst dangers of climate change are to be avoided—is rapidly drawing to a close.

Yet another way to help clarify the pace and scale of greenhouse gas emission reduction that needs to be achieved worldwide, and in Saskatchewan, is to express it in terms of greenhouse gas concentrations in the atmosphere. Emission reduction scenarios in which it is likely that the temperature change caused by manmade emissions will be kept below an average global temperature increase of 2°C (relative to pre-industrial) generally require greenhouse gas emission concentrations in the atmosphere to be no higher than 450 parts per million (carbon dioxide equivalent) by 2100.<sup>m</sup> As of 2011

greenhouse gas concentrations in the atmosphere were 430 parts per million (carbon dioxide equivalent) and rising at approximately 2 parts per million per year.<sup>68</sup> Unfortunately, greenhouse gas concentrations in the atmosphere rose even more rapidly between 2012 and 2013.<sup>69</sup> Thus, it is clear that very deep emission cuts are urgently required, and that there is no time to be lost in getting the process underway.<sup>70</sup>

Further complicating matters is the long atmospheric lifetime of carbon dioxide after it has been released into the atmosphere by processes such as the burning of fossil fuels. While half is removed by physical and biogeochemical processes within a few decades, 15-40% of the carbon dioxide released today is still expected to be in the atmosphere after 1,000 years.<sup>71</sup> Thus, even as society makes modest cuts to carbon emissions, atmospheric CO<sub>2</sub> will not decline. Rather it will continue to rise, but at a slower rate. It is only by eliminating manmade carbon dioxide emissions that CO<sub>2</sub> levels in the atmosphere can ultimately be stabilized.<sup>72</sup> This basic fact needs to guide Saskatchewan public policy in the decade ahead, just as it needs to guide the actions of every other jurisdiction worldwide.

Saskatchewan's single biggest source of greenhouse gas emissions is its oil and gas industry, including the venting and flaring of natural gas during oil and gas extraction.<sup>73</sup> Venting is the direct release of natural gas into the atmosphere. Flaring is the burning off of natural gas into the atmosphere. Fugitive emissions now account for over one million tonnes of carbon dioxide going into the atmosphere each year. More significantly they account for the release of vast quantities of

<sup>m</sup> 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 9 and page 11.

The term carbon dioxide equivalent is used to refer to the combined concentration of carbon dioxide, methane, nitrous oxide and the fluorinated gases in the atmosphere, and takes account of the heat capturing potential of each of the gases monitored under the Kyoto Protocol. Emissions reported in carbon dioxide equivalent are weighted by their global warming potential, and expressed in parts per million. The gas that accounts for the vast bulk of global warming potential is carbon dioxide. Second is methane and third is nitrous oxide.

methane, totaling 15 million tonnes annually, when expressed as carbon dioxide equivalent.<sup>74</sup> That methane has an atmospheric lifetime of 12 years.<sup>75</sup> Venting and flaring go largely unregulated in Saskatchewan, as part of a larger strategy to create an economic environment that is friendly to fossil fuel extraction. In total, the oil and gas and mining sector in Saskatchewan now accounts for 34% of provincial emissions.

Electricity generation and transport are Saskatchewan's other two largest emission sources. Together they account for 42% of Saskatchewan's annual greenhouse emissions, that is, 21% for each sector.<sup>76</sup> They are heavily dominated by emissions of carbon dioxide.

In the electricity generation sector, SaskPower's coal-fired power plants, which produce approximately half of Saskatchewan's electricity, account for the vast bulk of emissions.<sup>77</sup> The latest data available on emissions from these plants is for the year 2012. In that year the Boundary Dam Power Station near Estevan was the largest emitter at 6.93 million tonnes of greenhouse gas emissions, followed by Poplar River Power Station (Coronach) at 4.37 million tonnes and Shand Power Station (Estevan) at 1.66 million tonnes.<sup>78</sup> SaskPower emissions at Boundary Dam declined slightly in 2013 (0.35 million tonnes) by virtue of its oldest unit (62 MW) closing. However, these gains are likely to have been offset by emissions associated with a new 260 MW natural gas station that opened in North Battleford in June 2013.

The Saskatchewan government's major greenhouse gas emission reduction initiative has been in the electricity generation sector. SaskPower has invested heavily in carbon capture technology,

spending almost \$1.4 billion at its Boundary Dam power plant to refurbish one of its coal-fired units and to install the technology required to capture carbon dioxide emissions. The new facility opened in October 2014. However, despite the vast sum of money invested, the project will only reduce SaskPower greenhouse gas emissions by one million tonnes per year.<sup>79</sup> To put this in context, that reduction will be insufficient to offset the 2.1 million tonne rise in Saskatchewan's province-wide greenhouse gas emissions over the latest one year period (2011 to 2012) for which data has been publicly released.<sup>n</sup> In the electricity generation sector alone, SaskPower's annual greenhouse gas emissions from its fossil fuel generating plants and those it contracts with are likely to remain at close to 14 million tonnes.

There is certainly merit in testing carbon capture technology in different North American locations, but it is clear the Saskatchewan government cannot rely on this as its primary vehicle for reducing greenhouse gas emissions in the electricity generation sector, since it is far too expensive for the volume of emissions saved.<sup>o</sup> A much more cost effective strategy would be an investment in energy efficiency and renewable power. Further complicating the outcome of the carbon capture project is that some of the carbon dioxide is being sold to an oil company for further fossil fuel extraction—the very activity climate scientists are urging governments to curtail.<sup>80</sup>

The Saskatchewan transport sector is more diversified in terms of emission sources, with commercial transport constituting the largest source, followed by passenger vehicles, and

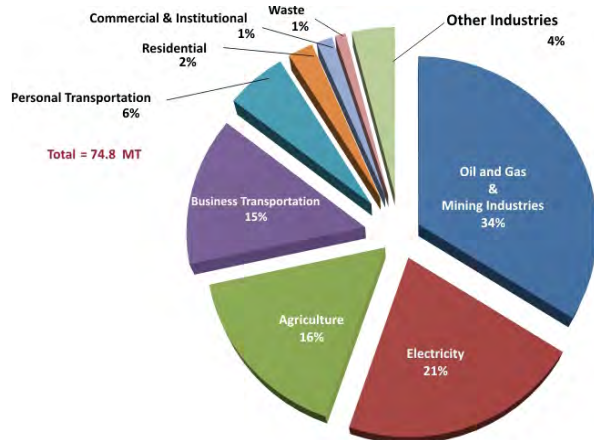
<sup>n</sup> *Canada's 2014 UNFCCC Submission—National Inventory Report 1990-2012*, Part 3, page 29, Table A11-16. The table is entitled: "1990-2012 GHG Emission Summary for Saskatchewan".

Saskatchewan's greenhouse gas emission emissions stood at 72.7 million tonnes in 2011 and 74.8 million tonnes in 2012. Tonnage is expressed as carbon dioxide equivalent.

<sup>o</sup> Further muddying the waters is the fact that some of the carbon dioxide that is captured at Boundary Dam will be liquefied and sold to oil companies to extract yet more crude from the ground, a final outcome that flies in the face of the urgent need to actually reduce fossil fuel production and consumption. ("SaskPower to launch \$1.4 billion carbon-capture project", *ibid.* The article notes that SaskPower has a 10 year contract with Cenovus Energy to buy captured carbon.)

then pipelines.<sup>81</sup> Emissions in the transport sector are rising rapidly (up from 15% of provincial emissions in 2007 to 21% in 2011). Transportation is also a sector where individual citizens must take a higher level of responsibility for carbon dioxide emission increases. For example, in recent years many residents of our province have strongly supported a higher speed limit on divided highways, favored the increased purchase of trucks and SUV's over cars, and increased their use of air travel.<sup>p</sup> However, the corporate sector has also driven emissions up through actions such as increasing transport of commercial goods by truck (instead of rail), and closing local grain elevators, forcing farmers to haul their grain longer distances by truck.

### Visual Representation of Saskatchewan Greenhouse Gas Emissions by Source



Source: *Environment Canada National Inventory Report, 1990-2012* and Government of Saskatchewan web site.

In the last section of this paper, we lay out key elements of a plan for addressing Saskatchewan's three biggest greenhouse gas emission sources. Some of the key initial steps we will elaborate on in the last section include strictly regulating the venting and flaring practices of the oil and gas industry, investing in Saskatchewan's public transportation system, and phasing out Saskatchewan's coal fired power plants. Coal-generated electricity would be replaced with electricity generation from wind power, solar power, biomass power, small scale hydro, electricity efficiency, and co-generation of electricity using natural gas.

At this point, however, the authors wish to emphasize that Saskatchewan's challenge is not only to eliminate its consumption of fossil fuels by 2070, but to phase out the production and export of fossil fuels over the next 50 years. The International Energy Agency is now advising countries to leave the bulk of their discovered fossil fuel reserves in the ground, if they wish to avoid the worst dangers of global climate change.<sup>q</sup>

Eliminating all manmade greenhouse gas emissions is imperative for curbing a wide range of climate change impacts including global average temperature rise and loss of Arctic sea ice, as the graphs below illustrate. Eliminating all manmade carbon dioxide emissions from fossil fuel burning and deforestation is also essential for curbing ocean acidification.

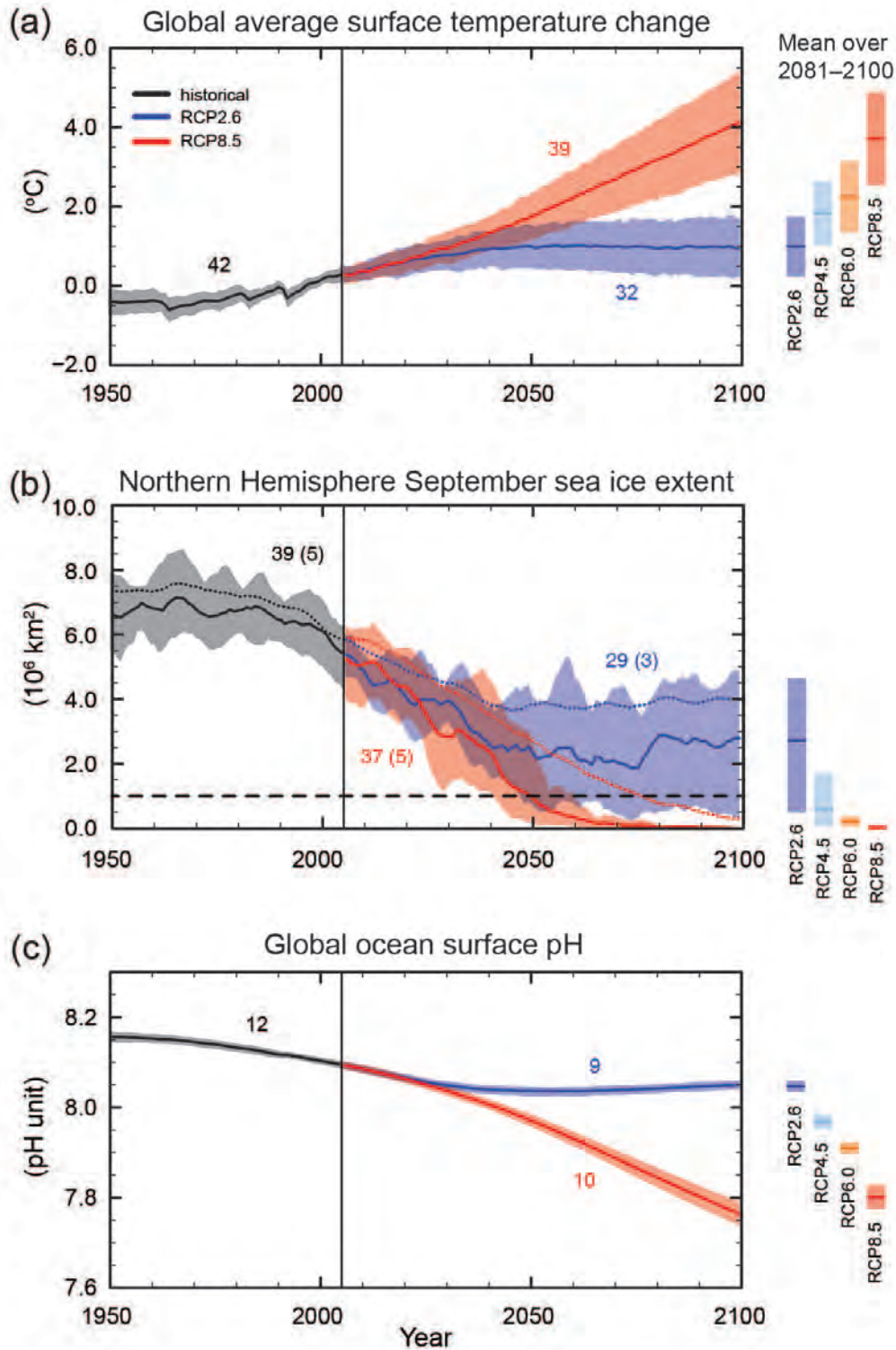
p Saskatchewan greenhouse gas emissions from light-duty gasoline vehicles has risen from 1,220,000 tonnes (carbon dioxide equivalent) in 1990 to 1,320,000 tonnes in 2000 and 1,360,000 tonnes in 2012. In contrast, Saskatchewan greenhouse gas emissions from light-duty gasoline trucks has risen from 893,000 tonnes in 1990 to 1,770,000 tonnes in 2000 to 2,300,000 tonnes in 2012. (*Canada's 2014 United Nations Framework Convention on Climate Change (UNFCCC) Submission – National Inventory Report 1990-2012, Part 3, Table A11-16 page 29.*)

Saskatchewan's speed limit on most four lane sections of Saskatchewan's major highways was increased from 100kmh to 110kmh in May 2003. (Government of Saskatchewan news release: "Speed limit increases this weekend", May 30, 2003. [www.gov.sk.ca/news?newsId=2163eac2-454d-4415-b96d-79cabbdfc2a3](http://www.gov.sk.ca/news?newsId=2163eac2-454d-4415-b96d-79cabbdfc2a3))

q International Energy Agency, *Redrawing the Energy Climate Map*, 2013. [www.iea.org/publications/freepublications/publication/WEO\\_RedrawingEnergyClimateMap.pdf](http://www.iea.org/publications/freepublications/publication/WEO_RedrawingEnergyClimateMap.pdf)

The International Energy Agency explains that no more than one third of proven reserves of fossil fuels can be consumed prior to the year 2050 if the world is to keep global average temperatures below 2°C, as agreed by the United Nations. "International Energy Agency urges stop-gap action", British Broadcasting Corporation, June 10, 2013. [www.bbc.com/news/science-environment-22845425](http://www.bbc.com/news/science-environment-22845425)

A Series of Different Greenhouse Gas Concentrations in the Atmosphere and the Resulting Consequences for Average Global Temperature Increase, Northern Hemisphere Sea Ice Extent and pH Levels in the Global Oceans





### Intergovernmental Panel on Climate Change Explanation of this Figure:

CMIP5 multi-model simulated time series from 1950 to 2100 for (a) change in global annual mean surface temperature relative to 1986-2005 (b) Northern Hemisphere September sea ice extent (5 year running mean), and (c) global mean ocean surface pH. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP 2.6 (blue) and RCP 8.5 (red). Black (grey shading) is the modelled historical evolution using historical reconstructed forcings. The mean and associated uncertainties averaged over 2081-2100 are given for all RCP scenarios as colored vertical bars. The number of CMIP5 models used to calculate the multi-model mean is indicated. For sea ice extent (b) the projected mean and uncertainty (minimum-maximum range) of the subset of models that most closely reproduce the climatological mean state and 1979-2012 trend of the Arctic sea ice is given (number of models given in brackets). For completeness, the CMIP5 multi-model mean is also indicated with dotted lines. The dashed line represents nearly ice-free conditions (i.e. when sea ice extent is less than 10 (to the 6th) km squared for at least 5 consecutive years).<sup>82</sup> The reference to the abbreviation CMIP5 stands for Coupled Model Inter-comparison Project Phase 5. This is a project of the World Climate Research Programme.

**Authors' Additional Explanatory Note:** The above IPCC chart shows the projected rise in average global temperature (relative to 1986-2005), the projected decline in September Arctic sea ice extent, and the projected decline in ocean pH (increase in acidity) under various greenhouse gas emission scenarios, each of which in turn results in a different concentration of greenhouse gases

in the atmosphere. The most ambitious greenhouse gas reduction scenario is RCP 2.6. It involves very deep emission reductions, including the elimination of manmade carbon emissions by 2070. This level of emission reduction significantly curbs dangerous increases in average global temperature and also prevents the worst of what will otherwise be a very dangerous decline in ocean pH. It also preserves a significant portion of Arctic summer sea ice. It assumes a CO<sub>2</sub> concentration in the range of 421 parts per million (ppm). Scenarios RCP 4.5 and RCP 6.0 are intermediate scenarios, with RCP 4.5 involving greater emission reductions than RCP 6.0. RCP 4.5 assumes a CO<sub>2</sub> concentration in the atmosphere of 538 ppm, while RCP 6.0 assumes a CO<sub>2</sub> concentration of 670 ppm. RCP 8.5 is a scenario with very high greenhouse gas emissions and an atmospheric CO<sub>2</sub> concentration of 936 ppm by 2100. (Refer to 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*, page 29.)

On the matter of ocean acidification, Earth System Models project a global increase in ocean acidification for all four of these scenarios by the end of the 21st century, with a slow recovery after mid-century under RCP 2.6. The projected decrease in surface ocean pH is as follow: (a) in the range of 0.06 to 0.07 (15-17% increase in acidity) for RCP 2.6, (b) in the range of 0.14 to 0.15 (38-41% increase in acidity) for RCP 4.5, (c) in the range of 0.20 to 0.21 (58-62% increase in acidity) for RCP 6.0, and in the range of 0.30 to 0.32 (100-109% increase in acidity) for RCP 8.5.

It is increasingly clear that most of the known fossil fuel resources on the planet should not be burned.<sup>r</sup> Recently the US State Department Climate Change Envoy Todd Stern acknowledged this fact, noting that the international community will have no choice but to forgo developing oil, coal and gas reserves in order to properly address the problem of climate change.<sup>83</sup>

This reality will not be an easy one for Saskatchewan residents and the Saskatchewan government to accept. Unfortunately, so far it is not even being seriously discussed. Saskatchewan is the second largest oil producer in Canada and our nation's third largest producer of natural gas.<sup>84</sup> Saskatchewan relies heavily on revenue from oil and gas exports to finance public services, and has not set aside any of this revenue for the purposes of one day transitioning off fossil fuels. Moreover, Saskatchewan's upstream oil and gas industry currently provides an estimated 36,000 person years of employment—when both direct and indirect jobs are included.<sup>85</sup> It is a major component of the provincial economy. In fact, the provincial government's economic growth agenda has been heavily focused on expanding oil extraction activities, including more fracking of oil shale deposits in southern Saskatchewan, and active encouragement of oil sands extraction in northern Saskatchewan.

However, all of this becomes secondary in the context of the consequences associated with climate change and ocean acidification. Failure to avert the devastating consequences of both these problems will have far greater negative impacts, and involve enormous risks that human society can simply not afford to take.

Clearly, every fossil fuel producing jurisdiction in the world faces the same dilemma. The phase out of fossil fuel production will need to take place over several decades and should be shared equitably. However, the phase-out process needs to begin now, so that it can be undertaken in a fair, planned and orderly manner, and so that the end goal of a safe and secure world can be achieved in time. The next decade is critical in terms of shaping Saskatchewan's and the world's climate path.

The Government of Canada needs to play an active role in cushioning negative economic impacts by providing transition funding for fossil fuel producing provinces, and by making important financial investments aimed at creating alternative employment opportunities for those whose jobs are impacted.

The entire process will be extremely challenging. However, there are also important benefits to be had, especially by way of thousands of new

r 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°C above pre-industrial levels, with the possibility of revising this down to 1.5°C. The modeling used in previous analyses by Carbon Tracker and the IEA (International Energy Agency) showed that the carbon budget for a 2°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 2,860GtCO<sub>2</sub>. A precautionary approach means only 20% of the total fossil fuel reserves can be burnt to 2050."

"The geographical distribution of fossil fuels unused when limiting global warming to 2 degrees C" by Christopher McGlade and Paul Ekins, *Nature*, Vol. 517, January 8, 2015, page 187. McGlade and Ekins emphasize that greenhouse gas emissions contained in present estimates of global fossil fuel reserves are around three times higher than the amount of carbon that can be allowed to be released into the atmosphere, if the increase in average global temperature is to be kept below 2 degrees C throughout the 21st century. Particularly relevant to Saskatchewan and Alberta is the authors' conclusion that: "any increase in unconventional oil production" is "incommensurate with efforts to limit average global warming to 2 degrees C."

“green jobs” that will be created in Saskatchewan and in other Canadian provinces. While the employment potential of renewable energy is not widely evident yet in Saskatchewan (due primarily to provincial government policy), it is clearly evident in several other Canadian provinces, most notably Ontario, Quebec and British Columbia.

Already, nation-wide in 2013, 37% more Canadians worked in the renewable energy industry than in 2009.<sup>86</sup> This was driven by what the non-profit group Clean Energy Canada estimates was

Canada-wide investment in renewable energy of \$24,000 million from 2009 to 2013.<sup>87</sup> Yet Clean Energy Canada’s estimate for renewable energy investment in Saskatchewan during this same 5 year time period was only \$70 million.<sup>88</sup> This is despite the fact that Saskatchewan has an outstanding wind resource, and the largest number of sunlight hours of any Canadian province. What is missing is the right set of public policies to complement those resources, and to kick start a low carbon, renewable energy transformation in Saskatchewan.



*Since purchasing the Confederation Inn in Saskatoon in 2006 Brian Sawatzky has steadily reduced energy and water consumption in his business. He has installed a solar hot water system and a solar photovoltaic system, along with triple pane windows, improved insulation and LED lighting. He is saving over \$130,000 per year on his utility bills, and has now achieved nearly a 70% reduction in energy use. His greenhouse gas reduction is approximately 460 tonnes CO<sub>2</sub>e (carbon dioxide equivalent) per year. Brian Sawatzky’s leadership example illustrates the potential direction that could be taken by thousands of other businesses across Saskatchewan. (Photo Credit: Lynette Suchar; Photo Location: Rooftop of the Confederation Inn; GHG reduction estimate: Special thanks to Angie Bugg.)*

### 3

## **Saskatchewan Policies are Contributing to a Loss of Native Prairie and the Global Decline in Biodiversity**

The grasslands region of Saskatchewan is considered one of the most ecologically altered environments in the world. Within Saskatchewan, much of the original biodiversity of the prairies was lost in the course of its conversion to agricultural lands during the early part of the twentieth century. Just 4% of the original 24 million hectares of prairie ecosystems remains in good condition.<sup>89</sup> Native grasslands are critical to the protection of biodiversity on the prairies, but in the Saskatchewan prairie ecozone they now total only 21% of ecozone land area.<sup>90</sup> Moreover, only 9% of the Saskatchewan prairie ecozone is managed for conservation purposes.<sup>91</sup> The rate of conversion of the land from grasslands to croplands has slowed in recent times, but agriculture and other land use practices have intensified and become increasingly mechanized. Moreover, a significant portion of the lands managed for conservation purposes are federal community pastures, and these are being transferred back to the Province of Saskatchewan. The ecological future of these community pasture lands is uncertain, since the federal resources for conservation management of these lands are being withdrawn by the Government of Canada.

Biodiversity faces a number of serious threats in Saskatchewan, the largest ones being: habitat loss and alteration, habitat fragmentation, invasion of exotic species, and impacts from the use of pesticides, agricultural chemicals and other forms of pollution.<sup>92</sup> In addition, many of the richest soils have been cultivated to produce crops, leaving the remaining native grasslands on less productive soils. Moreover, grazing, if not properly managed, can also have serious impacts. For instance, J. Thorpe found almost 50% of his study plots in the Aspen Parkland and

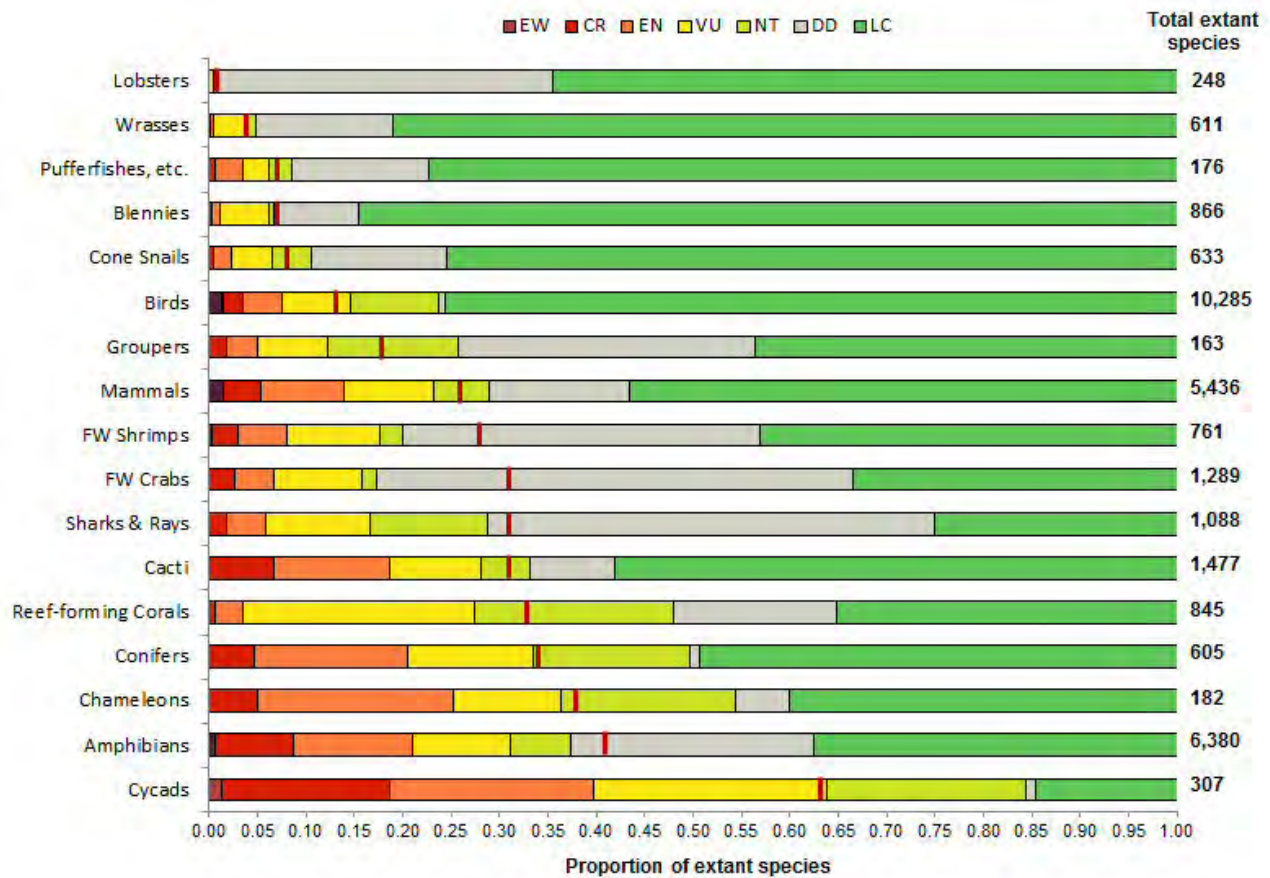
Mixed Grassland regions of Saskatchewan had, by 2007, been moderately or severely altered by livestock grazing.<sup>93</sup>

One prominent example of reduced biodiversity in Saskatchewan is the steady decline in populations of numerous grassland birds. Since 1970, grassland bird populations on the Canadian Prairies have dropped on average by almost 40%.<sup>94</sup> Declines in historical populations prior to 1970 were likely even greater, since a great deal of native grassland habitat was lost prior to the beginning of bird monitoring in 1970.<sup>95</sup>

At the present time there are approximately 50 plant and animal species in Saskatchewan that are considered species at risk, that is, species likely to show a significant decline or extinction in the foreseeable future. These species-at-risk categories (Threatened, Endangered, Special Concern) have been carefully assessed for populations in Saskatchewan, and 5 mammals, 21 birds, 5 amphibians and reptiles, 3 fish, 7 insects, and 10 plants have been assigned to these categories.<sup>96</sup>

These above-mentioned changes in Saskatchewan are contributing to a larger global trend in which bird, reptile and amphibian population numbers have declined by an average of 30% in the past 40 years.<sup>97</sup> Global land-based mammal population numbers have declined by an estimated one-quarter, marine fish by one-fifth, and fresh water fish by almost two-thirds, largely as a result of human population pressure, agricultural land conversion (and resulting habitat loss), pollution, logging, invasive species and over-exploitation.<sup>98</sup> Not only are wildlife populations declining, but an increasing number of species are now showing a risk of extinction.<sup>99</sup> In effect, global biodiversity is being seriously eroded.

## Proportion of Existing Species Considered to Be Threatened



Source: International Union for Conservation of Nature

**Explanation:** The proportion of extant (i.e. in existence/excluding Extinct) species in *The IUCN Red List of Threatened Species. Version 2014.3* assessed in each category for the more comprehensively assessed groups. Taxa are ordered according to the vertical red lines, which show the best estimate for proportion of extant species considered threatened (CR, EN, or VU). Best estimates of percentage threatened species (with lower and upper estimates) for each group are: cycads 63% (63-64%); amphibians 41% (31-56%); chameleons 38% (36-42%); conifers 34% (34-35%); reef-forming corals

33% (27-44%); cacti 31% (28-37%); sharks and rays 31% (17-63%); freshwater crabs 31% (16-65%); freshwater shrimps 28% (17-55%); mammals 26% (21-36%); groupers 18% (12-43%); birds 13% (13-14%); cone snails 8% (6-20%); blennies 7% (6-15%); pufferfishes, etc. 7% (6-20%); wrasses 4% (4-18%); lobsters <1% (0-35%). The numbers to the right of each bar represent the total number of extant species assessed for each group. **CR** – Critically Endangered, **EN** – Endangered, **VU** – Vulnerable, **NT** – Near Threatened, **DD** – Data Deficient, **LC** – Least Concern.<sup>100</sup>

Biodiversity and the environmental services provided by wild species (e.g. cleansing the water, enriching the soil, pollinating many crops and flowers) in fully functional ecosystems are essential for life on Earth. As human beings we are a part of nature, and our economy and our personal and societal well-being are highly dependent on the health of the ecosystems around us. Yet clearly, the resilience of natural systems is breaking down, and is doing so because of human actions.

It is thus imperative that jurisdictions around the world enact policies to reverse the decline in biodiversity. Yet in Saskatchewan new public policy measures are being taken which are likely to lead to more biodiversity loss.

An important example is the decision by the Government of Saskatchewan to lease out many of Saskatchewan's publicly owned community pastures to patron groups without providing resources for ecological protection of these sensitive lands.<sup>101</sup> These pastures are largely on provincial crown lands. They were being managed by the Government of Canada under the Prairie Farm Rehabilitation Administration (PFRA), until Ottawa decided in 2012 to cut funding for its management role, and turn management of the pastures back to the Government of Saskatchewan. The first 10 pastures were turned over to the Saskatchewan government in late 2013.<sup>102</sup>

The leasing arrangements the Saskatchewan government has now entered into on these pastures do not include any transfer to the pasture patrons of staff expertise or monies specifically dedicated to environmental stewardship of the pastures.<sup>103</sup> The ecological value of these community pastures has endured for many decades because they were kept in public hands, and because the federal government funded pasture managers who were charged with environmental stewardship, including protection

of species at risk. Now, as both the Saskatchewan and federal governments withdraw from their responsibilities to properly manage these pastures, this proven stewardship model is in grave danger.

As management of Saskatchewan crown land in the community pasture program is transferred out of the hands of public servants trained in protecting grasslands habitat and vulnerable species, as well as in managing and protecting the health of cattle, some of these lands will inevitably no longer be managed in a way that safeguards their ecological value to the same degree as when they were under PFRA management. Not only will grassland birds be in even further jeopardy, but many other threatened and endangered species will continue their decline. The provincial crown lands in the community pasture program are currently home to 31 endangered and threatened species.<sup>104</sup> These include rare wild butterflies and flowers, yellow-bellied racers, the Burrowing Owl, the Ferruginous Hawk and the Swift Fox.

A second example is provincial government inaction on a major report recommending the establishment of 35 ecological reserves in the southern half of the Great Sand Hills, located in southwest Saskatchewan.<sup>105</sup> This area remains unprotected despite being internationally recognized as one of the largest remaining remnants of native grassland in Canada. The Sand Hills are home to 70 species of birds, 19 species of mammals, 5 species of amphibians, and several rare plant species.<sup>106</sup> Many species are vulnerable because of expanding natural gas development in the Sand Hills combined with an ever growing road and trail network to service the gas wells.

In May 2007 the Great Sand Hills Regional Environmental Study, commissioned by the Government of Saskatchewan, laid out a comprehensive plan to protect biodiversity hot spots

in the southern portion of the Great Sand Hills. Seven years later, not a single one of the 35 ecological reserves proposed by the Regional Study has been created. Nor has action been taken on a second critical recommendation, namely to allow no new gas well pad development in core biodiversity areas of the Sand Hills, and to limit gas well pad surface leases beyond the core biodiversity areas to no more than 2 per section.<sup>107</sup> The inevitable result of government inaction on these recommendations will be further loss of biodiversity in the southern Great Sand Hills.

There is reason to be somewhat more optimistic about biodiversity in the northern half of Saskatchewan. Half of the province's landmass is boreal forest. Canada is one of the few countries that still has large tracts of forests that are relatively undisturbed from human activities, and are believed to still contain most of their native biodiversity. Global Forest Watch has published an interesting national survey identifying all intact and undisturbed forested lands in Canada that are 50 km<sup>2</sup> or larger in size. Global Forest Watch concludes that almost 50% of Canada's forested ecozones consist of intact forest landscapes. This includes 94% of the northern boreal ecozones. In contrast, the southern boreal regions in Canada are suffering greater impacts and fragmentation from a number of human activities, mainly forest harvesting, mining, seismic work and tar sands development. Only 37% of the Boreal Plains of Saskatchewan and Alberta remains as intact forest landscapes.<sup>108</sup>

Biodiversity protection in the boreal forest has been aided by improvements in ecologically sound forestry practices, including the creation and implementation of sustainable forestry certification schemes. These initiatives involve the certification of forest management and harvest practices to an agreed standard of sustainability.<sup>109</sup>

Biodiversity protection in the boreal forest in Saskatchewan has also been facilitated by the fact that consecutive Saskatchewan governments have made a genuine effort over the past two decades to advance the Saskatchewan Representative Areas Network in the boreal forest, and have given many of the designated lands Ecological Reserve Status.<sup>110</sup>

While most effectively used in the boreal forest, Saskatchewan's Representative Areas Network has become an important provincial government policy vehicle by which to protect and enhance biodiversity province-wide. The overall Representative Areas Network in Saskatchewan now constitutes approximately 6.1 million hectares, or just over 9% of Saskatchewan's geography.<sup>111</sup> The Network includes 35 provincial parks, plus wildlife habitat lands, ecological reserves, and other designations that are intended to be free of mines, roads, forest harvesting and industrial development.<sup>112</sup> One new provincial park and Representative area ecological reserve were added in 2013.<sup>113</sup> The Representative Areas Network is in addition to Saskatchewan's two national parks, which are operated by the Government of Canada, and which constitute over 0.7% of provincial land area.

While clearly significant, these province-wide efforts nevertheless fall far short of the targets for protected land area that have been agreed upon at the United Nations. The international community has resolved, through the UN process, to set aside 17% of total land area in each nation in a protected state by 2020.<sup>114</sup>

Saskatchewan has an obligation to help Canada reach the 17% goal, but is not on track to do so. Once again, economic growth and protection of biodiversity find themselves at least in partial conflict, and the provincial government is reluctant to earmark for protection lands that have potential for oil and gas extraction, mineral development, forest harvesting, or other forms

of economic development. Yet if this reluctance becomes the norm around the world, the decline in global biodiversity will continue unabated.

Nor is Canada as a nation meeting its obligations. In June, 1992, at the Earth Summit in Rio de Janeiro, the Prime Minister of Canada signed the Convention on Biological Diversity. In summary, its main objectives are to achieve: (1) the conservation of biodiversity; (2) the sustainable use of biological resources, and (3) the fair and equitable sharing of benefits resulting from the use of genetic resources. In December, 1992, the Canadian Parliament ratified this convention, making Canada the first industrial country to do so.<sup>115</sup> After this impressive start and after the passage of the Species at Risk Act, progress in Canada to restore populations of endangered and threatened species and to protect their critical habitat has slowed considerably. Not so in other nations. By 2002, 188 nations had signed the Convention on Biological Diversity.

By 2006, 130 nations of the 191 UN members had amended their constitutions to protect their national environments, in most cases directly or implicitly involving biodiversity.

Professor Edward O. Wilson of Harvard University expresses the urgency for effective global action. He states "A race is now on that will decide the fate of the greater part of Earth's biodiversity. The choice is simple: save biodiversity during the next half century or lose a quarter or more of the species." He also observes, "The human hammer having fallen, the sixth mass extinction has begun . . . The first five (extinction) spasms took ten million years on average to repair by natural selection. A new ten-million-year slump is unacceptable. Humanity must make a decision, and make it right now: conserve Earth's natural heritage, or let future generations adjust to a biologically impoverished world."<sup>116</sup> Immediate and effective conservation actions are needed now.



*Data from the Breeding Bird Surveys, conducted across Canada each summer for more than four decades, indicate that the populations of more than 40 bird species are in decline in Saskatchewan. Two are illustrated above. The Gray Jay is pictured on the left. There has been a noticeable reduction of sightings of this species in Prince Albert National Park raising concern about its status in the southern boreal forest of Saskatchewan (Photo credit: David Henry). The Burrowing Owl is pictured on the right. It is one of the bird species in Saskatchewan now classified as "threatened" (Photo Credit: Dan Wood; Special thanks to Josef Schmutz and Gwen Wood).*



## 4

# Saskatchewan Uranium Exports have Contributed to the Buildup of an Immense Nuclear Weapons Stockpile on Our Planet, as Well as to the Spread of Atomic Bombs Around the World

It should be kept in mind that Saskatchewan first developed its uranium resource strictly for the purposes of supplying the nuclear weapons industry with raw material. Operating on behalf of the Government of Canada, Eldorado Mining and Refining opened its uranium mines and mill at the edge of Beaverlodge Lake in northern Saskatchewan in 1953 to supply military contracts. It sold uranium to the United States Atomic Energy Commission, and did so for the purpose of providing the United States with uranium for the production of nuclear weapons.<sup>117</sup> Other uranium mines were also developed in the Uranium City area for this purpose, including the Lorado mine near Beaverlodge Lake and the Gunnar mine on the northern shore of Lake Athabasca.

To help facilitate uranium mining activities at Beaverlodge Lake and accommodate the necessary workforce, the Government of Saskatchewan worked to develop the community of Uranium City. All of this was in part about pursuing a growth agenda, as Uranium City became the fastest growing municipality in Saskatchewan,<sup>118</sup> and uranium became the fastest growing mineral export from Canada.<sup>5</sup> Fifty years later Saskatchewan taxpayers and the global community are left with the burden that was created—a dangerous stockpile of atomic weapons, abandoned uranium mine sites in northern Saskatchewan that are very costly to clean up, and five contaminated watersheds in the Uranium City area.<sup>t</sup>

<sup>s</sup> “A Brief History of Uranium Mining in Canada”, World Nuclear Association, [www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Appendices/Uranium-in-Canada-Appendix-1--Brief-History-of-Uranium-Mining-in-Canada/](http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Appendices/Uranium-in-Canada-Appendix-1--Brief-History-of-Uranium-Mining-in-Canada/)

The World Nuclear Association notes that the “first phase of Canadian uranium production peaked in 1959 when more than 12,000 tonnes of uranium was produced. The uranium yielded C\$330 million in export revenue, more than for any other mineral export from Canada that year.”

<sup>t</sup> By way of illustrating the cost of remediation, cleanup expenditures at the Gunnar uranium mine site on the north shore of Lake Athabasca have already cost the Government of Saskatchewan and provincial taxpayers \$59 million, while the Government of Canada has to date covered just over \$1 million. The Government of Canada is committed to covering approximately \$12 million of the remediation expenses. Costs of remediation are projected to grow to as much as \$260 million. Work has yet to begin on the biggest problems on the site. A 100 metre deep, heavily contaminated, mined-out pit sits near the shore of Lake Athabasca. So does more than 2 million cubic metres of radioactive waste rock, some of which is a source of radium contamination to Zeemel Bay in Lake Athabasca. Perhaps most challenging of all is the 4.4 million tonnes of radioactive tailings that were deposited as waste over a 70 hectare land area near the lake. At their highest point, the tailings lie 14 metres thick. Surface and groundwater that flows through those tailings picks up contaminants that are then carried into Lake Athabasca. Further complicating matters is that some of the radioactive tailings now sit in Langley Bay of Lake Athabasca, where they release radioactivity into the local environment every day. (Canadian Nuclear Safety Commission hearings addressing the matter of an application by Saskatchewan Research Council for a license to undertake remediation work at the mined-out Gunnar site. The hearing was held on November 6, 2014.)

Documentation for the five contaminated watersheds in the Uranium City area can be found by referring to: “Beaverlodge Project Annual Report for January 1, 2011 to June 30, 2012”, Table 4.1.1. The annual report was prepared by Cameco, who manages the decommissioned site. This table documents several locations in the Ace Creek watershed where uranium was mined by Eldorado Nuclear and where uranium concentrations in surface waters are still many times higher than Saskatchewan Surface Water Quality Objectives. It also documents the state of pollution in the Fulton Creek watershed where uranium mill tailings were deposited. For instance, Greer Lake, which is part of the Fulton Creek watershed, and is downstream of the mill tailings, still has uranium and radium concentrations 24 times higher than provincial guidelines.

“Beaverlodge Project Annual Report, January 1, 2011 to June 30, 2012”, Section 4. Sampling locations show Beaverlodge Lake uranium concentrations 8 to 9 times higher than Saskatchewan Surface Water Quality Objectives and selenium concentrations more than double Saskatchewan Surface Water Quality Objectives. (Beaverlodge Lake is approximately 57 square kilometers in surface area.) Sampling stations in Martin Lake watershed and the Crackingstone River also exceed Saskatchewan Surface Water Quality Objectives for uranium by 4 fold and 3 fold respectively. Refer to data from sampling stations BL 5, ML 1 and CS 1.

In the past four decades Saskatchewan-based uranium mining companies and the Government of Saskatchewan itself have entered into many other controversial uranium export contracts, including uranium sales to France while its government tested atomic weapons in the South Pacific, and uranium sales to South Korea and Argentina, while both countries were ruled by military dictatorships that were well known to be using civilian nuclear reactors as a cover for the development of an atomic weapons program.<sup>119</sup> Moreover, so-called depleted uranium of Canadian origin—left behind after the enrichment process at uranium enrichment facilities was complete—has been used to manufacture the outer ring of the hydrogen bomb, and to make heavy bullets and other military hardware.

In 1993 concerns about the risk of Saskatchewan uranium being used for military purposes was raised by a government appointed panel. The Joint Federal-Provincial Panel on Uranium Mining Development in Northern Saskatchewan flagged this issue in its October 1993 report to both the Government of Canada and the Government of Saskatchewan. In its report the five-member Panel stated: “The Nuclear Non-Proliferation Treaty, of which Canada is a signatory, prohibits the use of uranium in the production of enriched uranium for military applications. However, there is no process whereby exported Canadian uranium can be separated from uranium derived from other sources. Therefore, no proven method exists for preventing incorporation of Canadian uranium into military applications. Current Canadian limitations on end uses of uranium provide no reassurance to the public that Canadian uranium is used solely for non-military applications by purchasers.<sup>120</sup> Unfortunately, the Panel’s concerns were ignored by the respective governments to which they offered advice.

Today, the Saskatchewan government continues to disregard nuclear weapons concerns when it comes to uranium export policy. For instance,

in order to pursue the growth of the uranium industry, the Saskatchewan government has lobbied Ottawa to permit sales of uranium to China and India. So has the global uranium giant Cameco.

The first shipment of Saskatchewan uranium to China occurred in 2013, under new rules with less stringent accounting for how uranium is used than the Canadian government typically requires.<sup>121</sup> Also of concern is China’s unwillingness to ratify the Comprehensive Test Ban Treaty.<sup>122</sup> The Comprehensive Test Ban Treaty is intended to prevent atomic weapons testing by all signatories, but the United Nations has not yet been able to bring the treaty’s provisions into official effect, because of the refusal of a handful of countries to complete the ratification process. China’s failure to ratify the treaty does not appear to be a serious concern for the Saskatchewan government. Its focus is on growth of uranium production. The Chinese market is expected to generate billions of dollars in uranium sales for Saskatchewan in the coming decade.<sup>123</sup>

In response to the lobby to allow sales of Saskatchewan uranium to India, Saskatoon-based Cameco has been given permission by the Canadian government to pursue the export of uranium to the Indian market, despite that country’s refusal to sign the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).<sup>124</sup> This action by the Government of Canada has the effect of undermining the NPT. The treaty is a foundation for civilian nuclear trade in the world, and seeks to prevent the spread of nuclear weapons and their buildup. The treaty has the largest ratification of any multilateral disarmament agreement, with 189 nations participating.<sup>125</sup> India’s unwillingness to sign and ratify the treaty should be a red flag for any government engaged in uranium exports.

There is no excuse for the Saskatchewan and Canadian governments not to be fully cognizant of the risks of renewing uranium exports to

India. In May 1974 India exploded its first atomic bomb, and did so by using the plutonium produced in a nuclear reactor sold to it by Canada. Since then, it has steadily built up its atomic weapons arsenal, while also expanding its civilian nuclear reactor program. India has a very small domestic supply of uranium and for decades has needed to use it for both civilian and military purposes. Even if Saskatchewan uranium shipments are never used for direct military purposes, there is a risk that our sales of uranium to India will “free up” India’s domestic uranium supply for atomic weapons production.<sup>126</sup> A bilateral safeguards agreement that Canada and India have recently signed will do little to prevent this from happening.<sup>127</sup> It is extremely troubling to see both India and Pakistan building up their nuclear weapons arsenal, at a time of ongoing tension in the region.<sup>128</sup>

Rather than weakening the NPT through an irresponsible uranium export policy, Saskatchewan and Canada should be working cooperatively with the United Nations to advocate that the treaty’s existing provisions are properly enforced, and that new provisions are added to strengthen it. Saskatchewan provides almost 20% of the world’s uranium supply.<sup>129</sup> As the world’s second largest exporter, Saskatchewan is well placed to influence global policy on non-proliferation.

One example of where better NPT enforcement is required pertains to the policies pursued by the nuclear weapons states that are part of the treaty. A great many countries that do not possess nuclear weapons are asking why more progress is not being made on an NPT provision that obligates the Parties to the treaty to “pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.”<sup>130</sup> The intent of the NPT

was that this was to be done in exchange for non-nuclear weapons states promising not to acquire nuclear weapons and promising not to use uranium fuel supplies, nuclear reactors, enrichment facilities or reprocessing facilities for the purpose of developing atomic weapons.<sup>131</sup>

Examples of where the Treaty on the Non-Proliferation of Nuclear Weapons is weak include a failure to address the stockpiling of plutonium by member nations, and a failure to require uranium exports to be enriched (processed) in enrichment facilities that are civilian in nature.

At the present time, nations that are signatory to the treaty are free to reprocess and stockpile plutonium that is extracted from high level radioactive waste—for the purposes of future use in civilian breeder reactors. These facilities and the plutonium are subject to international inspection. Yet this plutonium could, if a future government chose to, quickly be drawn upon for nuclear weapons purposes. It is weapons grade quality material. Ideally, plutonium reprocessing would not be permitted under a strengthened NPT. Alternatively, the reprocessing facilities should not be solely owned by the national government whose country they are in, but jointly owned with the United Nations itself, so that reprocessing plants cannot suddenly be used for military purposes.

Currently, all Saskatchewan uranium exports to the United States and most uranium exports in the world are enriched in facilities that are military rather than civilian in nature. Once again, this needs to change so that uranium enrichment is done in plants that are strictly civilian in nature, and jointly owned by the host country and the United Nations.

In summary, the Saskatchewan government should press to ensure that the existing provisions of the NPT are properly enforced, and should work to advance implementation of the above-mentioned safeguard provisions. It should not

approve new uranium mines in Saskatchewan until significant progress has been made on these fronts. Under the current uranium export provisions, there are still too many circumstances in which the civilian and military nuclear fuel cycle are intertwined in ways that are not in the long term interests of human civilization.

Non-proliferation concerns are the most important problems that need to be resolved before new uranium mines in Saskatchewan are approved, but they are not the only ones. For instance, concrete progress also needs to be made on safe disposal of high level radioactive waste.

The challenge of finding a safe disposal solution continues to be daunting, and one need look no further than the United States to see the reality being faced in many parts of the world. High level radioactive waste (much of it originating from uranium of Saskatchewan origin) is rapidly building up at United States nuclear reactor sites. The US national government had originally planned to move forward with a repository for high level radioactive waste at Yucca Mountain, Nevada. However, the difficulties—including the risk of groundwater contamination—proved to be far greater than anticipated, despite a US expenditure of more than \$10 billion. As a result the United States still has no site for disposal of what is now well over 69,000 tonnes of high level radioactive waste from its civilian nuclear power plants.<sup>132</sup>

Further underlining the challenge that high level radioactive waste poses, is the fact that the US government cannot even dispose of its low and medium level nuclear wastes without running into serious difficulties. The most recent

example of this has occurred at the US geological repository for handling low and medium-level military nuclear waste in Carlsbad, New Mexico. This facility opened in 1999 amid promises that it would operate safely and cleanly for a long time into the future. Yet just 15 years later — in the spring of 2014 — the first serious accident has already occurred at the facility, resulting in a significant release of radiation, and exposing major safety deficiencies in the operation of the facility.<sup>133</sup> If low and medium-level radioactive wastes cannot be disposed of successfully by the most technologically advanced country in the world, there should surely be major doubts about whether society is ready to adequately handle high level radioactive waste disposal, without risking public safety and significant contamination of groundwater.

However, it is also not acceptable to leave these wastes at nuclear reactor sites over the long term, as some have suggested. While their temporary storage does not pose an immediate hazard, it poses grave risks in the event of a conventional war in a part of the world that has nuclear power installations. If the high level radioactive waste storage facilities next to these power plants were to be bombed with conventional weapons, they could release enormous quantities of radiation that would pose a major public health threat.

In effect, there clearly seems to be no good solution to the waste disposal issue. Given the serious difficulties that high level radioactive waste disposal poses, there would be a good deal of wisdom in not compounding the problem by building yet more nuclear reactors and opening yet more uranium mines, until a sound disposal solution has been demonstrated.

## Summary

Taken together, the above analysis suggests that several of Saskatchewan's economic growth policies need to be rethought. As constituted, they are disrespectful of the global commons. One of the results of the Saskatchewan's government's rapid economic growth strategy is that Saskatchewan has gradually become a global environmental laggard. There are high social and economic costs associated with such behaviour.

When considering the set of policy solutions that must now be taken to correct this situation, it is

important to bear in mind that at both a global and local level, the four environmental trends discussed above will interact with one another, potentially making consequences even more severe. For instance, the world's coral reefs will be negatively impacted by ocean acidification as well as by consequences of climate change such as sea level rise and more powerful hurricanes. Similarly, habitat loss will combine with climate change to increase the risks for many threatened species in Saskatchewan and across the globe.

# The Economic Costs of Saskatchewan's Policy Direction

The Earth is our home and its life support systems are fundamental to the existence of all species and all human beings. Preserving those life support systems should thus be at the top of every jurisdiction's priority list, including Saskatchewan.

Nevertheless, for much of society it is the economy that is top of mind. Thus putting a dollar value on the damage being done by anthropogenic carbon emissions, other greenhouse gas emissions, and biodiversity loss is a useful policy tool. It is also a very complex topic. For illustrative purposes here, we thus limit our focus to global climate change impacts, and estimate the economic costs of climate change impacts from Saskatchewan's greenhouse gas emissions.

A landmark work on economic modeling of climate change impacts is *The Economics of Climate Change*, a report prepared for the Government of the United Kingdom in 2006 and led by Sir Nicholas Stern. Stern warned that if society does act to significantly reduce anthropogenic greenhouse gas emissions, "the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP (Gross Domestic Product) each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more."<sup>134</sup> By a "wider range of risks and impacts", Stern was referring to direct impacts on the environment and human health (non-market impacts), the impact of amplifying effects of feedbacks in the climate system, and taking full account of the disproportionate burden of climate change impacts that will fall on poor regions of the world.<sup>135</sup>

Today, many new economic models addressing climate change impacts have been developed. The leading models all point in the same direction, namely that climate change causes "substantial economic harm, justifying immediate action to reduce emissions."<sup>136</sup> An inter-agency working group for the United States Government recently used three leading economic models to estimate that when a tonne of carbon dioxide is released into the atmosphere, it will cause \$37 (US dollars) worth of harm in today's dollars.<sup>137</sup> Some models use higher numbers, but to be cautious, let us use this figure.

Applying this value to Saskatchewan's current greenhouse gas emissions nets a figure of \$2.767 billion per year.<sup>138</sup> This "social cost of carbon" also represents the money that would be saved from avoided damage worldwide if these emissions were eliminated.

While this total is large, there is considerable evidence to suggest it likely errs on the low side. Damage estimates in models are generally calibrated to climate warming of less than 3°C, and the latest reports from the Intergovernmental Panel on Climate Change make it clear that average global temperatures could rise more than that by the end of this century.<sup>139</sup> Moreover, economic models on climate change impacts often omit damage to labour productivity and capital stock,<sup>140</sup> yet these could become important factors in the event of extreme weather damage, or loss of coastal cities due to sea level rise. Current modeling also has trouble accounting for social upheaval or economic crises that climate change could trigger. And models have difficulty dealing with very long term, but exceedingly negative climate change costs that are likely to be faced in coming centuries.

# The Negative Impacts of Current Economic Growth Strategies on Saskatchewan's Local Environment

In addition to the global impacts enunciated above, Saskatchewan's growth strategy is aggravating local environmental conditions. In other words, part of the growth in Saskatchewan's economy is based on transferring costs to the environment and to the public at large. For example:

1. Most new house construction in Saskatchewan is relatively energy inefficient, when compared to the energy efficient construction techniques that are now commercially available. Despite our cold winters, Saskatchewan still does not have a mandatory building code for energy efficiency in newly constructed buildings. Saskatchewan has experienced a boom in new housing starts, but the reality is that the vast bulk of this new housing is outdated from an environmental and technological point of view right from the time that construction is completed.
2. Saskatoon has failed to invest in an adequate public transportation system. The result is that population growth in Saskatoon is causing increased traffic congestion and more air pollution.
3. The Saskatchewan government is increasingly willing to encourage projects that bring significant health, safety and environmental risks to populated areas of the province. Recent examples include TORQ Transloading

Incorporated's proposed oil-by-rail terminal near Kerrobert, Saskatchewan, and the Metal Processing Plant proposed by Fortune Minerals near Langham, Saskatchewan. The TORQ project will mean 240 additional rail cars each day hauling a total of 168,000 barrels of crude oil per day through Saskatchewan communities.<sup>141</sup> This will bring with it increased risk of a derailment or explosion involving oil tankers in a populated centre. The quantity of oil that would move out of the Kerrobert terminal each day is roughly equivalent to one-fifth of the daily movement through the proposed Keystone XL Pipeline; yet the terminal has not been subject to a provincial or federal Environmental Impact Study.<sup>142</sup> The Fortune Minerals project would leave behind forever 2.8 million tonnes of metal processing residue laced with arsenic buried in 14 foot deep lined pits/cells over the Dalmeny Aquifer.<sup>143</sup> The project received approval from the Government of Saskatchewan in January 2014. If the plant proceeds, the presence of waste residue with tens of thousands of tonnes of arsenic in it will pose a long term risk to a valuable drinking water aquifer that serves many residents northwest of Saskatoon, including the communities of Langham and Dalmeny.

4. Saskatchewan homeowners have been applying pesticides at increasing rates.<sup>u</sup>

<sup>u</sup> *Protecting Public Health and the Environment – The Need for a Pesticide Reduction Bylaw in Urban Settings: A Policy Proposal for Regina* by Pascal Bongyu, (Canadian Cancer Society, the Lung Association of Saskatchewan and the Saskatchewan Environmental Society), 2011, page 4. Saskatchewan had the highest household use of pesticides on garden and lawns in Canada with 37% use in 1994 and 46% in 2007 compared to a national average of 31% and 25% respectively (Statistics Canada, 2007, 2009). [www.environmentalsociety.ca/main/wp-content/uploads/2011/05/Regina\\_PesticidePolicy.pdf](http://www.environmentalsociety.ca/main/wp-content/uploads/2011/05/Regina_PesticidePolicy.pdf)

Saskatchewan has the highest household use of pesticides on gardens and lawns of any province in Canada. Lawn and garden use is of particular concern because pesticide applications (on a per hectare basis) tend to be more intensive than in an agricultural setting. Increased pesticide use has negative impacts for public health in our communities. Infants, children and pregnant women are particularly vulnerable. It also has negative impacts on critical pollinators. The prevailing attitude of the provincial government is reflected in the fact that, unlike Nova Scotia, Quebec, Ontario and Manitoba, Saskatchewan has not moved to place restrictions on the cosmetic use of pesticides.<sup>144</sup>

5. The Saskatchewan government is actively pursuing oil sands development. However, oil sands is clearly incompatible with the need to focus on building a low-carbon economy in our province, since the extraction and upgrading of oil sands bitumen emits at least three times more greenhouse gas pollutants than does the extraction of conventional oil.<sup>145</sup> An oil sands industry is also not

compatible with Saskatchewan's impressive network of northern lakes and forests, which are extremely acid sensitive.<sup>146</sup> Oil sands operations in Alberta are expected to cause significant acid deposition in the northeastern part of that province,<sup>v</sup> and acid precipitation has already been recorded on several occasions in northwest Saskatchewan, a trend that is worrisome when extended over decades.

6. Saskatchewan has prioritized resource extraction over ecological protection for the past several decades, and thus is forgoing the opportunity to safeguard valued ecosystems. The immediate results are usually localized, but the cumulative impact is very negative. For example, southwest Saskatchewan's most biologically diverse native prairie is increasingly fragmented, with more road and gas well development putting increased pressure on rare and endangered species.<sup>w</sup> Meanwhile in northern Saskatchewan, uranium mining companies have left behind enormous radioactive tailings piles and polluted important watersheds.<sup>x</sup> Once these negative impacts occur, they are difficult to reverse.

v *Oil Sands Environmental Coalition Submission to the Joint Review Panel on the Shell Jackpine Mine Expansion Project*. Shell's air modeling shows that when the Jackpine oil sands mine and all other currently approved oil sands projects are completed, a large area of the oil sands region and 23 lakes in northeastern Alberta will exceed critical levels for acid rain deposition. *Oil Sands Environmental Coalition Submission to the Joint Review Panel on the Shell Jackpine Mine Expansion Project*.

w *The Great Sand Hills Regional Environmental Study: Final Report*, Great Sand Hills Scientific Advisory Committee, 2007, p. 179-182 and p. 171. There were 76 gas well surface leases present in the Great Sand Hills Review Area in 1979. By 1991 653 new gas wells were established and by 2005 an additional 738 gas wells were added. Between 1979 and 1991 435 km of roads and trails were added, and between 1991 and 2005 243 km more were constructed. There is a very strong spatial overlap between road/trail development and gas well-pad development. It is clear from Figure 3-1-3a (p. 171) that core biodiversity areas in the Great Sand Hills are generally not located in areas that have been heavily fragmented by road and trail construction.

x There are many examples of contaminated uranium mine sites. The example provided here is for uranium mine and milling operations at a site known as Rabbit Lake, which is located on the western shores of Wollaston Lake, a large freshwater lake in northeast Saskatchewan.

At the current Rabbit Lake uranium mine site, the sediment of the Link Lakes is seriously contaminated with a broad array of radionuclides, heavy metals and other constituents. There is an estimated 57,000kg of uranium and 190,000MBq of Radium 226 in the upper 5 centimetres of the Link lakes sediment. There is reason to be concerned that sediment-based uranium and radium will make their way back into the water column. (Source: Link Lakes Drainage Compilation Report, Ecometrix Inc., 2006, p. i-ii and 2-7 and 3-4.)

Cameco has two locations at the Rabbit Lake site where radioactive tailings are stored and managed. The Above Ground Tailings Management Facility is 53 hectares in size and houses 6.5 million tonnes of long-lived radioactive tailings. The Rabbit Lake In-Pit Tailings Management Facility has had 7.95 million tonnes of radioactive tailings deposited in it to date. (Source: "2012 Annual Report for the Rabbit Lake Operation", p. 3-37 and "Rabbit Lake Operation Site Wide Reclamation Plan". Refer to sections 5 and 6 of the Plan.)



# Building a More Sustainable Future for Saskatchewan

Saskatchewan has abundant human and natural resources, including a well educated and resourceful population, more than 1% of the world's fresh water (a precious resource to be protected and conserved), remarkable mineral wealth, a large boreal forest, the best solar energy regime in Canada, and a tremendous array of other low carbon, renewable sources of energy. We could readily choose to build an environmentally sustainable economy.

Here we summarize a set of first steps Saskatchewan's government could take at a provincial

level to help transition towards a more environmentally sustainable economic future for our province. We begin by focusing on 15 initiatives aimed at cutting carbon dioxide emissions and other greenhouse gas emissions, while building a green energy future. We then propose two policy initiatives intended to reduce the risk that Saskatchewan's exported uranium will facilitate the acquisition or buildup of nuclear weapons. The remaining measures focus on enhancing and protecting biodiversity in Saskatchewan, as well as on addressing other environmental concerns.

## Solar Energy Potential in Canada

Source: Natural Resources Canada. Refer to: [https://glfc.cfsnet.nfis.org/Map\\_server/pv/rank.php?lang=e](https://glfc.cfsnet.nfis.org/Map_server/pv/rank.php?lang=e)



**RANKINGS:**  
# 1 Regina, SK.  
# 2 Wild Horse, AB.  
#3 Waskada, MB.

**Saskatchewan Vs. Germany**  
Yearly Solar PV Potential  
Regina – 1,361 kWh per kw  
Bonn – 848 kWh per kw

Authors comment: Saskatchewan ranks #1 in Canada for its solar resource and its potential use of solar energy. Yet it is Ontario, through good public policy, that has become Canada's undisputed leader in solar electric installations. At the global level, Germany, with a much poorer solar resource than Saskatchewan, is a world leader in solar energy development because it has put solid public policies in place.

1. Saskatchewan residents could consciously choose to build a renewable energy future for the province over the next 30 years. Saskatchewan is fortunate to have the mix of wind, solar, biomass, hydro and geothermal resources necessary to achieve this goal. Accomplishing it, would set an important example for Canada and the rest of the world to follow.

The feasibility of obtaining a large portion of humanity's energy needs through renewable sources of energy is receiving growing support from the Intergovernmental Panel on Climate Change and from many prominent economists and energy experts. For instance, a special 2012 report on renewable energy and climate mitigation by IPCC documents a representative scenario in which 77% of the world's primary energy demand could be met using renewable energy by 2050.<sup>147</sup> Given Saskatchewan's relatively low population and excellent renewable energy resource potential, achieving that goal in our province should be doable, if the correct policies are deployed. Also facilitating achievement of this goal, is the fact that solar photovoltaic module costs and wind turbine costs have been steadily falling over the past decade.<sup>148</sup>

2. To help build a renewable energy future in the electricity sector, Saskatchewan could follow the lead of Ontario, Nova Scotia and many other parts of the world by introducing feed-in-tariffs to incent wind power, solar power, small scale hydro, geothermal energy, and electricity generation using biomass. Under a feed-in-tariff policy, homeowners, businesses, farmers and those who install renewable electricity facilities at the community level would receive a price for the electricity they produce that reflects the actual installation costs of each renewable energy technology. The success of this policy in

many other nations suggests that feed-in-tariffs would lead to a huge expansion of low carbon, renewable electricity generation in Saskatchewan. Feed-in tariffs are now in effect in more than 70 countries.<sup>149</sup>

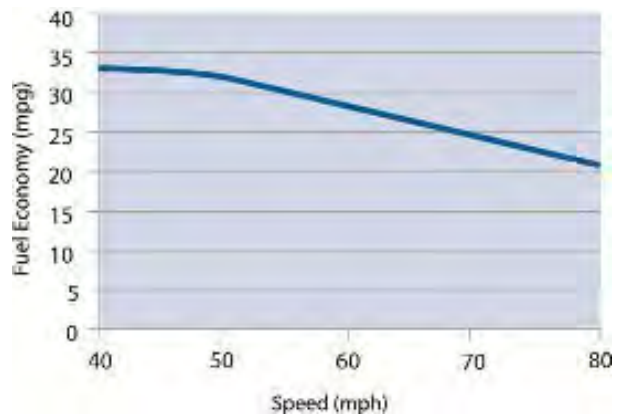
3. SaskPower could phase-out conventional coal-fired power plants over the next 10 years. Conventional coal could be replaced with a mix of Saskatchewan-based renewable electricity options, an aggressive program of electricity efficiency, hydro imports from Manitoba, and co-generation of electricity using natural gas already being burned at our potash mines for industrial heat purposes. The feasibility of meeting a large portion of Saskatchewan's electricity needs through renewable sources of energy is illustrated by the German experience. In a geographical area half the size of Saskatchewan, and with a wind, solar and biomass resource not nearly as impressive as Saskatchewan's, Germany met 27% of its electricity needs through renewable sources of energy (excluding hydro) in the first half of 2014. Solar and wind power alone delivered 17% of power needs for the country of 80 million people. Biomass accounted for 10% of power needs.<sup>150</sup> Germany plans to get 50% of its power from renewable energy by 2030.<sup>151</sup>
4. The Saskatchewan government could introduce strict regulations that sharply reduce venting and flaring practices during oil and gas extraction, except where release is required for clearly defined safety reasons. In addition to new regulatory requirements, oil and gas companies could be encouraged to install micro-turbines that make use of natural gas that would otherwise be vented or flared. These turbines would produce electricity that can be sold to SaskPower, and that can be used during the transition off coal and to renewable sources of electricity generation.

Verification that substantial progress could be made in Saskatchewan to prevent methane release when oil and gas are being extracted is provided by President Obama's announcement in January 2015 that he will use his executive authority to move forward with new US Environmental Protection Agency regulations on this front. The proposed new regulations will be designed to curb methane leaks from oil and gas wells, as well as from pipelines and valves. They will apply to new or modified oil and gas systems. The aim is to cut methane emissions from oil and gas production in the United States by 45% by 2025 from the recorded levels in calendar year 2012.<sup>152</sup>

5. The Saskatchewan government could disallow the construction and operation of oil sands facilities in our province. Rejecting oil sands development would send a clear statement that it is time to stop extracting our most carbon-intensive fossil fuels from the ground.
6. SaskPower could bring industrial rates for electricity up much closer to the level that farm and residential customers currently pay. This would incent electricity efficiency practices by large industry.<sup>153</sup>
7. The Saskatchewan government could reduce speed limits in our province to 90 kilometres an hour. This would be an important gasoline saving measure (see graph below) and would immediately lead to urgently needed reductions in carbon dioxide emissions in Saskatchewan's transport sector.<sup>154</sup> Most important of all, such a policy measure

would have the added benefit of reducing the number of highway accidents in Saskatchewan, saving lives and lessening the extent of injuries. For our population size, Saskatchewan's loss of life from motor vehicle accidents is more than double the national average.<sup>y</sup>

#### Rate at Which Fuel Economy Declines as Highway Speed Increases



Source: US Department of Energy: [www.fueleconomy.gov/feg/driveHabits.jsp#speed-limit](http://www.fueleconomy.gov/feg/driveHabits.jsp#speed-limit)

Authors Note: There are variations in the speed at which different vehicles reach optimum fuel economy, but in general, gasoline mileage declines significantly at vehicle speeds over 50 miles per hour. The result is a corresponding increase in greenhouse gas emissions. For simple mph to kilometers conversion, 90 km per hour is approximately 55.9 miles per hour; 110 km per hour is approximately 68.4 miles per hour.

8. The Saskatchewan government could work in conjunction with wholesalers, retailers and rail companies to shift transportation of a large number of goods away from truck and back to rail. Rail is a far more energy efficient

<sup>y</sup> Canadian Motor Vehicle Traffic Collision Statistics 2012, Transport Canada, 2014. In 2012 Saskatchewan had 16.8 fatalities per 100,000 people. In contrast, Manitoba had 7.7 per 100,000. The national average was 6 fatalities per 100,000. [www.tc.gc.ca/media/documents/roadsafety/cmvtcs2012\\_eng.pdf](http://www.tc.gc.ca/media/documents/roadsafety/cmvtcs2012_eng.pdf)

In 2012 there were 184 deaths and 7,305 injuries from traffic accidents in Saskatchewan. By comparison there were 167 deaths, and 6,518 injuries in 2010. For further detail refer to "2012 Saskatchewan Traffic Accident Facts" and "2010 Saskatchewan Traffic Accidents Facts" published by Saskatchewan Government Insurance. ([www.sgi.sk.ca/pdf/tais/TAIS\\_2012\\_Annual\\_Report](http://www.sgi.sk.ca/pdf/tais/TAIS_2012_Annual_Report))

means of transport than truck, and investing in a revitalized rail system would have major economic, social and environmental value. By reducing the number of heavy vehicles on our highway system, it would also help reduce the cost of repairs to roads and bridges.

9. The Government of Saskatchewan could provide targeted financial assistance to municipalities to improve urban transit services in our cities, and to install an extensive system of bike paths in each urban municipality. The Province should in general encourage a shift from use of private vehicles to use of public transportation and bicycling.
10. The Saskatchewan government could incent the purchase and use of highly energy-efficient vehicles by Saskatchewan residents, including hybrid cars, and electric cars powered by renewable electricity sources.
11. Many actions could be encouraged at the municipal level. For example, cities like Saskatoon, Regina, Moose Jaw and Prince Albert could set ambitious greenhouse gas reduction targets. They could adopt a more stringent energy efficiency code at the municipal level for new building construction, place restrictions on the idling of vehicles, improve the frequency and convenience of urban transit services, and encourage cycling by investing in a system of dedicated bike lanes. They could also encourage solar energy development in existing neighborhoods and new subdivisions, and could encourage the formation of renewable energy co-operatives.
12. The Saskatchewan government could introduce far better provisions for energy efficiency in the provincial building code. For example, all new home construction could be required to be done at a minimum of ENERGY STAR® (R80), and financial incentives could be put in place to encourage the building of net zero energy homes. The Province could also introduce provisions for efficient use of water into the provincial building code.
13. Saskatchewan could follow British Columbia's lead and introduce a revenue neutral carbon tax to encourage an immediate shift away from consumption of fossil fuels, particularly coal and oil (which are the most carbon intensive fossil fuels). An evaluation of the implementation of the first four years of BC's carbon tax (July 1, 2008 and July 1, 2012), suggests it was an effective tool for emission reduction.<sup>155</sup>
14. The Saskatchewan government could require the largest industrial customers in the province to meet their new (i.e.: additional) long term electricity requirements solely through low-carbon sources of electricity that they pay SaskPower for in full. Such a policy would be a major departure from current practice, and should be focused on the 100 largest companies that account for 40% of total electricity consumption in Saskatchewan.<sup>156</sup> The expanding need for electricity on the part of these companies is currently driving a large part of the growth of fossil fuel electrical generation capacity in Saskatchewan, and is currently being subsidized by all other SaskPower ratepayers, since the cost of expanding our power supply exceeds the costs industrial customers are currently paying. This is markedly the case when environmental damage is factored in.

15. The Saskatchewan government could give its Ministry of Environment's Climate Change Unit an adequate budget for implementing a major greenhouse gas reduction initiative, and properly monitoring greenhouse gas emissions in Saskatchewan. The Saskatchewan Ministry of Environment cannot mount an adequate greenhouse gas reduction initiative on its current budget. That declining budget was \$5,434,000 in fiscal year 2012, and was reduced to \$4,347,000 in fiscal year 2013, and further reduced to \$2,815,000 in the 2014 fiscal year.<sup>157</sup>
16. The Saskatchewan government could enter into amended surface lease agreements with every existing uranium mining company in Saskatchewan, in which the mining companies would be specifically obligated never to sell uranium to countries that have not signed and ratified the Treaty on the Non-Proliferation of Nuclear Weapons and the Comprehensive Test Ban Treaty.
17. Using the surface lease mechanism with existing uranium mines discussed above, the Government of Saskatchewan could implement a policy aimed at non-renewal of uranium supply contracts to nuclear reactor operators that ship high-level nuclear waste to reprocessing facilities for the purposes of plutonium production. In effect, nuclear material of Saskatchewan origin would no longer be allowed to be used for the purpose of extracting plutonium. The stockpiling of plutonium for use in civilian nuclear power plants poses very significant long term risks. This fuel is pure atomic weapons-grade material that requires exceptional security. A country that currently possesses a civilian stockpile of plutonium could move quickly to possess atomic weapons, if a future government in that country chose to do so.
18. The Province of Saskatchewan could double the size of the Representative Areas Network by increasing designated land areas from 9% of Saskatchewan's land area to 17%. In doing so, Saskatchewan would comply with the United Nations target for protected land areas in each member country. This objective could be achieved over the course of the next eight years, and could be carried out in consultation with affected First Nations and Métis governments, municipal governments, and a wide array of community and not-for-profit groups. Protection of remaining native prairie, such as biodiversity hot spots in the Great Sand Hills, could be one important dimension of this initiative. Another could be the designation of a Representative Area in the Cumberland Delta and along a portion of the Churchill River.
19. The Saskatchewan government could maintain public ownership of community pastures, and manage the pastures in a coordinated manner that protects endangered species and maximizes long term environmental stewardship.
20. The Saskatchewan government could encourage increased planting of shelterbelts to protect biodiversity and increase uptake of carbon dioxide from the atmosphere. One vehicle for accomplishing this would be for the provincial government to take over operations of Saskatchewan's tree nursery at Indian Head (the Agroforestry Development Centre) that the federal government recently eliminated funding for.<sup>158</sup>

21. The provincial government could encourage land use planning aimed at enhancing ecosystem services across Saskatchewan and maximizing carbon sequestration. Examples of specific measures that might be taken include restoration of wetlands, encouraging more moderate grazing practices on grasslands to maximize their carbon sequestration capacity,<sup>z</sup> a local tree planting initiative, and enhanced efforts to replant forests that have been logged.
22. The Saskatchewan government could follow the lead of the state of Oregon and work closely with municipalities to jointly develop urban growth boundaries around Saskatchewan's larger communities.<sup>159</sup> Beyond urban growth boundaries, major limits could be placed on the subdivision of land. Such a strategy would be intended to preserve agricultural land and important natural areas. It would be an important way of reducing urban sprawl, and containing and directing population growth in ways that minimize its net environmental footprint.
23. Saskatchewan cities could adopt bylaws disallowing the cosmetic use of pesticides. The Government of Saskatchewan could introduce legislation to achieve the same objective province-wide. This would reduce risks to public health and protect pollinators in urban settings.
24. The Saskatchewan government could set more stringent standards to protect water quality in our province. For example, the Saskatchewan Surface Water Quality Guidelines could be given the force of official regulations. This would immediately require mining companies to improve their effluent treatment, and their management of waste rock piles and tailings facilities.
25. The Saskatchewan government could reject industrial proposals such as the proposed Fortune Minerals plant near Langham, Saskatchewan as a way of sending a clear signal that unacceptable risks to Saskatchewan's water resources will not be tolerated.
26. The Saskatchewan government could encourage expanded vegetable production in the province. Saskatchewan currently imports \$26 million of vegetables annually, excluding potatoes, underlining the fact that there is significant opportunity for expansion of local production.<sup>160</sup>
27. The Saskatchewan government could support municipalities that wish to encourage local ownership and local production. This would include such measures as supporting a local farmers market or launching a co-operatively owned renewable power installation.
28. Not-for-profit organizations, municipal governments and the Saskatchewan government could promote a culture of consuming less. Consumption of more goods is almost always associated with a larger environmental footprint, whereas less province-

<sup>z</sup> Presentation by Diego Steinaker, a member of the Biology Department at the University of Regina to the Saskatchewan Citizen Hearings on Climate Change, November 1, 2013. Diego Steinaker has demonstrated that policies that promote grasslands health in turn result in large improvements in the ability of grasslands to hold carbon that would otherwise be released into the atmosphere. For instance, by moving from heavy grazing on grasslands to lighter grazing, 20% more carbon can be sequestered by plant roots. For further details refer to: *Saskatchewan Citizens' Hearings on Climate Change Final Report*, Peter Prebble, Maria Campbell, Harry Lafond, Marcia McKenzie, Willard Metzger, Darrin Qualman, Davida Bentham, Mark Bigland-Pritchard, Matt Dow, Sarina Gersher, Bonnie Lawrence, Julie Maxwell, Rick Morrell, Janelle Pewapsonias, Karen Rooney, Rasheed Soomro, Jonathan Stockdale and Megan Van Buskirk (eds.), Saskatoon, Saskatchewan, Canada, 2014, pages 37-38. <http://skclimatehearings.files.wordpress.com/2014/04/chapter-9.pdf>

wide consumption would translate into a lower carbon footprint, less pressure on our landfills, and less impact on ecosystems at home and around the world.

29. In conjunction with promoting less consumption, the above mentioned institutions could press the Government of Canada to set extensive quality standards for the production of consumer goods with the view to extending their lifetime and usage. We need to focus on manufacturing high quality goods that, on average, will last far longer than today's consumer products. To the greatest degree possible, such quality

standards need to be applied to imported goods as well, although free trade provisions are likely to make this challenging.

30. To lead by example, every department of the Government of Saskatchewan could be formally mandated to integrate environmental sustainability into their purchasing policies, their contracts, and their travel practices. The Crown Investments Corporation could be mandated by the Government of Saskatchewan to take a major leadership role in promoting investment in environmentally sustainable forms of economic development.

## Conclusion

In conclusion, Saskatchewan urgently needs to rethink its economic future, which at present is making a worrisome contribution to climate change, ocean acidification, and nuclear weapons proliferation. Saskatchewan also needs to take additional measures to preserve local ecosystems and prevent further biodiversity loss.

Saskatchewan's government should seek to build a carbon-free economy and an environmentally

sustainable economy, that works to advance the collective good of all Saskatchewan residents and all with whom we share this planet. Our long term goal should be a steady-state economy that provides a high quality of life for everyone, while relying on reduced energy and material flows, as well as an economy that recognizes our dependence on nature and seeks to be in harmony with it.

# Endnotes

- 1 *Canada's 2014 United Nations Framework Convention on Climate Change (UNFCCC) Submission – National Inventory Report 1990-2012, Part 3, Table A11-16 and Table A11-17, pages 29-30. Table A11-16 is entitled: “1990-2012 GHG Emission Summary for Saskatchewan”. Table A-11-17 is entitled “2012 GHG Emission Summary for Saskatchewan”.*

Saskatchewan’s annual human-induced greenhouse gas emissions in 2012 were 74.8 million tonnes (carbon dioxide equivalent). Of this 45.6 million tonnes were carbon dioxide, 19 million tonnes were methane and 9.8 million tonnes were nitrous oxide.
- 2 *Canada's 2014 United Nations Framework Convention on Climate Change (UNFCCC) Submission – National Inventory Report 1990-2012. Canada's per capita greenhouse gas emissions in 2012 were 20.1 tonnes. Saskatchewan's per capita emissions were approximately 67 tonnes.*

Global emissions are approximately 7 tonnes per capita. Global anthropogenic emissions in 2010 totaled 49 billion tonnes carbon dioxide equivalent. World population in 2010 totaled approximately 6.9 billion. For the 2010 global GHG emission total refer to: *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 5. For the world population figures in 2010 refer to: World Population Data Sheet at: [www.prb.org/Publications/Datasheets/2010/2010wpds.aspx](http://www.prb.org/Publications/Datasheets/2010/2010wpds.aspx)
- 3 National Oceanic and Atmospheric Administration, Global Analysis – Annual 2014, [www.ncdc.noaa.gov/sotc/global/2014/13](http://www.ncdc.noaa.gov/sotc/global/2014/13)
- 4 *The Global Climate 2001-2010: A Decade of Climate Extremes*, World Meteorological Organization, 2013, pages 2 and 3.

World Meteorological Organization Press Release 976 [www.wmo.int/pages/mediacentre/press\\_releases/pr\\_976\\_en.html](http://www.wmo.int/pages/mediacentre/press_releases/pr_976_en.html)
- 5 National Oceanic and Atmospheric Administration, National Climatic Data Center, State of the Climate: Global Analysis for December 2014, [www.ncdc.noaa.gov/sotc/global/2014/12](http://www.ncdc.noaa.gov/sotc/global/2014/12) and NOAA Global Analysis – Annual 2014, <http://www.ncdc.noaa.gov/sotc/global/2014/13> NOAA reports that the average combined global land and ocean average surface temperature for January-December of 2014 was 0.69°C above the 20th century average of 13.9 degrees Centigrade. Nine of the ten warmest years in the 135 years that global records have been kept have been in the 21st century. It is significant that in the record warm months of 2014, unlike previous record high periods since the turn of the century, there has not been a sustained signal of an El Nino cycle at work. The last time an annual global temperature record was exceeded with no warm-phase El Nino conditions in effect was 1990.
- 6 *IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 1.1.
- 7 *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 5. [http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5\\_SPM\\_FINAL.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf)
- 8 *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 30-32. [http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5\\_SPM\\_FINAL.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf)
- 9 *IPCC, 2013: 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, G.K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)), Cambridge University Press, Cambridge, UK and New York, USA, page 211 and 213.
- 10 NOAA Arctic Report Card 2013, Figure 20, [www.arctic.noaa.gov/reportcard/sea\\_ice.html](http://www.arctic.noaa.gov/reportcard/sea_ice.html) Figure 20. <http://nsidc.org/arcticseaicenews/2014/09/> Refer to Table 1 titled: ‘Previous Minimum Arctic Sea Ice Extents’
- 11 “Rising air and sea temperatures continue to trigger changes in the Arctic: Arctic is warming at twice the rate of anywhere else on Earth”, National Oceanic and Atmospheric Administration news release, December 17, 2014.
- 12 *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*, *ibid*, page 9. Refer to section B.3 entitled ‘Cryosphere’.



- 13 "More of Greenland is starting to melt", *Nature*, Vol. 507, March 20, 2014, page 277.
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- 15 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*, *ibid*, page 9.
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- 19 Warren, F.J. and Lemmen, D.S. (2014): Synthesis; in *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, (eds.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, Ontario, p. 1-18. Figure 4: Map of Mountain Pine Beetle distribution, showing change for the 2002–2006 and 2007–2011 time periods and direction of change (*Natural Resources Canada*).
- 20 World Health Organization web site, [www.who.int/heli/risks/climate/climatechange/en/](http://www.who.int/heli/risks/climate/climatechange/en/)
- 21 Berry, P., Clarke, K., Fleury, M.D. and Parker, S. (2014): Human Health; in *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, (eds.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, Ontario, p. 201. Natural Resources Canada reports there were 315 cases of Lyme disease in Canada in 2012, and that number is expected to rise substantially.
- 22 United States NOAA National Climatic Data Centre, *National Overview – Annual 2012*, [www.ncdc.noaa.gov/sotc/national/2012/13](http://www.ncdc.noaa.gov/sotc/national/2012/13) US weather records have been kept since 1895.
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- "Superstorm's swath: America's East Coast is still recovering six months after Sandy swept through", Associated Press, *The Star Phoenix*, May 5, 2013. The article reports that 72 deaths were directly attributed to Hurricane Sandy and 87 more were indirectly attributed from causes such as hypothermia due to power outages, carbon monoxide poisoning and accidents during cleanup efforts. The article also reports that six months after the storm, in New Jersey alone, 39,000 families remained displaced.
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- 26 "Haiyan prompts risk research", *Nature*, Vol. 503, November 21, 2013, page 324.
- 27 *The Guardian*, December 5, 2012 and February 17, 2013.
- "Filipino super-typhoon an ominous warning of climate change impact", *The Guardian*, Feb 17, 2013.

- 28 *Climate Council Seasonal Update: Abnormal Autumn* by Will Steffen, June 2, 2014. [www.climatecouncil.org.au/abnormalautumn](http://www.climatecouncil.org.au/abnormalautumn) This is the web site of Australia's Climate Council.
- 29 "Australian heat wave nears 50 degrees Centigrade inland as severe fire threat declared", *The Guardian*, January 10, 2013.
- 30 "California declares drought emergency: 2013 was driest year on record". *Reuters*, January 18, 2014.  
<http://local.msn.com/why-californias-drought-isnt-going-anywhere>; and "California officials prepare for worst as historic drought deepens wildfire risk" *The Guardian*, March 19, 2014; and US Drought Monitor, April 8, 2014.
- As of April 2014, nearly 70% of California was suffering from an "extreme" or "exceptional" drought. The snowpack across the entire state was at only 35% of its normal level. One indication of the trend that is developing is that half of the worst fires in California's recorded history have occurred since 2002.
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- "California drought linked to humans", *Nature*, Vol. 509, May 1, 2014, page 10.
- 31 "Drought impact study: California agriculture faces greatest water loss ever seen", University of California (Davis), July 15, 2014, [http://news.ucdavis.edu/search/news\\_detail.lasso?id=10978](http://news.ucdavis.edu/search/news_detail.lasso?id=10978)
- 32 <http://droughtmonitor.unl.edu/> November 25, 2014.  
 Note: Rains in December 2014 slimmed the drought coverage area slightly from that depicted on November 25th. By December 28, 2014 California's range and pastures were rated 70% poor to fair by the United States Department of Agriculture, up slightly from 65% on November 23rd. Winter wheat growing conditions improved, but by the end of December 2014 the high elevation Sierra Nevada snowpack had only half its normal amount of water for this time of year. (US Drought Monitor: 'National Drought Summary for December 30, 2014)
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[www.metoffice.gov.uk/news/releases/archive/2013/2012-weather-statistics](http://www.metoffice.gov.uk/news/releases/archive/2013/2012-weather-statistics)  
[www.metoffice.gov.uk/news/releases/archive/2014/early-winter-stats](http://www.metoffice.gov.uk/news/releases/archive/2014/early-winter-stats) United Kingdom Met Office rainfall figures from December 1, 2013 to February 25, 2014 confirm the UK had its wettest winter since national series records began to be kept in 1910.
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<http://alberta.ca/Flood-2013-commemoration.cfm>
- 35 "German flood waters reach 500-year high", *The Associated Press*, June 4, 2013.  
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 Map showing total rainfall in India, Nepal and Neighbouring Countries in the Week of June 14 to June 20, 2013, <http://earthobservatory.nasa.gov/IOTD/view.php?id=81450> and National Oceanic and Atmospheric Administration.
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 "Floods spur mountain study: Himalayan nations take action in response to changing climate and its deadly effects" by Jane Qiu, *Nature*, Vol 501, September 5, 2013, page 14. The article notes that rainfall in the Himalayas is increasing at a rate of 65 millimetres per decade.  
 National Oceanic and Atmospheric Administration, [www.ncdc.noaa.gov/sotc/service/global/extremes/201306.gif](http://www.ncdc.noaa.gov/sotc/service/global/extremes/201306.gif) Refer to world map entitled: "Selected Significant Climate Anomalies and Events June 2013". The map's description of the June flooding in India and Nepal is as follows: "Northern

- India's states and Nepal experienced heavy rains that triggered floods and landslides due to the monsoon. Over 5,000 people were killed in India, with nearly 40 people killed in Nepal."
- 37 "National Guard evacuating Colorado town: About 1,600 people in remote town of Lyons, north of Boulder, rescued from metre-deep flood waters", *The Globe and Mail*, September 14, 2013.
- "Rain slows rescue efforts amid deadly Colorado floods" by David Simpson, Nick Valecia and Emma Lacey-Bordeau, CNN, September 16, 2013.
- "Perilous floods prompt tens of thousands to scramble in Russia's Far East", CNN, August 18, 2013.
- 38 "Manitoba declares flood emergency", *The Saskatoon Star Phoenix*, July 5, 2014.
- "Water rising at Round Lake", *The Saskatoon Star Phoenix*, July 5, 2014. The article notes that as of Friday July 4, 2014, 75 Saskatchewan communities were under local emergency declarations.
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- "Carnduff and area helping out flood evacuees", *Regina Leader Post*, July 1, 2014.
- "Prairie flooding prompts evacuations in western Manitoba", CBC, July 1, 2014.
- "Climate calamity: More prolonged storms a reality, researcher say", *The Star Phoenix*, July 8, 2014, p. A1 and A4.
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- 42 *IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 2.3.
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- 45 *IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 2.3.
- 46 "All in the timing", *Nature*, Vol. 493, January 2013, p.35.
- "Probalistic cost estimates for climate change mitigation" by Joeri Rogelj, David McCollum, Andy Reisinger, Malte Meinshausen and Keywan Riahi, *Nature*, Vol. 493, ibid, pp. 79-83.
- 47 *Canada's 2014 UNFCCC Submission – National Inventory Report 1990-2012, Part 3*, page 30, Table A11-17. The table is entitled "2012 GHG Emission Summary for Saskatchewan". The table breaks Saskatchewan GHG emission sources down by the category of greenhouse gas being emitted.
- 48 *IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 1.2. IPCC notes that 30% of the manmade carbon dioxide emissions released to the atmosphere between 1750 and 2011 have been absorbed by the oceans.
- Note: Anthropogenic (manmade) ocean acidification is sometimes treated as one of the consequences of global climate change. Here we treat it as a closely related but distinct issue, since it is not caused by the buildup of heat in the climate system, but rather is a problem specifically related to too much carbon dioxide being transferred from the atmosphere to the ocean. The process of more and more carbon dioxide being taken up by the oceans changes the chemical balance of sea water. Over many decades it causes a drop in the pH of sea water.
- Like climate change, anthropogenic ocean acidification is caused by human activity—specifically deforestation and the burning of fossil fuels. The portion of sea water pH reduction attributed to these activities is anthropogenic ocean acidification.
- 49 *IPCC, 2014: Summary for Policy Makers, in Climate Change 2014: Synthesis Report*, (eds: Rajendra K. Pachauri, Chair; Leo Meyer, Head of Technical Support, and the Core Writing Team), November 1, 2014. Refer to section 1.2.

- 50 *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*, *ibid*, page 12. Refer to section B.5 entitled 'Carbon and Other Biogeochemical Cycles'. The pH scale is logarithmic. Thus a change of one unit (for example: from a pH of 8.0 to 7.0) represents a 10-fold change in acidity.
- 51 *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 6, page 22. [http://ipcc-wg2.gov/AR5/images/uploads/WGIAR5-Chap6\\_FGDall.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WGIAR5-Chap6_FGDall.pdf)
- 52 *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 17. ([http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5\\_SPM\\_FINAL.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf)) IPCC states: "For medium- to high-emission scenarios, ... ocean acidification poses substantial risks to marine ecosystems, especially polar ecosystems and coral reefs ..."
- 53 *Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Chapter 3: 'Observations: Ocean', page 297. The Fifth Assessment notes that "average surface pH could be 0.2 to 0.4 lower than it is today".
- 54 *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 6. Refer to section 6.1.2.2 entitled 'Paleontological Records'. IPCC states: "The key environmental issue of the 21st century is one of an unprecedented rate of change, not simply magnitude of CO<sub>2</sub> levels (Hönisch et al., 2012). The current rate and magnitude of ocean acidification are at least 10 times faster than any event within the last 65 Ma." [http://ipcc-wg2.gov/AR5/images/uploads/WGIAR5-Chap6\\_FGDall.pdf](http://ipcc-wg2.gov/AR5/images/uploads/WGIAR5-Chap6_FGDall.pdf)
- 55 "Scallops, too, are victims of greenhouse gas emissions: Hidden side to ongoing CO<sub>2</sub> emissions biting us, too" by Tom Pedersen, *Vancouver Sun*, January 18, 2013. Tom Pedersen is executive director of the Pacific Institute for Climate Solutions at the University of Victoria and a Professor of Marine Geochemistry in the School of Earth and Ocean Sciences at the University of Victoria.
- National Oceanic and Atmospheric Administration, <http://pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F> NOAA notes: "When carbon dioxide (CO<sub>2</sub>) is absorbed by seawater, chemical reactions occur that reduce seawater pH, carbonate ion concentration, and saturation states of biologically important calcium carbonate minerals".
- 56 "An Overview of Canada's Changing Climate", Bush, E.J., Loder, J.W., James, T.S., Mortsch, L.D. and Cohen, S.J. (2014), in *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, Ontario, p. 52.
- 57 "Scallops, too, are victims of greenhouse gas emissions: Hidden side to ongoing CO<sub>2</sub> emissions biting us, too" by Tom Pederson, *Vancouver Sun*, January 18, 2013.
- "Pacific Ocean acid levels jeopardizing marine life", *CBC News*, July 17, 2012. Refer to section entitled: 'Lessons from a scallop farm'.
- 58 *Consensus Statement on Climate Change and Coral Reefs* released at the 12th International Coral Reef Symposium, July 9-13, 2012. [www.icrs2012.com/Consensus\\_Statement.htm](http://www.icrs2012.com/Consensus_Statement.htm)
- 59 "Rising acidity of oceans a major threat to coral reefs: NOAA scientists sound alarm about CO<sub>2</sub> effect on oceans at Australia reef conference", *The Associated Press*, July 9, 2012.
- 60 Total annual global anthropogenic emissions were approximately 49,000,000,000 tonnes in 2010. (*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 5.) As reported earlier, Saskatchewan's total anthropogenic greenhouse gas emissions totaled 74,800,000 tonnes in 2012, the latest year for which data is available.
- 61 Saskatchewan's population was 1,117,503 on January 1, 2014. Government of Saskatchewan, Bureau of Statistics. [www.stats.gov.sk.ca/](http://www.stats.gov.sk.ca/) The global population was approximately 7,137,577,750 on January 1, 2014. [www.census.gov/newsroom/releases/archives/population/cb13-tps112.html](http://www.census.gov/newsroom/releases/archives/population/cb13-tps112.html)
- 62 *The Economics of Climate Change: The Stern Review*, Nicholas Stern, 2007. Refer to Chapter 8 entitled 'The Challenge of Stabilization', particularly sections dealing with a stabilization scenario for 450ppm CO<sub>2</sub> eq.
- Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 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*, page 9 and page 11.
- 63 *Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Chapter 12, page 1114. Refer to Figure 12.46(a).

- 64 This figure has been calculated by dividing the latest publicly available numbers for Saskatchewan's total emissions (74,800,000 tonnes) by Saskatchewan's population as of January 1, 2014 (1,117,503).
- 65 Collins, M., R. Knutti, J. Arblaster, J.-L. Dufresne, T. Fichet, P. Friedlingstein, X. Gao, W.J. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A.J. Weaver and M. Wehner, 2013: Long-term Climate Change: Projections, Commitments and Irreversibility. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Figure 12.46, page 1114.
- 66 IPCC 2013: Summary for Policy Makers, in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, page 27.
- 67 IPCC 2013: Summary for Policy Makers, in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, page 12. Numbers cited for carbon emitted by fossil fuel combustion, cement production and anthropogenic land use change were multiplied by 3.667 to obtain a Gt figure for annual global carbon dioxide release.  
<http://co2now.org/Current-CO2/CO2-Now/global-carbon-emissions.htm> In 2013, global carbon dioxide emissions due to fossil fuel use (and cement production) were 36 gigatonnes (GtCO<sub>2</sub>); this was 61% higher than 1990 (the Kyoto Protocol reference year) and 2.3% higher than 2012. In addition, there are significant annual global emissions of carbon dioxide associated with deforestation and other land use changes that are in the range of 3.3 gigatonnes. (Refer to IPCC 2013, *ibid*, p. 12)
- 68 *Ibid*.
- 69 [www.wmo.int/pages/mediacentre/press\\_releases/documents/1002\\_GHG\\_Bulletin.pdf](http://www.wmo.int/pages/mediacentre/press_releases/documents/1002_GHG_Bulletin.pdf) WMO Greenhouse Gas Bulletin, No. 10, September 9, 2014. The atmospheric increase for carbon dioxide alone between 2012 and 2013 was 2.9 parts per million, the biggest annual increase since 1984. The annual CO<sub>2</sub>e increase was at least 3ppm given that methane's atmospheric concentration rose 6 parts per billion between 2012 and 2013, and nitrous oxide's atmospheric concentration rose 0.8 parts per billion during the year.
- 70 In fact, this perspective suggests fossil fuel phase-out by 2070 may not be soon enough. 2050 or 2055 may be a more necessary target. Alternatively, actual negative emissions may have to be achieved later in the century.
- 71 IPCC, 2013: *Climate Change 2013: The Physical Science Basis: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (TF Stocker, D. Qin, G-K Plattner, M. Tignor, S.K. Allen, J. Boschung, A Nauels, Y Xia, V. Bex and P.M. Midgley (eds), Cambridge University Press, United Kingdom and New York, USA. Refer to FAQ 12.3: What would happen to future climate if we stopped emissions today?, page 1106.
- 72 *Ibid*, page 1106-1107. The authors note that "if concentration of greenhouse gases (in the atmosphere) were held constant at present day level, the Earth surface would still continue to warm by about 0.6°C over the 21st century relative to the year 2000." This is the climate effect of current concentrations in the atmosphere.  
Also refer to: Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007: Global Climate Projections. 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* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. See section entitled: 'If emissions of greenhouse gases are reduced, how quickly do their concentrations in the atmosphere decrease', page 824 and 825.
- 73 *Canada's 2014 UNFCCC Submission – National Inventory Report 1990-2012, Part 3*, page 30, Table A11-17. The table is entitled "2012 GHG Emission Summary for Saskatchewan". Fugitive emissions from Saskatchewan's oil and gas patch accounted for 16 million tonnes of greenhouse gas emissions in 2012 (expressed as carbon dioxide equivalent).  
Flaring is the controlled burning off of natural gas—produced in association with oil—into the atmosphere. Venting is the controlled direct release of unburned gases in natural gas into the atmosphere. These practices are often done in oil drilling areas that do not have connections to pipelines, and in situations where today's natural gas prices make conservation of the gas economically unattractive. In circumstances where the infrastructure has not been put in place to ensure the natural gas that has been extracted from the ground can be stored or used commercially, safety issues arise, which venting and flaring are intended to overcome. It is clearly imperative to get appropriate infrastructure in place to utilize the natural gas.
- 74 *Canada's 2014 UNFCCC Submission – National Inventory Report 1990-2012, Part 3*, page 30, Table A11-17. The table is entitled "2012 GHG Emission Summary for Saskatchewan". The 15 million tonne figure for methane is expressed as carbon dioxide equivalent.

- IPCC defines fugitive emissions as the intentional or unintentional release of greenhouse gases that may occur during the extraction, processing and delivery of fossil fuels to the point of final end use. Refer to: [www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2\\_Volume2/V2\\_4\\_Ch4\\_Fugitive\\_Emissions.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf)
- 75 "Recent Greenhouse Gas Concentrations" by T.J. Blasing, February 2014, <http://cdiac.ornl.gov/pns/current.ghg.html> (Carbon Dioxide Information Analysis Centre) DOI: 10.3334/CDIAC/atg.032.
- 76 Government of Saskatchewan web site: [www.environment.gov.sk.ca/Default.aspx?DN=4f1c9a61-5550-4dab-8fac-03795e4fb481](http://www.environment.gov.sk.ca/Default.aspx?DN=4f1c9a61-5550-4dab-8fac-03795e4fb481)
- 77 SaskPower, 2013 Annual Report, page 53. In 2013 coal-fired power generation accounted for 47% of Saskatchewan electricity consumption.
- 78 Environment Canada, "Greenhouse gas emissions from large facilities, Canada, 2012", <http://maps-cartes.ec.gc.ca/indicators-indicateurs/TableView.aspx?ID=1&lang=en#Saskatchewan>
- 79 "SaskPower to launch \$1.4 billion carbon-capture project" by Clare Clancy, The Canadian Press, September 29, 2014.  
"SaskPower launches world's first commercial CCS process", October 2, 2014, [www.saskpower.com/about-us/media-information/news-releases/saskpower-launches-worlds-first-commercial-ccs-process/](http://www.saskpower.com/about-us/media-information/news-releases/saskpower-launches-worlds-first-commercial-ccs-process/)
- 80 "SaskPower launches world's first commercial CCS process", October 2, 2014, [www.saskpower.com/about-us/media-information/news-releases/saskpower-launches-worlds-first-commercial-ccs-process/](http://www.saskpower.com/about-us/media-information/news-releases/saskpower-launches-worlds-first-commercial-ccs-process/)
- 81 *Canada's 2014 United Nations Framework Convention on Climate Change (UNFCCC Submission) – National Inventory Report 1990-2012, Part 3, Table A11-16, page 29. Table A11-16 table is entitled: "1990-2012 GHG Emission Summary for Saskatchewan".*
- 82 *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, ibid, Figure SPM.7, page 21.*
- 83 "Obama's climate change envoy: fossil fuels will have to stay in the ground", *The Guardian*, November 25, 2014.
- 84 Government of Saskatchewan web site <http://economy.gov.sk.ca/OG-Fact->
- 85 Government of Saskatchewan web site <http://economy.gov.sk.ca/OG-Fact-Sheet>
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- 89 Gauthier, D. A., and J. D. Henry, *Misunderstanding the Prairies. In: Endangered Spaces: The Future for Canada's Wilderness*, M. Hummel (ed.) Key Porter Books. Toronto, Ontario, 1989. 288pp.
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- 97 "One-fifth of world's back-boned animals face extinction, study warns", *The Guardian*, UK, October 26, 2010. The article discusses the Evolution Lost report published in the journal *Science* by more than 100 of the world's leading botanists and zoologists.
- 98 "One-fifth of world's back-boned animals face extinction, study warns", *The Guardian*, UK, October 26, 2010.
- 99 "Extinction looms for many mammals", *Nature*, March 14, 2014, Vol. 507, page 143.  
"One in eight bird species threatened with extinction", CBC News, June 20, 2013. CBC discussed a report released by Birdlife International. Birdlife International determined the main culprits to be unsustainable agriculture and climate change.  
"One in five reptile species faces extinction— study: Half of all freshwater turtles close to extinction while three species, including jungle runner lizard, are possibly extinct", *The Guardian*, February 15, 2013.

*The Guardian* reports on a study published by the Zoological Society of London in conjunction with the IUCN species survival commission. The article points out that many reptile species are highly specialized in terms of habitat use and the climatic conditions they require for day to day functioning, making them sensitive to environmental changes.

“Amphibians facing ‘terrifying’ rate of extinction”, *The Guardian*, November 16, 2011. The article reports that amphibians have been hit hard by climate change, habitat loss and the deadly fungal disease chytridiomycosis. It states: “Around half of amphibian species are in decline, while a third are already threatened with extinction.”

- 100 Source: [www.iucnredlist.org/about/summary-statistics](http://www.iucnredlist.org/about/summary-statistics)  
The IUCN Red List of Threatened Species™ is recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species. Species assessed as Critically Endangered (CR), Endangered (EN), or Vulnerable (VU) are all referred to as “threatened” species. Figure 3 provides an overview of proportions of threatened species within each of the more comprehensively assessed groups. IUCN’s web site notes that this Figure “compares data for very different groups of species ranging from ecosystem groups (e.g., reef-forming corals) to whole classes (e.g., mammals, birds)”. The intention “is to present a summary of assessments for groups that have been comprehensively evaluated through the various projects carried out by IUCN ...” IUCN cautions that “although the IUCN Red List gives a good snapshot of the current status of species, it should not be interpreted as a full and complete assessment of the world’s biodiversity. Currently the main gaps in coverage that IUCN and its partners are working on are plants, invertebrates, and freshwater and marine species ...” (Note: The IUCN Red List of Threatened Species™ does not just focus on threatened species; it considers the status of all species across an increasing number of taxonomic groups.)

Canada currently has a total of 88 threatened species on the Red List as of July 2014. Refer to: [http://cmsdocs.s3.amazonaws.com/summarystats/2014\\_2\\_Summary\\_StatsPage\\_Documents/2014\\_2\\_RL\\_Stats\\_Table5.pdf](http://cmsdocs.s3.amazonaws.com/summarystats/2014_2_Summary_StatsPage_Documents/2014_2_RL_Stats_Table5.pdf)

- 101 Canada Community Pasture Program Transition, [www.agriculture.gov.sk.ca/community-pasture-transition](http://www.agriculture.gov.sk.ca/community-pasture-transition) (accessed June 16, 2014).
- 102 “Still at home on the range” by Andrea Hall, *Star Phoenix*, July 26, 2014.
- 103 “Still at home on the range, Andrea Hall, *Star Phoenix*, July 26, 2014.
- 104 “Action needed to save legacy pastures” by Candace Savage, *The Star Phoenix*, May 17, 2012. Candace Savage is also author of *Prairie: A Natural History*.

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“Protected grassland faces uncertain future” by Andrea Hall, *Post Media News*, January 29, 2014.

- 105 *Great Sand Hills Regional Environmental Study, Final Report*, May 2007. The recommendation for the establishment of 35 ecological reserves is discussed on page xxxiv and pages 213-14. A map of the proposed reserve areas can be found on page 200.
- 106 *Great Sand Hills Regional Environmental Study, Final Report*, May 2007, page 14.
- Importantly, northern areas of the Great Sand Hills received protection in 2005 through the establishment of a 36,585 square kilometre Great Sand Hills Ecological Reserve, under the leadership of Saskatchewan Environment Minister David Forbes. (“Province Provides Further Protection for the Great Sand Hills”, April 5, 2005 Government of Saskatchewan news release.) However, ecologically important areas in the southern half of the Great Sand Hills – where natural gas drilling is a major commercial activity – lack such protection.”
- 107 *Great Sand Hills Regional Environmental Study, Final Report*, May 2007. Page 220 discusses the recommendation to limit gas well pad surface leases.
- By way of background, a change of government occurred in Saskatchewan in November 2007, a short time after the Regional Environmental Study recommendations were received.
- 108 Federal, Provincial and Territorial Governments of Canada, *Canadian Biodiversity: Ecosystem Status and Trends 2010*. Canadian Councils of Resource Ministers, Ottawa, Ontario, 142 pp, 2010. For further details, see [www.biodivcanada.ca](http://www.biodivcanada.ca)
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- 110 According to the Government of Saskatchewan web site, the objectives of the Saskatchewan Representative Areas Network Program include :
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  - protection of areas known to contain species at risk;

- c) preservation of areas of high scenic value and unique physical features, such as waterfalls, badlands and sand dunes; and
- d) provision of appropriate recreational, educational and research opportunities” [www.environment.gov.sk.ca/adx/asp/adxGetMedia.aspx?DocID=748,623,247,94,88,Documents&MediaID=321&Filename=RAN+FAQs.pdf&l=English](http://www.environment.gov.sk.ca/adx/asp/adxGetMedia.aspx?DocID=748,623,247,94,88,Documents&MediaID=321&Filename=RAN+FAQs.pdf&l=English)
- 111 “New Ecological Reserve is Saskatchewan’s Largest”, July 4, 2013, Government of Saskatchewan news release.
- 112 “Government of Saskatchewan Proclaims Great Blue Heron Provincial Park”, August 9, 2013, Government of Saskatchewan news release.  
Saskatchewan Representative Areas Network (RAN), Government of Saskatchewan website [www.environment.gov.sk.ca/Default.aspx?DN=f6946bd6-174f-437f-82b9-14bbbee9db8d](http://www.environment.gov.sk.ca/Default.aspx?DN=f6946bd6-174f-437f-82b9-14bbbee9db8d) (accessed May 17, 2014)
- 113 “New Ecological Reserve is Saskatchewan’s Largest”, July 4, 2013, Government of Saskatchewan news release.  
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- 114 “Why biodiversity loss and climate change are equal threats”, Robert Bloomfield, *The Guardian*, December 26, 2010. Dr. Bloomfield served as UK coordinator for the International Year of Biodiversity.
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- 118 *The Encyclopedia of Saskatchewan* (2005), Entry entitled ‘Uranium City’. [http://esask.uregina.ca/entry/uranium\\_city.html](http://esask.uregina.ca/entry/uranium_city.html)
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- “SMDC Offers Share of Land to South Korea”, *Regina Leader Post*, May 13, 1983.
- Not Man Apart*, The Journal of Friends of the Earth, Volume 10, Number 7, July 1980, pages 10 and 11.
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- 120 *Report of the Joint Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan* (Don Lee, Chair, James Archibald, John Dantouze, Richard Neal, Annalee Yassi), October 1993, page 26.
- 121 “PM Relaxes Accountability Rules for China’s Use of Uranium”, *Globe and Mail*, February 10, 2012. The article states that “the deal with Beijing has raised concerns in Ottawa, because it includes less stringent accounts for how the uranium is used than Canada typically demands, sources say. When Australia made a similar deal with China in 2008 that included less accountability, it faced criticism from other uranium suppliers, including Canada. China insisted on getting the same sort of accounting requirements for Canadian exports that it got from Australia. As well as using uranium for other purposes, it also has military nuclear programs, which are not subject to accounting or inspection ... Now the booming Chinese market will underpin a planned expansion at Cameco, that will increase production to 40 million pounds a year by 2018 from 22 million pounds, with potential for an additional 20 million pounds after 2020.”  
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India also refuses to sign the Comprehensive Test Ban Treaty ([www.ctbto.org](http://www.ctbto.org))
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- never signed the Treaty on the Non-Proliferation of Nuclear Weapons or the Comprehensive Test-Ban Treaty. So the Canada-India deal is a watershed moment in the nuclear movement that goes beyond simply bilateral trade, say experts. Even if Canadian uranium never makes it near a weapons facility, our exports will still free up India's domestic (uranium) supply, said Cesar Jaramillo, a nuclear disarmament expert with Project Ploughshares. 'India requires uranium for both its civilian and military nuclear programs and, since it is generally in short supply domestically, the uranium imported for civilian needs may allow the country to allocate more of its domestic holdings for the military' Jaramillo said in an email."
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- The details of the Nuclear Co-operation agreement between India and Canada will remain secret.
- 128 It is a reflection of the weakness of Canada's safeguards, that Pakistan's route to an atomic bomb was, in part, also made possible by Canada's willingness to sell Pakistan a nuclear reactor. Pakistan's government then separated the plutonium in that reactor from the rest of the reactor's nuclear waste, and used it to produce a nuclear weapon. Pakistan went on to conduct its first atomic bomb test in 1998.
- 129 'Saskatchewan Mining Facts, *Regina Leader Post*, February 19, 2013. [www.leaderpost.com/Saskatchewan+Mining+Facts/7971148/story.html](http://www.leaderpost.com/Saskatchewan+Mining+Facts/7971148/story.html)
- 130 Article 6 of the Treaty on the Non-Proliferation of Nuclear Weapons, [www.un.org/en/conf/npt/2005/npttreaty.html](http://www.un.org/en/conf/npt/2005/npttreaty.html)
- 131 Article 3 of the Treaty on the Non-Proliferation of Nuclear Weapons is intended to prevent "diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices".
- 132 The estimate of 69,000 tonnes is based on the work of the Blue Ribbon Panel on America's Nuclear Future. On page 14 of its January 2012 report to the Energy Secretary of the United States, it placed total spent fuel in the country at 65,000 metric tons, and noted that the industry as a whole generates between 2,000 and 2,400 metric tons on an annual basis. For further details refer to: [http://cybercemetery.unt.edu/archive/brc/20120620220235/http://brc.gov/sites/default/files/documents/brc\\_finalreport\\_jan2012.pdf](http://cybercemetery.unt.edu/archive/brc/20120620220235/http://brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf)
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- "Call for better oversight of nuclear-waste storage" by Declan Butler, *Nature*, May 15, 2014, pages 267-68.
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- 136 "Improve economic models of climate change", Richard L. Revesz et al, *Nature*, Volume 508, April 10, 2014. This article discusses projected damages as assessed by several models including DICE 2010, FUND3.8, PAGE3.8, CRED 1.4 and ENVISAGE.
- 137 "Improve economic models of climate change", *Nature*, Richard L. Revesz et al, Volume 508, April 10, 2014. The authors are referring to the Interagency Working Group on Social Cost of Carbon. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis*, US Government, 2013.
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- 141 "Kerobert to build oil rail hub", Jason Warick, *The Star Phoenix*, August 15, 2013.
- 142 September 18, 2013 correspondence between the Saskatchewan Environmental Society and Saskatchewan Environment Minister Hon. Ken Cheveldayoff.

- July 29, 2014 correspondence from the Canadian Environmental Assessment Agency to the Saskatchewan Environmental Society.
- 143 Environmental Impact Study for the Fortune Minerals Limited Saskatchewan Metals Processing Plant, Section 3.4 entitled 'Process Residue Storage Facility', pages 38-43. [www.environment.gov.sk.ca/2010-064EISMainDocument](http://www.environment.gov.sk.ca/2010-064EISMainDocument) Also refer to table 3.3.
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- 144 "Manitoba weeds out cosmetic pesticides in new legislation", April 14, 2014. The new restrictions are to take effect in 2015. [www.cbc.ca/news/canada/manitoba/manitoba-weeds-out-cosmetic-pesticides-in-new-legislation-1.2617260](http://www.cbc.ca/news/canada/manitoba/manitoba-weeds-out-cosmetic-pesticides-in-new-legislation-1.2617260)
- Comprehensive cosmetic pesticide bans are in place in Nova Scotia, Ontario and Quebec. [www.pesticidefreebc.org/index.php?option=com\\_content&view=category&layout=blog&id=53&Itemid=72](http://www.pesticidefreebc.org/index.php?option=com_content&view=category&layout=blog&id=53&Itemid=72)
- Web site of the Canadian Environmental Law Association [www.cela.ca/collections/pollution/banning-cosmetic-pesticide-use](http://www.cela.ca/collections/pollution/banning-cosmetic-pesticide-use)
- 145 One hundred and eleven kilograms of greenhouse gas emissions are produced to create one barrel of synthetic crude in the oil sands industry. When compared with conventional crude oil, the average greenhouse gas emissions intensity to produce synthetic crude from oil sands is 3.2 to 4.5 times higher. (Sources for this information include: National Energy Technology Laboratory, November 2008. Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum Based Fuels, DOE/NETL, page 12, Table 2-4 and Table 2-5; and Alex Charpentier et al., Understanding the Canadian oil sands industry's greenhouse gas emissions.' *Environmental Research Letters* 4, 2009).
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- Intergovernmental Panel on Climate Change Press Release, May 11, 2012. The opening paragraph states: "Close to 80 percent of the world's energy supply could be met by renewables by mid-century if backed by the right enabling public policies a new report shows." The press release highlights the above mentioned report.
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- 148 "Back the Renewables Boom: Low-carbon technologies are getting better and cheaper each year, but continued public-policy support is needed to sustain progress" by Jessika E. Trancik, *Nature*, Volume 507, March 20, 2014. The author notes that wind turbine costs have fallen by roughly 5% per year, while photovoltaic module costs have dropped about 10% per year over the past 30 years.
- 149 *Renewables 2013 Global Status Report*, REN21 Network. Refer to section entitled: 'Power Generation Policies'. Seventy one countries and 28 states/provinces have adopted some form of feed-in tariff policy.
- 150 "Germany Reaches New Levels of Greendom, Gets 31 Percent of Its Electricity From Renewables" by Caroline Winter, *Business Week*, August 14, 2014 [www.businessweek.com/articles/2014-08-14/germany-reaches-new-levels-of-greendom-gets-31-percent-of-its-electricity-from-renewables](http://www.businessweek.com/articles/2014-08-14/germany-reaches-new-levels-of-greendom-gets-31-percent-of-its-electricity-from-renewables)
- "Electricity production from solar and wind in Germany in 2014", by Dr. Bruno Burger, Fraunhofer Institute For Solar Energy Systems ISE (Freiburg, Germany).

Germany occupies 337,021 sq km compared to Saskatchewan's 651,036 sq km. The German population was 80.6 million in 2013.

- 151 "Germany's Renewables Revolution" by Amory Lovins, Chief Scientist, Rocky Mountain Institute, Colorado, USA, April 17, 2013.

- 152 "Obama is planning new rules on oil and gas industry's methane emissions", *New York Times*, January 15, 2015. The regulations will be developed under the framework of the United States Clean Air Act. The Environmental Protection Agency will issue the specifics of its proposed rule by the summer of 2015. A final rule will be in place in 2016.

Note: One of the keys to success in reducing methane emissions is for regulations to require that an adequate natural gas gathering system is in place before companies start to pump large amounts of oil from a field. It is also important to ensure that oil and gas companies pay royalties and taxes on any gas that is vented or flared, a move that would encourage faster action to reduce pollution levels. Instituting proper regulations in this arena offers the added public benefit of ensuring that natural gas is not unnecessarily wasted.

- 153 The residential rate for electricity in Saskatchewan as of the summer of 2014 was 11.93 cents per kilowatt hour. The reported 2014 industrial rate for electricity was approximately 5.7 cents per kilowatt hour, according to a March 17, 2014 presentation made to the RM Council of Corman Park by Fortune Minerals.

- 154 [www.fueleconomy.gov/feg/driveHabits.jsp](http://www.fueleconomy.gov/feg/driveHabits.jsp) The US Department of Energy reports that: "While each vehicle reaches its optimal fuel economy at a different speed (or range of speeds), gas mileage usually decreases rapidly at speeds above 50 mph"

At the present time there are few precedents in the world for speed limit reductions on environmental

grounds. One recent example, however, is the United Kingdom where the national government has announced that speed limits will be cut from 70 mph to 60 mph on a 32 mile stretch of highway to meet European Union pollution targets. ("60 mph 'green' speed limit on the motorway: Slower stretch on M1 to meet EU pollution target ... and more are planned", *Daily Mail*, January 14, 2014.) [www.dailymail.co.uk/news/article-2534919/60mph-green-speed-limit-motorway-Slower-stretch-M1-meet-EU-pollution-target-planned.html](http://www.dailymail.co.uk/news/article-2534919/60mph-green-speed-limit-motorway-Slower-stretch-M1-meet-EU-pollution-target-planned.html)

- 155 "BC carbon tax showing positive results", *The Globe and Mail*, July 23, 2013.

"BC carbon tax cut fuel use, didn't hurt economy: Research report asks premiers to discuss carbon tax at summit", CBC, July 23, 2013.

- 156 The reference for the amount of electricity consumed by the province's one hundred largest customers can be found in: SaskPower 2013 Annual Report, page 19. [www.saskpower.com/wp-content/uploads/2013\\_saskpower\\_annual\\_report.pdf](http://www.saskpower.com/wp-content/uploads/2013_saskpower_annual_report.pdf)

- 157 Government of Saskatchewan 2012-13 Estimates, page 58; Government of Saskatchewan 2013-14 Estimates, page 60; and Government of Saskatchewan 2014-15 Estimates, page 50.

- 158 "Last stand for tree program", *The Star Phoenix*, June 6, 2013.

- 159 [http://newwest.net/city/article/the\\_oregon\\_example\\_statewide\\_planning\\_works/C396/L396/](http://newwest.net/city/article/the_oregon_example_statewide_planning_works/C396/L396/)

- 160 "Irrigation needed for veggie growth", *The Star Phoenix*, July 12, 2014. The article refers to a 2014 study by the Saskatchewan Irrigation Projects Association that found that in 2013 Saskatchewan "used 1,000 acres for vegetable production, a self-sufficiency rate of 10% for in-season demand."

