Climate Adaptation

A Better Response to Uncertainty?

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Contents

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Climate Adaptation – A Better Response to Uncertainty?

EXECUTIVE SUMMARY

Over the period 2011 to 2018, the actions that had been taken by governments around the world to respond to climate change cost almost U.S. $3.7 trillion. Of that total, only U.S. $190 billion, or 5%, was spent on adaptation. Almost all the rest was spent on mitigation.

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This article offers some information and views about what climate adaptation means, its present and possible role in the Canadian climate policy response, and principles that might guide governments in their decisions with respect to the nature and timing of adaptation investments. It argues that adaptation and, more important, building economic reliance in changing times, are more prudent than attempting to mitigate uncertain future effects, but that policy discipline is required whichever path is taken.

Humans have been adapting to changes in the global climate for as long as they have existed. Adaptation to future climate changes, whether or not caused by human activities, will occur if and when the people affected determine that there is a need to change. This is what natural adaptation means. In climate policy, however, adaptation relates to the actions that governments will take and/or require people to take soon in order to anticipate changes in the climate that have not yet occurred but are projected on the basis of mathematical models. In other words, climate policy largely is concerned with adaptation to events based on high levels of uncertainty.

Some view adaptation as more economically justified than measures to mitigate potential climate changes through reducing greenhouse gas (GHG) emissions. They estimate that one dollar invested in adaptation yields about four dollars in benefits. Danish economist Bjorn Lomborg estimates that one dollar going to mitigation yields only 11 cents in benefits. A dollar invested in helping Canada adapt to climate changes here is more likely to have genuine national benefits than a dollar spent on mitigating global climate changes over which Canada, with its small share of emissions cannot possibly hope to influence, let alone control. Policy pragmatists, aware of the enormous influence of the environmental lobby in Canada, view adaptation as a policy “half-way house” that is less expensive and intrusive

than mitigation measures and may be useful to endorse if only to evade the vile insult of being called a "climate denier".

Adaptation policy faces the same challenge as mitigation policy – the uncertainty about what the future holds, about when to act and how much to spend. The more alarmed observers focus on the substantial challenges associated with long-lived decisions with high stakes and high sunk costs. These include major infrastructure, building developments and land use planning. Thus, some have proposed major restrictions on infrastructure development within 15 kilometres of ocean coastlines, moving whole cities inland, banning all development in certain areas, and fundamentally altering building codes at great cost to future residential, commercial and industrial building owners. Depending on how extreme these measures were, they might come to rival the immense costs of mitigation measures now underway and contemplated. The more intrusive adaptation measures are often premised on the efficacy of government planning of the economy, based on probabilistic modeling of the future costs and benefits of options. An alternative is called "Dynamic Adaptive Policy Pathways" (DAPP). Flexibility and iterative planning are core elements of this approach. Its objective is to *"develop an iterative, learning decision process that cost-effectively reduces risk today while avoiding foreclosing future options".* Considering the full range of plausible scenarios, the DAPP approach provides clear information on the effectiveness and timing of options, enabling analysts to assess under which conditions and on which timescale a plan could fail.

Thus, there is room for anticipatory adaptation, so long as it is flexible and dynamic. Yet, the best policy approaches could involve borrowing a page from economics – the concept of resilience. Resilience is the ability of an economy to "bounce back" in the face of unexpected events and shocks to the system. Germany after the Second World War offers an example. A completely devastated country recovered its prosperity within a generation due to a cultural tradition that emphasized hard work, efficiency, pride in a job well done, valuing education, stable family relationships, and respect for the rule of law. Equally important, the economic culture valued enterprise, risk taking and individual responsibility, as well as broadly cordial relationships between capital and labour groups and support for the modern welfare state. The same principles of resilience are applicable to dealing with any climate changes that may occur in future.

Whether justified or not, political elites in Canada and other western countries, along with the media and a substantial share of the public, support a large climate policy response. In these circumstances, adaptation measures cost far less and offer far more certain national benefits than mitigation measures. Like mitigation, they can involve much more intrusive government planning and regulation of the economy, and they can be extremely expensive. It is important that the approach to adaptation instead be based on flexible and iterative planning, with a shift away from probabilistic modelling. It is even more important that they promote a permanent form of economic resilience rather than an increased dependence on central planning.

Climate Adaptation – A Better Response to Uncertainty?

In a September 2020 article, a group of scientists analyzed the actions that had been taken by governments around the world to respond to climate change over the period 2011 to 2018.[1] The total cost of these actions was almost U.S. $3.7 trillion. Of that total, only U.S. $190 billion, or 5%, was spent on adaptation. Almost all the rest was spent on mitigation. There are no publicly-available data concerning the total expenditures of federal and provincial governments in Canada on climate-related policies and measures, so there is no way to compare the share of expenditures in Canada on mitigation and adaptation to those on a global level.

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This article will offer some information and views about what climate adaptation means, its present and possible role in the Canadian climate policy response, and principles that might guide governments in their decisions with respect to the nature and timing of adaptation investments. It will argue that adaptation and, more important, building economic reliance in changing times, are more prudent than attempting to mitigate uncertain future effects, but that policy discipline is required whichever path is taken.

Defining Adaptation

As Dr. Patrick Moore, the eloquent environmentalist and climate skeptic, has stated, humans have been adapting to changes in the global climate for as long as they have existed. The adaptation has taken many forms, including migrating from one area to another, changing habitation, clothing and eating habits, and building structures that reduce the adverse effects of actual climate changes. Adaptation to future climate changes,

[1] Ohseedha, Collin, et al. *Energy and Climate Policy – An Evaluation of Global Climate Change Expenditure 2011-2018*, Energies 13(18)4839, September 2020

whether or not caused by human activities, will occur if and when the people affected determine that there is a need to change. This is what natural adaptation means.

In the context of global climate policy, however, adaptation has taken on a quite different meaning. It relates to the actions that governments will take and/or require people to take soon in order to anticipate changes in the climate that have not yet occurred but are projected on the basis of mathematical models. In other words, climate policy largely is concerned with adaptation to events based on high levels of uncertainty.

The Government of Canada, in its public communications about climate adaptation, seeks to portray it as necessary to deal both with current extreme weather events, such as wildfires and floods, and with future changes for which it may be necessary to build "resilience". Here is the official definition:

"Adaptation means adjusting our decisions, behaviours and activities to account for existing or expected changes in climate. Adaptation measures can be taken either before or after we experience the effects of a changing climate. Examples of adaptation measures include:

- *Creating tougher building standards for areas where more snow is expected*
- *Limiting development in coastal areas where sea level is expected to rise*
- *Restoring wetlands to reduce flooding*
- *Making changes to protect our health during heat events"*[2]

This definition omits any suggestion that adverse climate changes are uncertain. According to the Canadian government definition, these climate changes are "expected".

The Global Commission on Adaptation, in its September 2019 report, portrayed accelerating climate adaptation as "a human, environmental and economic imperative". [3] The report is full of cataclysmic language about widening disparities between high income and lower income regions, species extinction, ice-free land subject to degradation, increasing sea levels, and other frightening outcomes. The Global Commission views adaptation as more economically justified than measures to mitigate potential climate changes through reducing greenhouse gas (GHG) emissions. Its report stated that one dollar invested in adaptation yields about four dollars in benefits. Danish economist Bjorn Lomborg, another advocate of adaptation, estimates that one dollar going to mitigation yields only 11 cents in benefits.

Others view adaptation as less than an imperative, but still worthwhile. The Climate Intelligence Foundation (CLINTEL), a group of several hundred scientists largely based in Europe, examined the potential benefits of climate adaptation at a summit held in the Netherlands in January 2021. The scientists present concluded that "adaptation has already

[2] Climate Change Adaptation and Plans. Canada.ca

[3] *Adapt Now: A Global Call for Leadership on Climate Resilience,* The Global Commission on Adaptation, September, 2019

amply proven its value, while mitigation turns out to be inefficient and expensive."[4] CLINTEL views adaptation options as being treated by governments as though they were a "last resort" to be deployed only if the Paris Accord objectives of restraining the increase in global temperatures to no more than two degrees Celsius cannot be met.

Yet another view, once expressed commonly within the Canadian federal government but now probably frowned on, is that a dollar invested in helping Canada adapt to any climate changes that may be coming is more likely to have genuine national benefits than a dollar spent on mitigating global climate changes over which Canada, with its small share of emissions cannot possibly hope to influence, let alone control.

Still others see adaptation as just as pointless as mitigation, given that the causes of climate change are primarily natural and unlikely to impose significant adverse effects on humans in any case. They acknowledge that, given the uncertainty that still clouds much of climate sciences, adaptation measures may have some merits as an "insurance policy".

Finally, policy pragmatists, aware of the enormous influence of the environmental lobby in Canada, view adaptation as a policy "half-way house" that is less expensive and intrusive than mitigation measures and may be useful to endorse if only to evade the vile insult of being called a "climate denier".

The Case for Adapting to Extreme Weather

An obvious starting point for considering which, if any adaptation measures should be taken is to consider the scientific case upon which claims of current and impending damages rests. There is a long list of such damages, but it may help to examine the case for four:

- Rising sea levels
- Increasing droughts
- Rising temperatures in heavily populated areas
- Increasing snow extent

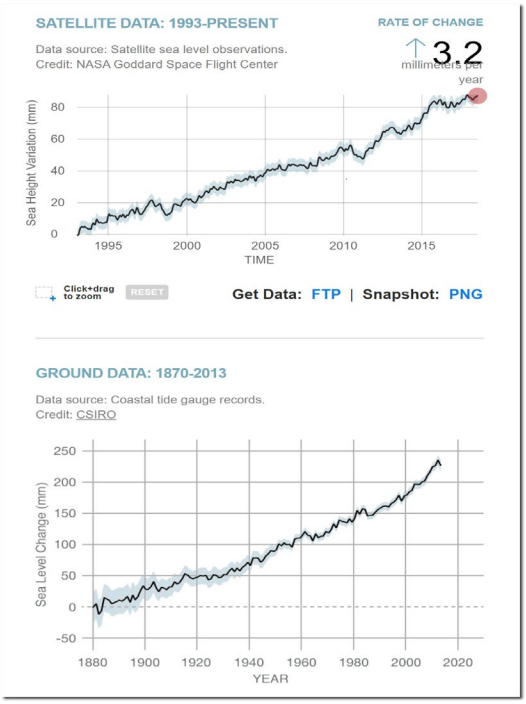
Rising Sea Levels

Global sea level is estimated using averaged measurements from a worldwide network of coastal tide-gauges or from satellite-borne instruments. Both sources are used to calculate a worldwide average, so neither has any useful application to coastal management in specific locations. The position of the sea level is only one of several factors that controls the position and changes in disposition of the shoreline. Others include the rise or fall of the land (subsidence), the supply of sediment, the weather and climate (short and long-term temperature, wind, rainfall), and the temperature and movement of the oceans.

[4] *Climate Adaptation Much More Profitable than Climate Mitigation,* The Friends of Science Society, January 27, 2021

Based on geological studies, it appears that slow global sea-level rise - typically less than 10 millimetres per year (four inches per century) – has been taking place over the last 10,000 years. There has been some acceleration over the past two centuries.[5]

The data from tide gauges and satellites is portrayed in the following two graphs.



The ground data indicates that, over the period 1880 to 2016, average sea levels rose about 235 millimetres, or nine inches; that works out to just over seven inches per century. According to the satellite data, the average sea level rise from 1990 to 2016 averaged 3.2 millimetres per year, which if extended over a century would be equal to 12.6 inches. That rate of rise has not caused problems, nor can it be characterized as "catastrophic".[6]

While global trends offer a useful reference, for practical coastal management one needs a knowledge of local relative sea-level change, as measured at specific coastal locations. Local sea levels are rising or falling in different parts of the world depending upon the direction and rate of movement of the underlying land.

[5] Willem P. de Lange and Robert Carter, *Sea-Level Change: Living with Uncertainty.* Global Warming Policy Foundation, 2014

[6] ibid

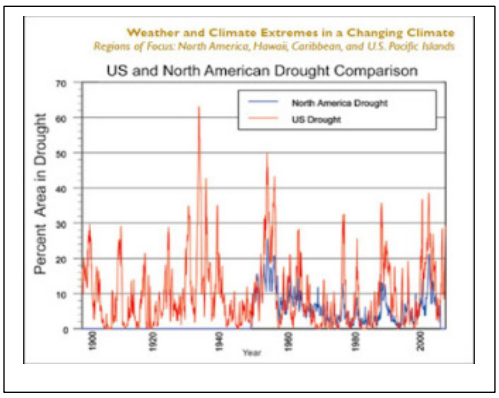
Lights out in Manhattan, following Super Storm Sandy.
Many of the worst flooded areas used to be 'water lots', reclaimed from the sea.
Image licensed from Shutterstock.

Increasing Droughts

The experience of droughts varies with the region concerned. In 2012, the IPCC reported thus:

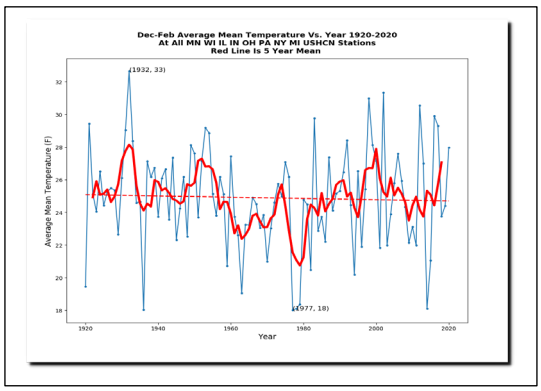
"There is medium confidence that since the 1950s some regions of the world have experienced a trend to more intense and longer droughts, in particular in southern Europe and West Africa, but in some regions, droughts have become less frequent, less intense, or shorter, for example, in central North America and northwestern Australia."

The same findings were borne out in the report of the United States Climate Science Program CCSP) in 2008. The following graph from the CCSP report, shows in red the percentage of area in severe to extreme drought as measured by the Palmer Drought Severity Index for the United States from 1990 to 2008. It shows that drought patterns vary by year and decade, that the worst drought was in the 1930's, and that there has been no significant upward trend over the century.



Rising Temperatures

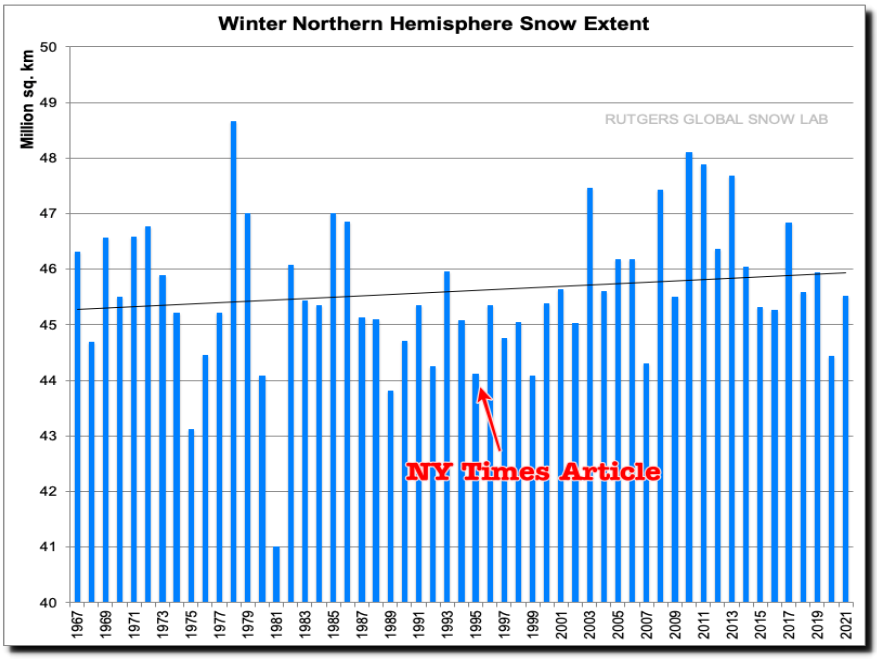
Most of Canada's population is located within 150 km of the Canada-U.S. border. Thus, we can use the comprehensive data available from the United States Historical Climatology Network (USHCN) to observe the long term temperature trends for the northern states The following graph shows the trends from 1920 to 2020 December to February average mean temperatures. As indicated both by the annual data in blue and the five-year mean in red, the century-long trend is largely stable, with a slight downward, not upward, trend in temperatures.



Increasing Snow Extent

The debate about snow extent in the northern hemisphere is a puzzling one, with proponents of climate alarm in Europe and the United States sometimes claiming that we will soon see "the end of snow" and some in Canada claiming that we are about to see much higher than historic levels.

Th following graph from the Rutgers University Global Snow Lab indicates the actual trends in winter northern hemisphere snow extent, as measured in million square kilometres, from 1967 to 2021. While there have been some large changes year to year, the overall trend in a modest rise of less than one million square kilometres per year, or 1.5%, over a 54-year period. Again, these trends fail to indicate that catastrophic changes are occurring that demand adaptation measures.



Projecting the Future

I must admit to being highly skeptical about the merits of policy debates based around disagreements about which side has the best crystal ball. My long experience in the public policy field taught me that no one knows the future, and that efforts to project it based upon examinations of current trends tend to be interesting as intellectual exercises but of very little practical value. Even that value declines sharply with the length of the projection. Climate modelers apparently have no such misgivings, or if they do, will not publicly admit to them.

The IPCC has developed four main emission pathway scenarios (RCPs) that it uses for projection purposes. G.W. Payne has provided a very good, although complex, explanation of the Representative Concentration Pathways that were developed to use in integrated assessment models. See it here:

https://skepticalscience.com/rcp.php

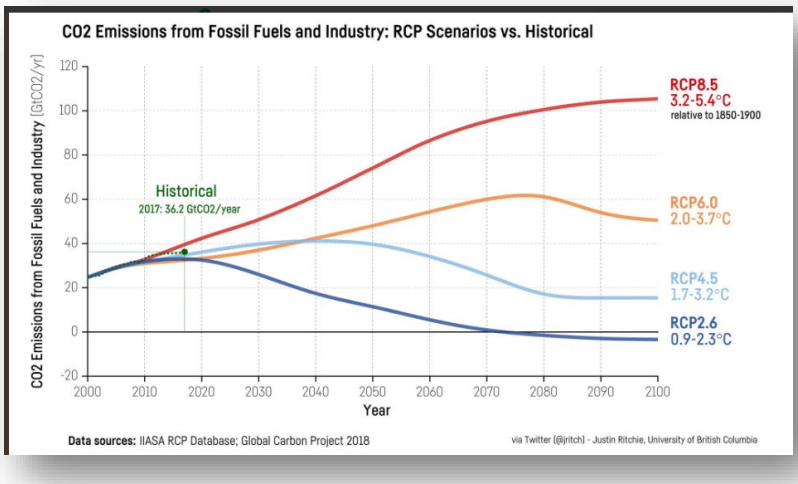
The following is a greatly simplified description of what these pathways are intended to represent:

RCP 2.6 represents scenarios in the academic climate literature that lead to very low GHG concentration levels. It is a "peak-and-decline" scenario; it reaches a low peak by mid-century and drops sharply by 2100. It is close to the scenario foreseen by those who demand "net zero" emissions by 2050. The CO2 concentration in the atmosphere in 2100 would be 490 parts per million (ppm).

RCP 4.5 is a stabilization scenario in which radiative forcing is stabilized shortly after 2100.By 2100 the CO2 concentration level would be 650 ppm.

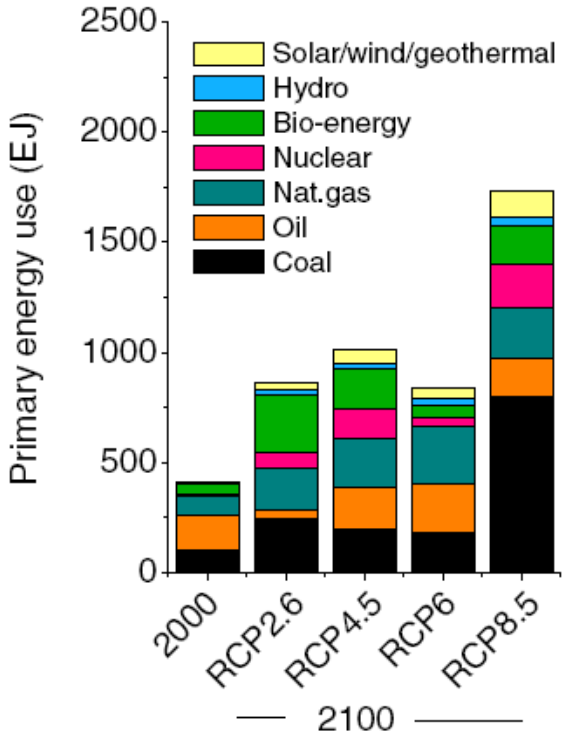
RCP 6 is also a stabilization scenario in which radiative forcing is stabilized shortly after 2100 by the application of a specific range of technologies and strategies proposed by the National Institute for Environmental Studies in Japan. By 2100, the CO2 concentration level would be 850 ppm.

RCP 8.5 is an outlier scenario, characterized by constantly rising GHG emissions over time, leading to very high GHG concentration levels. By 2100, the CO2 concentration level would be 1370.



The following bar chart offer a comparison of the four scenarios in terms of projected primary energy use and fuel shares in 2100. Energy consumption grows significantly from

2000 levels in all four scenarios. Solar, wind and geothermal energy have relatively modest roles in the energy mix in all four scenarios, but bioenergy has a very large role, mainly at the expense of oil, in RCP 2.6. RCP 8.5 is an outlier in many ways; it foresees total primary energy use being four times that of 2000 by 2100 and a tripling in coal use by 2070.



Source: The representative concentration pathways: an overview, van Vuuren et. al 2011, Climatic Change (2011) 109:5–31, DOI 10.1007/s10584-011-0148-z

It should be noted that RCP 2.6, 4.5 and 6 rely on population estimates that are 3 billion fewer people on earth than in RCP 8.5, leading to concern by some people that policymakers and activists misunderstand this to mean that depopulation should be part of public policy when that is not the case. Van Vuuren et al (2011) specifically stated that the RCPs are not meant for policymaking and the scenarios are for research purposes only and should not be compared to each other as 'pathways' to emissions reduction. None-the-less, "Canada's Changing Climate Report 2019" is rife with colorful comparative images. Many other climate scientists, like Dr. Katharine Hayhoe,[7] [8] as well as the climate activist group like the Canadian Institute for Climate Choices[9] reuse and reiterate these images 'as if' fact and 'as if' climate policy 'pathway choices'.

[7] https://youtu.be/HjVyvKNlI2Q
[8] https://open.alberta.ca/dataset/89a69583-a11b-4e31-a857-b311ab6563cc/resource/17ce2d24-ba7b-466c-acd9-33a2cf6beb69/download/aep-alberta-climate-report-arc.pdf
[9] "Charting Our Course" https://climatechoices.ca/wp-content/uploads/2020/01/FINAL_Charting-Our-Course.pdf

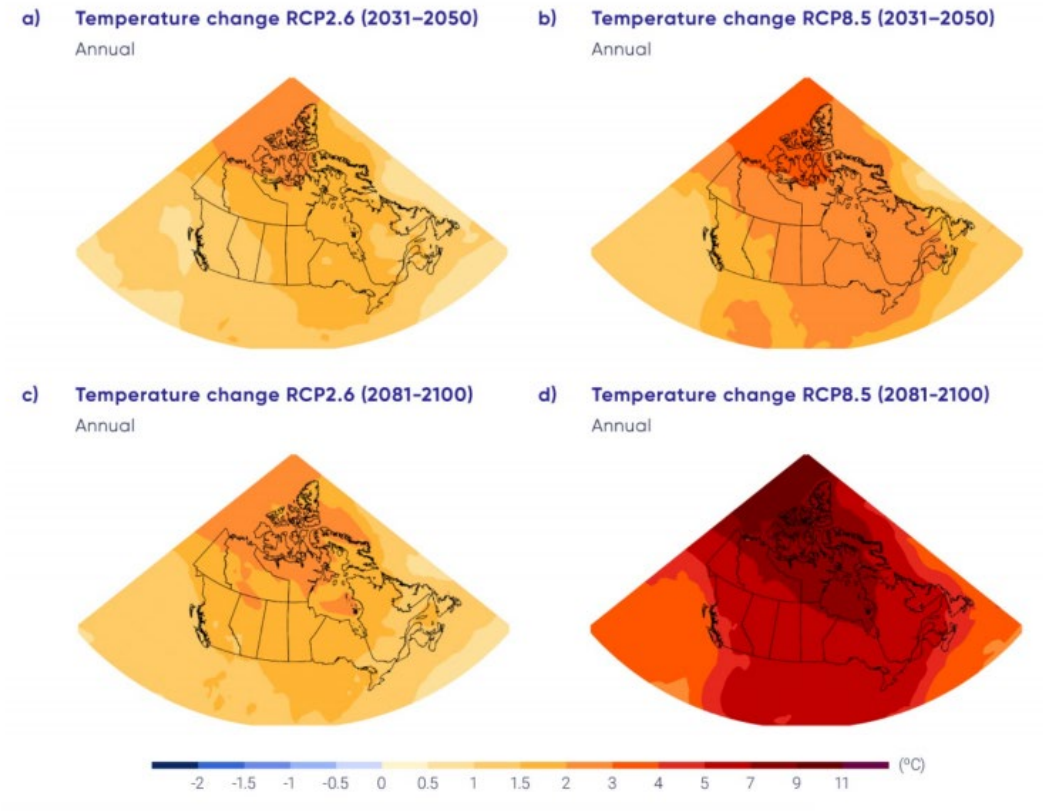


Figure 5. Projected changes in annual average temperatures, in degrees Celsius, over the near-term (2031-2050, top) and by end of century (2081-2100, bottom) for a very low scenario (RCP2.6, left), and a higher scenario (RCP8.5, right). This report is based on the same higher scenario, RCP8.5, and RCP4.5, a lower scenario that does not require negative carbon emissions before end-of-century as RCP2.6 does. For further discussion of these scenarios, please see the **Data, Models and Methods** section of this report. Source: Canada's Changing Climate Report, Bush and Lennen 2019.

Source: "Alberta's Climate Future" by Katharine Hayhoe and Anne Stoner(pg. 10)

Returning to sea level rise, the differences among these pathways can be illustrated in terms of the CMIP5 climate model projections used in the IPCC AR5 report as these relate to sea levels. In a "Special Report on Oceans, Cryosphere and Climate Change" (SROCC) issued in 2019, the IPCC Final Report projected that sea levels would rise from a baseline period of 1986-2005 to 2100 by the following amounts:

Emission Scenario	Sea Level Rise in Metres
RCP2.6	0.43
RCP4.5	0.55
RCP8.5	0.84

To place that in context, the continuation of the rates of increase actually experienced since 1995, would produce a rise of 0.32 metres, or 12.6 inches, over the century. The sea level rises under the IPCC scenarios would thus be 17 inches under RCP2.6, 22 inches under RCP4.5 and 33 inches under RCP 8.5.

Almost all major papers on climate change publicized in the mainstream media use RCP 8.5 as the assumed scenario. The result is a succession of catastrophic projections that deeply affect the public perceptions and dialogue. **Yet, for reasons elaborated on at length by Dr. Judith Curry,[10] Dr. Ross McKitrick [11] and others, the RCP8.5 scenario is implausible, indeed borderline impossible.** The observed warming for the past two decades is considerably less than the average of the rate of warming predicted in the climate models. Therefore, there is good reason to believe that the more credible projections of sea level rise over the next century fall into the range of 13 to 22 inches, or less. As these rises, at worst, would happen gradually, there would be ample time for countries to adapt through the use of dykes and other measures.

Policy Making under Conditions of Uncertainty

There is a large and growing academic literature about the problems and choices that governments and companies face when seeking to make important policy or investment decisions under conditions of uncertainty. When dealing with potential threats, the best options can only be determined based on a rigorous assessment of the magnitude of the risks, the probability of their occurring, and the costs of avoidance.

The projections of climate damage and specifically of sea level rises for the 21st century are characterized by deep uncertainty.

"Deep uncertainty (recognized ignorance) – fundamental uncertainty in the mechanisms being studied and a weak scientific basis for developing scenarios; future outcomes may lie outside of the realm of regular or quantifiable expectations; no agreement on how to define the possible outcomes."[12]

Apart from uncertainties in emissions scenarios, there are substantial uncertainties in: climate sensitivity to increasing carbon dioxide concentration levels; future volcanic eruptions; solar variability; multi-decadal ocean oscillations; and possible instabilities in ice sheets.

If and when there is a clear expectation of specific and localized adverse climate effects, It may be possible to take effective land use planning approaches and other measures that are well targeted, moderate in cost and timely in effect. Some of the measures being taken

[10] Judith Curry, *Climate Adaptation Sense. Part III: Dynamic Adaptation Policy Pathways,* Posted on March 17, 2021
[11] Ross McKitrick, *The Flaw in Relying on Worst-Case-Scenario Climate Model.* Financial Post Comment, June 23, 2020
[12] Judith Curry, ibid

in Canada fit this description. They involve a range of adaptation measures, depending on the local vulnerabilities, land use and nature of the assets at risk. These include protection, accommodation, reclamation or retreat.

The question remains, however, "When and how much must we do to adapt?" The more alarmed observers focus on the substantial challenges associated with long-lived decisions with high stakes and high sunk costs. These include major infrastructure, building developments and land use planning. Thus, some have proposed major restrictions on infrastructure development within 15 kilometres of ocean coastlines, moving whole cities inland, banning all development in certain areas, and fundamentally altering building codes at great cost to future residential, commercial and industrial building owners. Depending on how extreme these measures were, they might come to rival the immense costs of mitigation measures now underway and contemplated.

Like many mitigation strategies, the more intrusive adaptation measures are often premised on the efficacy of government planning of the economy. There are, however, important variations within this approach. Much of what happens today is based on probabilistic modeling of the future costs and benefits of options. An alternative, largely focused on the Netherlands' experience, is called "Dynamic Adaptive Policy Pathways"(DAPP). This approach includes two elements:

- Adaptive Policymaking: a planning process with different types of actions (e.g. mitigating actions" and "hedging actions") and signposts to monitor to see whether adaptation is needed
- Adaptation Pathways: an analytical approach for exploring and sequencing a set of possible action based on alternative external developments over time[13]

DAPP incorporates flexibility into adaptation plans that can be changed over time as more is learned and conditions change. In other words, flexibility and iterative planning are core elements of the approach. It is predicated on a strong understanding of the decision problem itself, rather than focusing on climate projections. It focuses on understanding the characteristics of the decision problem (the objectives and values of the stakeholders, tradeoffs, constraints and other decision criteria), the vulnerability of the system and the adaptation options themselves.

The objective of DAPP is to *"develop an iterative, learning decision process that cost-effectively reduces risk today while avoiding foreclosing future options".* Considering the full range of plausible scenarios, the DAPP approach provides clear information on the effectiveness and timing of options, enabling analysts to assess under which conditions and on which timescale a plan could fail. The approach explicitly recognizes that adaptation over time will be determined not only by what can be anticipated today, but also what is observed and learned in the future. The approach ensures that the short-to-medium term

[13] Marjolijn Haasnoot et al, *Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world.* Global Environmental Change, Volume 23 Issue 2, April 2013, pages 485-498.

plan is set in a framework that will not be maladaptive if climate change progresses at a rate that is different from current expectations."

Resilience

As noted previously, humans have been adapting to changes in the global climate for thousands of years. Their ability to do so, however, has improved as income levels have increased and as new technologies have developed. Richer societies can adapt better and faster than poorer ones. They have more resources with which to adapt.

I have already argued that adaptation to climate change should involve more than simply responding to events and changes after they occur. There is room for anticipatory adaptation, so long as it is flexible and dynamic. Yet, the best policy approaches could involve borrowing a page from economics – the concept of resilience.

Resilience is the ability of an economy to "bounce back" in the face of unexpected events and shocks to the system. While it has the connotation of returning to the original state as soon as possible, because of changed circumstances it more often means "bouncing forward" to a new equilibrium in which the economic structures, practices and even the infrastructure are modified to cope better with future volatility. [14]

The study of economic resilience is still in its infancy, but some aspects of it have been known and practiced for centuries. A good example of economic resilience was the recovery of West Germany after the Second World War. At the end of the war, Germany was devastated, many of its citizens killed or traumatized, its infrastructure largely in ruins and its trading patterns ended. Yet, within a generation Germany recovered to the point at which it was again one of the leading countries of Europe.

How did it do so? To be sure, it benefitted from the foreign aid provided through the United States Marshall Plan, but it also made use of far more deep-seated sources of resilience. These included a cultural tradition that emphasized hard work, efficiency, pride in a job well done, valuing education, stable family relationships, and respect for the rule of law. Equally important, the economic culture valued enterprise, risk taking and individual responsibility, as well as broadly cordial relationships between capital and labour groups and support for the modern welfare state.

Germany's resilience, in other words, was largely the result both of the historic culture of its people and the dynamism of free markets. It was not accomplished by central planning, in which governments, in their often clumsy ways, seek to decide who the winners and losers will be and what will be the pace of change.

The same principles of resilience are applicable to dealing with any climate changes that may occur in future.

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[14] Stephen Goetz et al. *What makes one economy more resilient than another?* The Conversation. March 7, 2016

Conclusion

Adaptation has been the default response of humans to climate change from the beginning of time. Today, in confronting the thesis that human GHG emissions are causing extreme weather events and risking long-term climate catastrophe, governments are devoting the lion's share of the resources to attempting to mitigate possible effects. They do so not only in conditions of great uncertainty, but also by emphasizing the credibility of worst case scenarios.

Arguably, trillions of dollars are being spent on measures that may not be needed at all.

Whether justified or not, political elites in Canada and other western countries, along with the media and a substantial share of the public, support a large climate policy response. In these circumstances, adaptation measures cost far less and offer far more certain national benefits than mitigation measures. Like mitigation, they can involve much more intrusive government planning and regulation of the economy, and they can be extremely expensive. It is important that the approach to adaptation instead be based on flexible and iterative planning, with a shift away from probabilistic modelling. It is even more important that they promote a permanent form of economic resilience rather than an increased dependence on central planning.

About the Author

Robert Lyman is an economist with 27 years' experience as an analyst, policy advisor and manager in the Canadian federal government, primarily in the areas of energy, transportation, and environmental policy. He was also a diplomat for 10 years. Subsequently he has worked as a private consultant conducting policy research and analysis on energy and transportation issues as a principal for Entrans Policy Research Group. He is a frequent contributor of articles and reports for Friends of Science, a Calgary-based independent organization concerned about climate change-related issues. He resides in Ottawa, Canada. Full bio.

About Friends of Science Society

Friends of Science Society is an independent group of earth, atmospheric and solar scientists, engineers, and citizens that is celebrating its 18th year of offering climate science insights. After a thorough review of a broad spectrum of literature on climate change, Friends of Science Society has concluded that the sun is the main driver of climate change, not carbon dioxide (CO_2).

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