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ADAPTATION

needs greater focus in climate policy

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Discussion of climate policy is overwhelmingly focused on options for mitigation, or emission reduction, with relatively little attention paid to options for and benefits of adaptation. Proponents of climate policy have long resisted discussing adaptation perhaps out of fear that it might be effective: if through adaptation we can substantially reduce or even eliminate the negative effects of climate change, this will weaken the case for deep decarbonization and elimination of fossil fuels, which some in the climate movement view as an end in itself.

But while adaptation has an excellent record of success, mitigation has proven a costly failure. Despite 30 years of aggressive international mitigation effort, global carbon dioxide emissions have continued to rise whereas adaptation efforts have shown considerable success at reducing risks to health and agricultural yields from weather variability. It is, moreover, a long-established view in mainstream climate economics that the primary response to climate change will (and should be) adaptation rather than heroic but prohibitively costly attempts to prevent warming. As the costs of mitigation efforts mount it is necessary for policy-makers to confront the risk that continued attempts at aggressive mitigation policy may in fact impede adaption and increase the harm from future warming.

For example, research has shown that mortality due to heat waves has declined dramatically in the United States since 1960 when households obtained access to air conditioning and low-cost electricity. Policies that drive up the cost of electricity put air conditioning out of the reach of many people, thereby increasing their vulnerability to hot weather.

When it comes to choosing an overall direction in climate policy, priorities must be set, and the record shows that while mitigation is often costly and futile, adaptation is relatively inexpensive and highly effective. It deserves greater focus in climate policy planning. MLI

Les débats entourant la politique climatique *portent essentiellement sur les options d'atténuation, ou la réduction des émissions, et accordent relativement peu d'attention à la faisabilité et aux bienfaits des mesures d'adaptation. Les partisans de la politique climatique refusent depuis longtemps d'en discuter par crainte, peut-être, que ces mesures ne soient efficaces : en effet, si les mesures d'adaptation permettaient de réduire considérablement, voire d'éliminer, les effets négatifs des changements climatiques, elles affaibliraient les arguments pour une décarbonisation radicale et l'élimination des combustibles fossiles, une fin en soi pour certains membres du mouvement climatique.*

Or, pendant que les mesures d'adaptation connaissent un franc succès, l'atténuation se solde par un échec coûteux. Malgré 30 ans d'efforts internationaux agressifs pour réduire les émissions mondiales de dioxyde de carbone, ces dernières continuent d'augmenter, alors que les mesures d'adaptation réussissent, quant à elles, à diminuer considérablement les problèmes de mortalité et de production agricole liés à la variabilité météorologique. En outre, selon une position établie de longue date en économie climatique, le principal moyen de lutter contre les changements climatiques passe (et devrait passer) par l'adaptation, plutôt que par d'héroïques, mais excessivement coûteuses, tentatives d'empêcher le réchauffement. À mesure que s'élève le coût des options d'atténuation, il est indispensable pour les décideurs de veiller à ce que le risque posé par la mise en œuvre répétée de politiques d'atténuation agressives ne nuise pas, en fait, aux mesures d'adaptation ou au climat futur.

Par exemple, certaines recherches ont montré que la mortalité due aux vagues de chaleur a considérablement diminué aux États-Unis depuis 1960, moment où les ménages ont obtenu l'accès à la climatisation et à l'électricité à bas prix. Les politiques qui renchérissent les prix de l'électricité diminuent l'accès à la climatisation de nombreuses personnes, augmentant ainsi leur vulnérabilité aux fortes chaleurs.

Lorsque vient le temps de choisir une orientation générale pour la politique climatique, il faut fixer des priorités en tenant compte des faits, qui montrent que sur le plan de l'efficience et des coûts, l'adaptation est bien plus avantageuse que l'atténuation. L'adaptation mérite plus d'attention dans la planification de la politique climatique. **MLI**

Introduction

Discussion of climate policy overwhelmingly focuses on mitigation, or emission reduction, but pays relatively little attention to options for and the benefits of adaptation. Proponents of climate policy have long resisted discussing adaptation perhaps out of fear that it might be effective, and if so we could substantially reduce or even eliminate the negative effects of climate change, which would undermine the push for deep decarbonization and elimination of fossil fuels.

But decarbonization should not be viewed as an end in itself. If adaptation is effective at eliminating the negative impacts of climate change (or even turning them into benefits) then abandoning the decarbonization push would be the appropriate response. The current focus on mitigation may be due to people erroneously thinking there is no alternative to the elimination of fossil fuels, or it may represent the distorting effect of financial incentives. A great deal of public money has been directed towards mitigation options such as carbon capture and storage, renewable energy options such as wind and solar, and rebates for electric vehicles. And there are large potential windfall profits available to certain firms if regulatory mandates are imposed that force consumers to buy their products.

Nonetheless it is obligatory for policy-makers to consider whether adaptation has the potential to be a less costly and more effective means of promoting social welfare. Despite the enormous expenditure of effort and resources on mitigation over the past 30 years global greenhouse gas emissions have continued to rise. As will be shown below, mainstream economic analysis has long revealed that, even taking climate model warnings at face value, most mitigation options being pursued by governments around the world are unaffordable and do more harm than good. By contrast there are important bodies of research

showing that adaptation can reduce or even eliminate the potential risks from projected climate change.

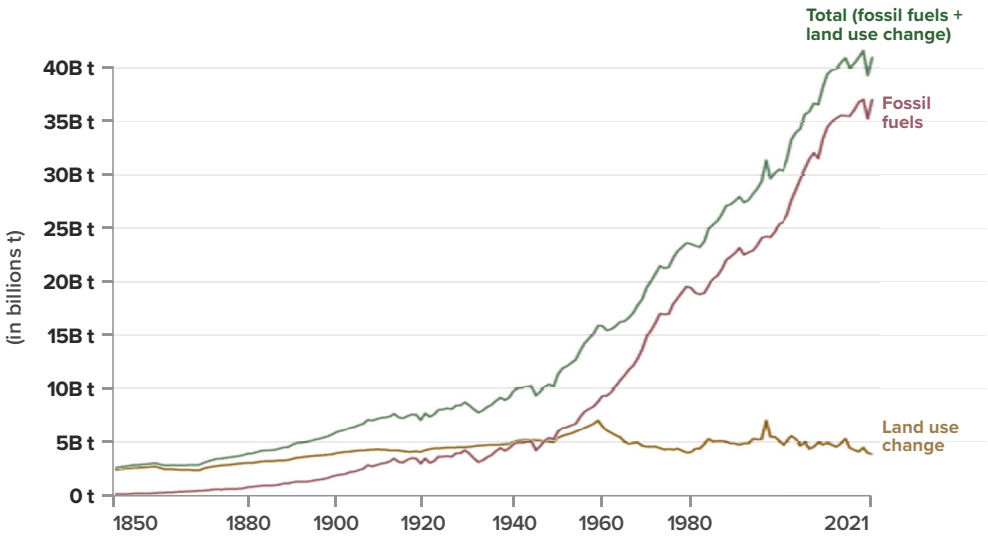
As the costs of mitigation policy continue to skyrocket it is incumbent on policy-makers to step back and ask some important questions, beginning with what they are trying to accomplish. Climate change sometimes gets conflated with industrial policy. If a policy-maker's real aim is to facilitate the growth of new industries or to stimulate certain kinds of technological change then that should be stated clearly and the best options for that goal should be studied. If the goal is to find the climate policy path that yields the maximum benefits for the lowest cost then much more attention needs to be paid to the role of adaptation, especially since, as I will show, mitigation and adaption are not necessarily complements. It may be a case of choosing one or the other.

The suggestion that our response to climate change should focus primarily on adaptation rather than mitigation might seem very controversial today. It was also controversial 20 years ago, yet it is precisely what the world ended up doing, and there is good reason to suppose it will continue to be the path chosen in the future. It is also very close to what mainstream economic analysis has long prescribed. That being the case there is a strong argument for being deliberate about it and avoiding mitigation options that undermine successful adaptation.

Failure of the mitigation agenda

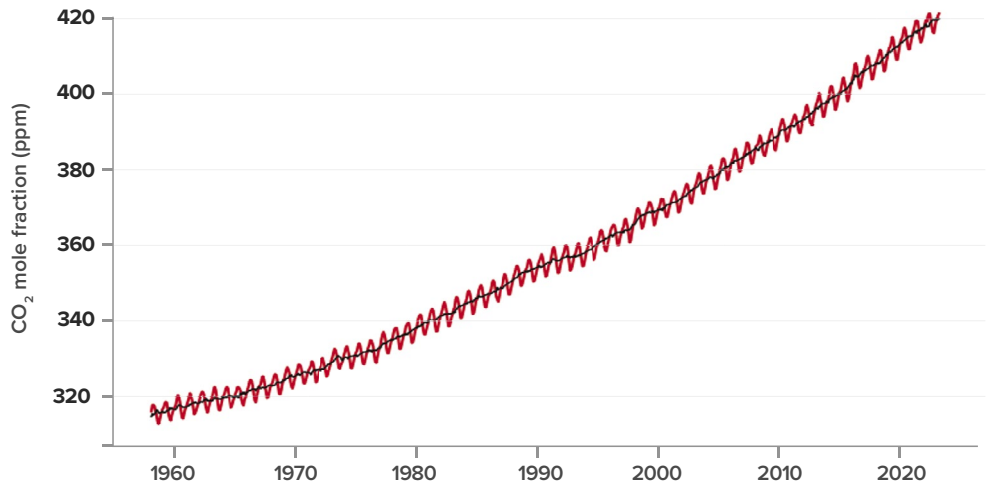
The search for an international agreement on GHG emission reductions began in the late 1980s and has been a permanent feature of global policy efforts following the signing of the 1992 UN Framework Convention on Climate Change. Yet these efforts have not resulted in a reduction of global CO_2 emissions or a cessation of the rise of CO_2 in the atmosphere. Figure 1, which shows global CO_2 emissions since 1850, indicates that the main interruptions to emissions growth are associated with major global recessions, namely, 1979-1980, 1990-1991, 2008 and 2020, not global climate policy. Notably neither the UN Framework Convention of 1992, the Kyoto Protocol (ratified in 2002), or the Paris Accord of 2015 are visible events along the emissions path (much less any Canadian policy efforts).

FIGURE 1: GLOBAL CO_2 EMISSIONS SINCE 1850



Source: Ritchie and Roser (Undated).

FIGURE 2: GLOBAL CO_2 CONCENTRATIONS SINCE 1960



Source: Global Monitoring Laboratory (Undated).

The average concentration of CO_2 in the atmosphere has also increased steadily, as shown in Figure 2, which covers the post-1960 interval.

There are two key reasons why the mitigation agenda has not worked: the scale of the carbon cycle relative to the size of proposed emission reduction policies, and the leakage problem.

Scale of the carbon cycle relative to emission cuts

The CO_2 released when fossil fuels are burnt is a small but important part of a much larger natural carbon cycle. The numbers can be found in chapter 6, section 6.1 of the *Fifth Assessment Report Working Group I* (hereinafter "AR5-WG1") from the Intergovernmental Panel on Climate Change. About 44,000 Gigatonnes of carbon-equivalent (GtC) are stored in the atmosphere, oceans, vegetation, and permafrost, mostly in the form of CO_2. Of this, about 830 GtC is held in the atmosphere. About 200 GtC are released naturally to the atmosphere each year through oceanic outgassing and land-based processes like plant decay and animal respiration. A variable but roughly equivalent amount is absorbed each year by the land and oceans, with a small net loss from the atmosphere through the formation of deep ocean sediment.

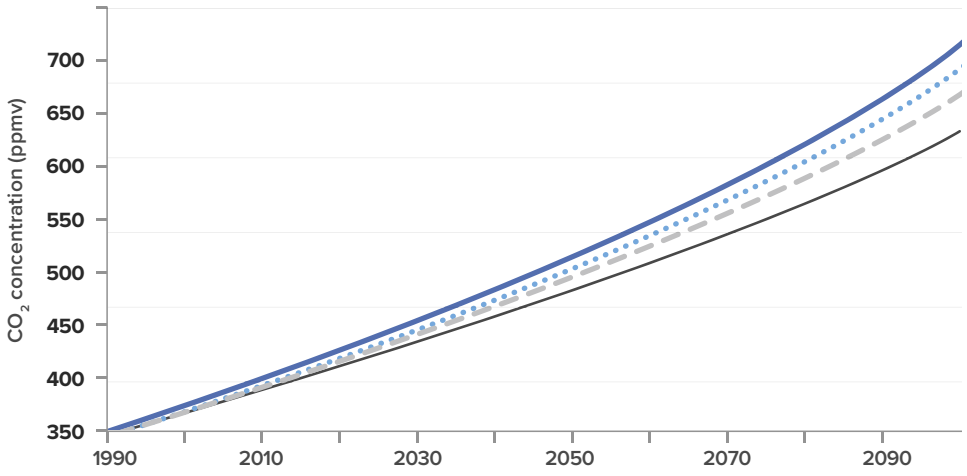
According to the BP *Statistical Review of World Energy* (2022) global CO_2 emissions in 2020 were 32 $GtCO_2$ which converts to 8.7 GtC using the standard accepted conversion factor of 3/11. According to chapter 6 of AR5-WG1, about half these emissions are sequestered by land sources (extra photosynthesis) and absorption by the ocean surface leaving a current net flux of about +4.5 GtC globally. Thus, if the current rate of sequestration remains constant, eliminating net anthropogenic CO_2 additions to the atmosphere would require cutting global CO_2 emissions by about 50 percent.[1]

By contrast, climate policy proposals, even at their most ambitious, have sought to reduce global emissions by only a few percent. For instance, the commitments made by countries participating in the Kyoto Protocol amounted to, on average, a five percent reduction in emissions (UNFCCC 1998) by 2012 compared to 1990 levels, which would have reduced global emissions by about 2.5 percent.

Not surprisingly such measures are not projected to have much effect on the path of global warming. In a 1998 paper climate scientist Tom Wigley simulated the effects of full compliance with the Kyoto Protocol on the global atmospheric CO_2 concentration over the 21st century. His main results are shown in Figure 3, copied from his paper.

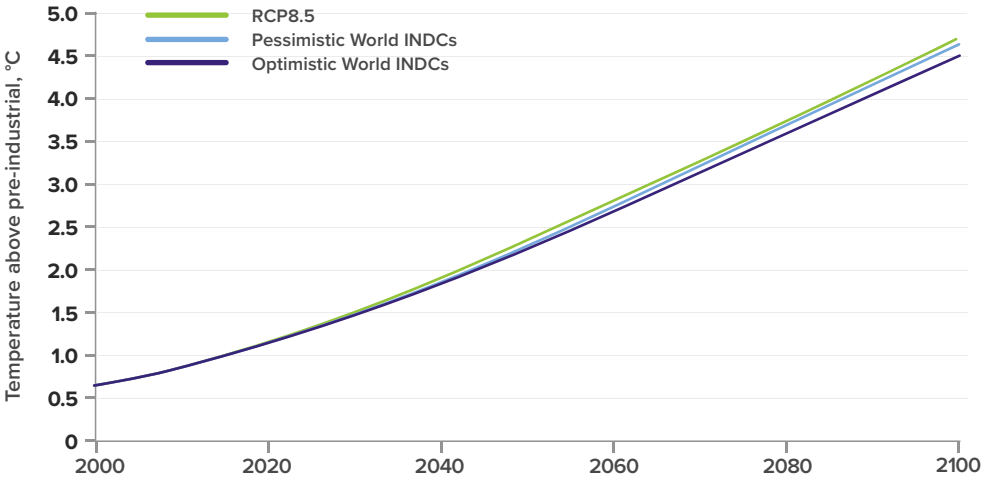
The topmost thick blue line represents projected atmospheric CO_2 levels over the 21st century based on an emissions scenario called IS92a. The next line down (dotted) shows the results from full compliance with the Kyoto Protocol, yielding a reduction of about 15 parts per million (ppm) as of the year 2100. The other lines show what would happen if Kyoto were

FIGURE 3: EFFECTS OF COMPLIANCE WITH THE KYOTO PROTOCOL ON THE GLOBAL ATMOSPHERIC CO_2 CONCENTRATION OVER THE 21ST CENTURY



Source: Reproduced from Wigley (1998).

FIGURE 4: EFFECTS OF COMPLIANCE WITH THE KYOTO PROTOCOL ON THE TEMPERATURE CHANGES OVER THE 21ST CENTURY



Source: Reproduced from Lomborg (2016).

supplemented later with more stringent climate policies. It is immediately apparent that even full compliance with Kyoto would not have stopped CO_2 from accumulating in the atmosphere; instead it would have merely delayed by a couple of years the date at which CO_2 reaches 700 ppm, as of the end of the century.

Bjorn Lomborg (2016) did a similar analysis for the Paris Climate Treaty pledges. The results were shown in Figure 11 of that study, which is reproduced as Figure 4 here. (Note it is shown in terms of projected temperature changes rather than CO_2 concentrations).

The assumed baseline emissions path yields the topmost green line. Full compliance with the Paris Treaty yields either the light or dark blue lines, depending on whether countries supplement their emission reduction activities later in the century beyond the initial requirements. Even under the optimistic scenario, the Paris Treaty only results in a global average temperature reduction of 0.17°C as of 2100 below the no-policy baseline, and only 0.05°C in the pessimistic scenario, yielding an expected change of about 0.1°C.

The clear implication is that even total compliance with the current global policy frameworks will have little to no material effect on the accumulation of CO_2 in the atmosphere or the progress of climate change. The proposed changes are too small at the global level in the context of the global carbon cycle to matter, despite which they have also largely proven to be too costly to implement. To an even greater extent therefore, all domestic Canadian policies are likewise utterly irrelevant to the progress of climate change over the coming century.

The leakage problem

When an international emissions control treaty like Kyoto or Paris binds some regions but not others, it creates an incentive for industries whose costs will rise to relocate production to the non-participating regions. In the case of climate policy this is referred to as "carbon leakage." Since climate does not respect international borders only the global total of emissions matters; if climate policy simply rearranges the location of emissions but does not reduce them, it is a futile gesture.

Prior to the implementation of Kyoto there were large-scale modeling studies that suggested leakage might or might not be a problem depending on how easily industrial activity could relocate. In a worst-case scenario, if heavy industry were to migrate from a region with low carbon intensity to one with high carbon intensity, it might yield a net increase in global emissions. Empirical evidence in the years after Kyoto's implementation showed that leakage is, in fact, a real phenomenon and helps explain why Kyoto has had no effect.

Participating countries did reduce their emissions, but they also increased the carbon intensity of their imports: in other words, the emitting activity simply shifted to regions without CO_2 controls such as China and India.

> *The emitting activity simply shifted to regions without CO_2 controls such as China and India.*

In a pair of peer-reviewed papers in 2012 and 2015, economists Rahel Aichele and Gabriel Felbermayr analyzed large international databases that measured bilateral trade and carbon intensity factors. They found that after Kyoto was implemented, participating countries reduced their emissions while non-participating countries increased theirs by an amount sufficient to fully offset the reductions. In effect some countries reduced their carbon emissions but not their carbon "footprint" since the emissions-intensity of their imports went up. The authors concluded that the Kyoto Protocol "imposed substantial costs on firms and consumers in committed countries, but the return of all these efforts – lower global carbon emissions – has been statistically indistinguishable from zero" (Aichele and Felbermayr 2012).

One reason for the ineffectiveness of mitigation policy is that governments have pursued very costly options that have turned out not to be economically viable. In this regard Germany serves as a good example. Under Angela Merkel's *Energiewende* policy Germany invested heavily in wind and solar generation which, along with natural gas, was intended to replace coal-fired and nuclear capacity. Yet when the Russia-Ukraine war began and Germany faced a sudden need to wean itself off Russian gas, its response was not to build wind turbines and solar panels but to restart its coal-fired power plants (Montel 2023) and to expedite construction of a new floating liquified natural gas (LNG) import terminal (Connolly 2022). One of the world's biggest promoters of wind and solar power thus turned to fossil fuels when faced with a sudden need for reliable and affordable electricity, which is a tacit admission that its pursuit of renewables was incompatible with reliability and cost-effectiveness.

Effectiveness of adaptation

In contrast to the relative ineffectiveness of mitigation policies at reducing global CO_2 emissions or concentrations, adaptation measures have been shown to be effective at reducing vulnerability to climate and weather risks.

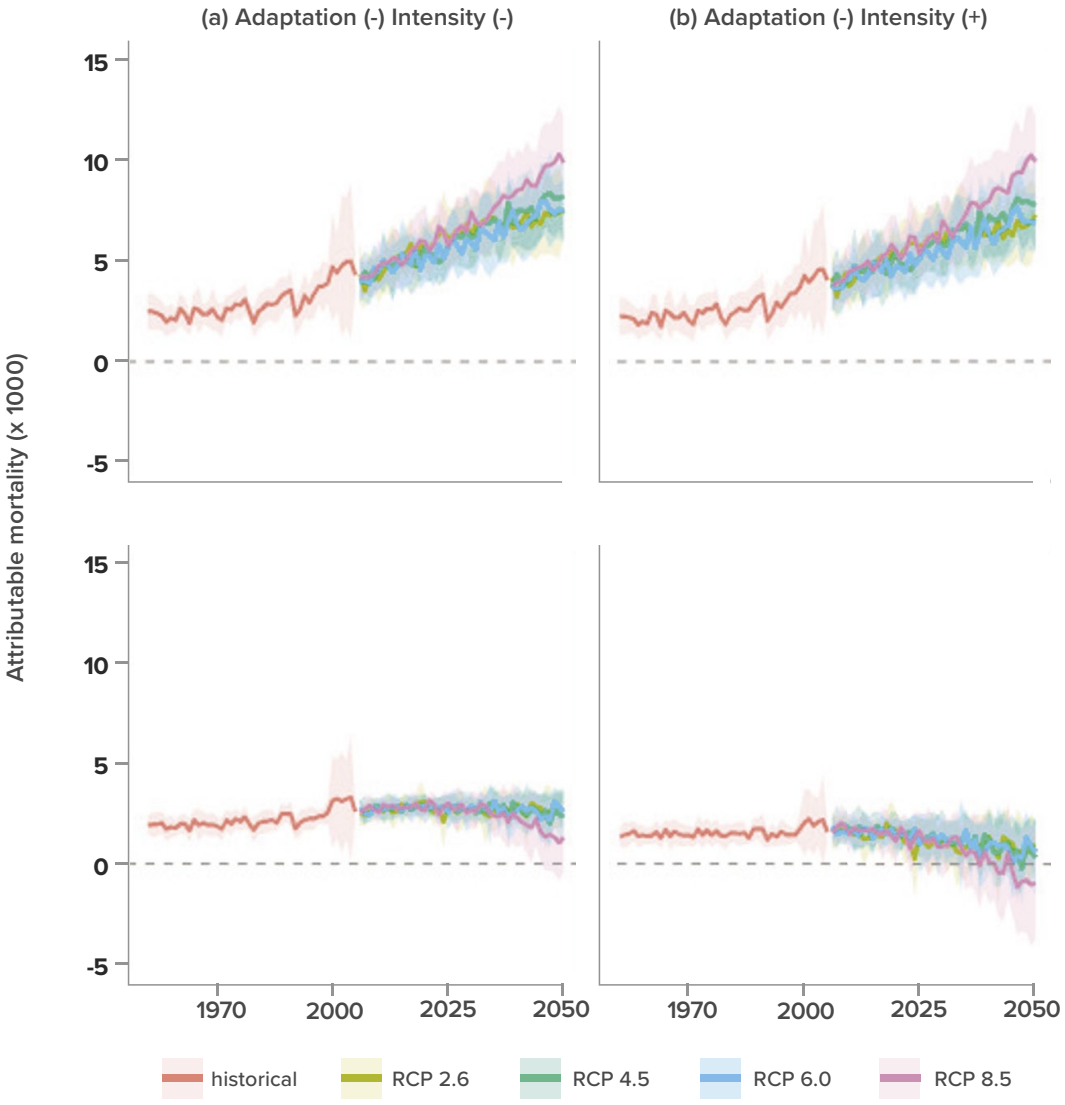
Heat waves and health outcomes

Numerous studies have shown that heat-related mortality risks in US cities have declined over time despite increasing population levels. Davis et al. (2003) examined heat-related excess mortality in 28 US cities from the 1960s to the end of the 1990s and found that heat-related mortality declined by three-quarters over the sample period. Bobb et al. (2014) examined mortality data for 106 million people in 105 US cities from 1987 to 2005. They found a 60 percent decline in average heat-related mortality over this time, from 51 deaths per thousand to 19. Furthermore, they found that the greatest drop in heat-related mortality was among seniors over the age of 75. Nordio et al. (2015) examined 42 million deaths in 211 US cities from 1962 to 2006 and found a decline of more than 90 percent in the risk of mortality from excess heat over the sample period.

> *This decline in heat-related mortality has been specifically attributed to adaptation.*

This decline in heat-related mortality has been specifically attributed to adaptation. Different locations appear to experience differing levels of risk from hot weather. Wang et al. (2018) examined the reasons for these variations using a dataset covering 209 US cities from 1962 to 2006. They took in account evidence of adaptive behaviour and of the way effects vary depending on the intensity of a heat wave and concluded that adaptive behaviour has been effective in eliminating the relationship between heat and mortality in the United States.

FIGURE 5: HOW PROJECTIONS OF FUTURE WARMING AFFECT ATTRIBUTABLE HEAT-RELATED MORTALITY UNDER FOUR ASSUMPTIONS

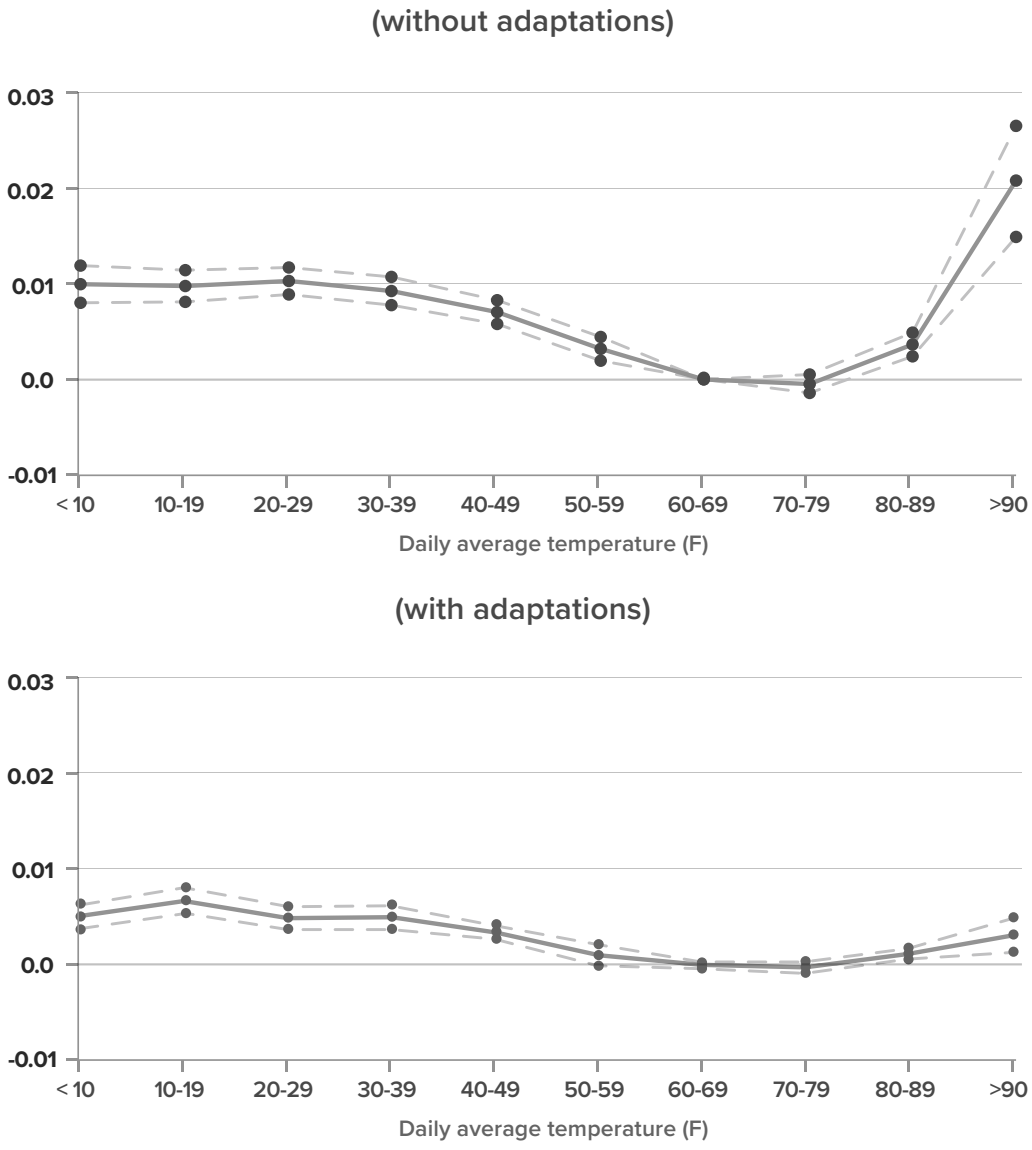


Source: Reproduced from Wang et al. (2018).

Figure 5 (their Figure 2) summarizes the results by showing how projections of future warming would affect attributable heat-related mortality under four assumptions: (a) no controls for adaptation or intensity of a heat wave; (b) controls only for intensity; (c) controls only for adaptation; (d) controls for both.

Focusing on panel d (bottom right), the authors project that once adaptation is accounted for, there would be an outright decline in heat-related

FIGURE 6: ESTIMATED IMPACT OF TEMPERATURE VARIATIONS ON MORTALITY IN 1931-1959 WITHOUT ADAPTATIONS AND IN 1960-2004 WITH ADAPTATIONS



Source: Reproduced from Barreca et al. (2016): 129.

mortality even under the most extreme warming scenario. The authors state: "Ignoring adaptation would result in a substantial overestimate of future mortality related to heat waves... Accounting for adaptation, the overall heat-related mortality by 2050 would not change substantially over time compared to 2006."

The success of adaptation has become possible due to the availability of air conditioning (AC) and inexpensive electricity. Barreca et al. (2016) examined US long term mortality risks associated with temperature variations and showed that increases in mortality are associated with both cold and hot weather. But over time, the introduction of electricity and the adoption of central heating and air conditioning dramatically reduced both risks, especially those associated with hot weather. Their main results are summarized in the pair of graphs shown in Figure 6.

The top panel shows results for data spanning 1931 to 1959 and the bottom covers data from 1960 to 2004. The data points show the increase in mortality risk associated with an extra day in the indicated temperature range, relative to a day in the 60-69°F (15-21°C) range. Prior to 1960, a day above 90°F (32°C) added 2.2 percent to the average mortality risk rate, but after 1960 the same weather added only 0.3 percent to mortality risk, an 85 percent reduction. Prior to 1960 temperatures below 39°F (4°C) added about 1 percent to mortality risk but after 1960 the same weather only added about half that amount. Adaptation through conventional household improvements therefore dramatically reduced public vulnerability to weather extremes. The study went on to show that the entire reduction in hot weather mortality was attributable to widespread adoption of indoor AC.

> *This form of adaptation depends critically on the availability of reliable and affordable electricity.*

This form of adaptation depends critically on the availability of reliable and affordable electricity. Doremus et al. (2022) showed that on very hot days (>30°C) US residential electricity spending rises in high-income households but not in low-income households. The latter result is observed even in subsamples where all households have AC. The implication is that even with widespread adoption of home heating and cooling systems, the inability to afford energy leaves low-income households exposed to weather extremes.

This points to the problem with aggressive mitigation policies: they may impede adaptation and increase vulnerability to weather. Policy-makers need to

understand the potential trade-offs they are making with their plans. Attempts to reduce emissions through policies that push high energy prices even higher will expose more members of the public to greater risk of harm from heat waves, yet as we saw in the previous section, such policies have a track record of being completely ineffective at reducing future temperatures.

Agriculture

In the Working Group II volume of the IPCC's *Fifth Assessment Report* (Arent et al. 2014) the authors highlighted the importance of adaptation in limiting the negative consequences of future warming. They concluded:

> It is only about as likely as not that the net effect of climate and CO2 changes on global yields will be negative by 2050, but likely that such changes will occur later in the 21st century. At the same time, it is likely that socioeconomic and technological trends, including changes in institutions and policies, will remain a relatively stronger driver of food security over the next few decades than climate change. (p. 513)

Challinor et al. (2014) presented a meta-analysis of studies looking at responses to combinations of increased temperature, CO_2 levels, and precipitation, contrasting the results with and without adaptation. CO_2 levels matter independently of their effect on temperature because plants consume CO_2 so increased abundance in the air enhances crop growth. Challinor et al. found that average crop yield gains increased 0.06 percent per part per million (ppm) increase in CO_2 concentration and 0.5 percent per percentage point increase in precipitation while warming decreased it by 4.9 percent per °C. They also found that adaptation was associated with an overall 7.2 percent crop yield gain. Putting these together, suppose that over the next 100 years CO_2 doubles from 400 to 800 ppm while temperatures rise by 3°C and precipitation increases on average by 2 percent. Challinor et al.'s regression coefficients would imply an average crop yield increase of 2.2 percent in the tropics without adaptation versus 9.3 percent with; and 5.0 percent outside the tropics without adaptation versus 12.1 percent with.

The IPCC's *Sixth Assessment Report* from Working Group II (Bezner et al. 2022) again highlighted the importance of adaptation:

> Two global-scale studies using multiple global gridded crop models found that growing season adaptation through cultivar changes offsets global production losses up to 2°C of temperature increase. (p. 742)

The two studies did not account for gains due to CO_2 fertilization. Another study which did take account of CO_2 fertilization projected losses after 2040 even with adaptation but unfortunately relied on the extreme RCP8.5 high emissions scenario which has been heavily criticized as implausible (e.g. Hausfather and Peters 2020; Pielke and Ritchie 2020) so its projections are likely too pessimistic. Overall the IPCC called for more research on the effects of adaptation, concluding

> Various adaptation options are currently feasible and effective at reducing climate impacts in different socio-cultural, economic and geographical contexts (*high confidence*), but some lack adequate economic or institutional feasibility or information on limits (*medium confidence*). (Bezner et al. 2022, 5; emphasis in original)

Bareille and Chakir (2023) is a new entrant in the economics literature that aims to begin filling the information gap. Past work relating climate conditions to agriculture used variations in land values and their correlation to climate variables to infer the benefits and costs of changes in temperature and precipitation. This approach (called "Ricardian analysis") tended to conclude that, in temperate zones at least, climate warming would on balance be beneficial for agriculture once adaptation is accounted for. This approach was subsequently criticized for potentially leaving out other important drivers of land value that change over time, and later authors argued the benefits of warming would be much smaller or even negative. Bareille and Chakir (2023) addressed the criticisms by assembling a large database on farm sale prices in France for properties that sold twice between 1996 and 2019. By comparing the change in land value on the same farm to local climatic and economic changes they were able to remove the confounding influence of fixed site-specific characteristics and isolate the contribution of climate variables. They concluded that, taking adaptation into account, a warming climate would yield positive benefits for French agriculture that were between 2 and 20 times larger than had been estimated previously. On average, with full adaptation, climate changes anticipat-

ed under the RCP4.5 medium emissions scenario could add 100 percent to the value of French farmland by 2100.

Here again we need to note that adaptation practices on farms depend on the availability of, among other things, affordable energy and nitrogen fertilizers. Yet both of these are being put at risk by contemporary mitigation policies.

Forestry

The IPCC AR5 Working Group II report (Arend et al. 2014) included an assessment of the effects of adaptation to climate change on forest management outcomes. They concluded adaptation would yield net gains:

> Including adaptation in forest management, climate change will accelerate tree growth. This will reduce prices to the benefit of consumers everywhere. (Arend et al. 2014, 676).

The AR6 (Bezner et al. 2022, sec. 5.6.3) reiterates the importance of adaptation: "A systematic review of literature revealed that successful adaptation in forest management can be achieved if there are partnerships between key stakeholders such as researchers, forest managers and local actors," although they cautioned that under high emission scenarios adaptation may not happen quickly enough to prevent loss of some forest ecosystem services.

Extreme weather

Even if a slow warming trend is not considered a problem, many worry that increased extreme weather, especially heavy precipitation and windstorms, will cause escalating flooding and property damage. In general, Canadian buildings must already be able to withstand a wide range of weather conditions including extreme heat and cold, high winds, and heavy precipitation. This is not new. Also, despite popular beliefs about worsening precipitation in Canada, Environment and Climate Change Canada does not claim such a trend has been observed (Robson 2019). Also, referring to precipitation extremes, the IPCC AR6 noted, "In Canada, there is a lack of detectable trends in observed annual maximum daily (or shorter duration) precipitation" (IPCC 2021, ch. 11, 55). An advantage to an adaptation-focused approach is that it prioritizes responses to actual hazards rather than projected ones that may not materialize.

Mainstream economics has always emphasized adaptation

In January 1992 the president of the American Economic Association, Professor Thomas Schelling, delivered an address to the membership summarizing his views on the economics of climate change. Schelling considered the likely impacts of 3 degrees warming over the coming century and concluded they would hardly be noticeable for most people.

> Manufacturing rarely depends on climate, and where temperature and humidity used to make a difference, air conditioning has intervened. When Toyota chooses among Ohio, Alabama, and Southern California for locating an automobile assembly, geographical considerations are important, but not because of climate. Minerals are extracted where they happen to occur, and oil fields and coal mines inhabit all kinds of climates and are little affected.... Finance is little affected by climate; similarly for health care, or education, or broadcasting. Transportation can be affected, but improvements in all-weather landing and take-off in the last 30 years are greater than any differences that climate makes. If the average effect is a warming, iced waterways and snow removal may decline in importance. Construction is affected, mainly by cold, and if the average effect is in the direction of warming, construction may benefit slightly.
>
> **... I conclude that in the United States, and probably Japan, Western Europe, and other developed countries, the impact on economic output will be negligible and unlikely to be noticed. And there is no reason to believe that in these countries there could be a noticeable impact on health.** Any influence of climate on health in this country would be more in the regional distribution of the population than in changes in local and regional climates. (Schelling 1992, emphasis added)

The mainstream view on climate policy among economists in the decades since hewed closely to this view. They are best represented by the findings from Integrated Assessment Models (IAMs) of climate change policy, for which Yale economist William Nordhaus was awarded the 2018 Nobel Prize in economics. His work supports modest climate policy but also shows that many current policy plans are far costlier than doing nothing and instead simply adapting to the changes.

> *Trying to limit warming to 2.5°C is worse than doing nothing at all and simply adapting to it.*

Nordhaus (2018) presents an analysis of three climate scenarios: doing nothing (which in his model leads to 4.1°C warming relative to preindustrial times), the optimal level of mitigation, and an aggressive attempt to limit warming.[2] The first scenario leads to $134.2T (trillion dollars) in climate damages but incurs only $0.4T in abatement costs for a total cost of $134.6T. The optimal policy scenario yields 3.5°C warming relative to preindustrial times, which is only a little below the business-as-usual path. It involves $84.6T in damages and $20.1T in abatement costs for a total cost of $104.7T, which is better than the baseline by about $30T. Notably this scenario primarily involves adapting to warming rather than trying to prevent it. The third scenario proposes emission cuts aimed at capping warming at 2.5°C, which still means considerable adaptation is required. This path involves $34.1T in damages and $134.6T in abatement costs, for total costs of $177.8T, which is $43.2T worse than the baseline. In other words, trying to limit warming to 2.5°C is worse than doing nothing at all and simply adapting to it.

Some economists have been critical of Nordhaus' model because he does not have an explicit representation of the possibility of large-scale climate disasters (like melting polar ice caps). He has discussed this issue and has taken the empirically relevant aspects of it into account in the version of the DICE (Dynamic Integrated Climate-Economy) model which I cite here, so I do not find this argument provides compelling grounds to reject his results. Bressler

(2021) added an estimated warming-induced mortality function to DICE which causes the damages to jump nearly 10-fold. However, Bressler himself reported that the mortality effects are too imprecise to be statistically significant. He estimated a 90 percent confidence interval on the mortality effect for the year 2100 from to , which means the effect is statistically indistinguishable from zero. Also the entire mortality effect is driven by the RCP8.5 scenario, diminishing its validity.

Carleton et al. (2022) analyzed a newly developed global database of climate variations and mortality rates around the world and, similarly to Bressler, used the mortality function to project death rates attributable to carbon dioxide emissions. Unfortunately they also focused on RCP8.5 scenarios for their main results. But in their online appendix they report results using the more reasonable RCP4.5 emission scenario. They project that without adaptation, global warming will raise mortality rates worldwide by 40.3 deaths per 100,000 persons. Accounting for the benefits of income growth and adaptation this falls by two-thirds to 14.2 deaths per 100,000, at which point the effect is not statistically significant. Once again, these results show that adaptation and income growth are key to providing an effective response to climate change, but the current focus on costly mitigation policy puts both at risk.

Other proposed modifications to DICE work in the other direction, namely, reducing projected damages. For example, one criticism of DICE is that it does not identify a distinct CO_2 fertilization effect, so new evidence on the "greening" benefit associated with rising atmospheric CO_2 levels cannot be incorporated. Zhu et al. (2016), for instance, used satellite-derived estimates of leaf coverage from 1982 to 2009 and showed significant global greening which the authors concluded was 70 percent attributable to increased atmospheric CO_2 levels. A different Integrated Assessment Model called the Climate Framework for Uncertainty, Negotiation and Distribution (FUND) (see Anthoff and Tol 2013) includes much more detailed region-specific damage functions that allow for slight gains in agriculture due to extra CO_2 in the atmosphere and typically generates smaller climate estimated damages compared to DICE. Dayaratna et al. (2020) incorporated updated scientific evidence on CO_2 fertilization and climate sensitivity to greenhouse gas emissions into FUND and found the implied economic costs of CO_2 emissions dropped dramatically, becoming near zero through the mid-20th century.

Conclusion

Over the past 30 years mitigation has been the dominant focus of policy responses to the climate change issue, yet in practice it has not been successful. Global emissions have continued rising and people have simply adapted to the climate changes they have experienced, often without even thinking about it. It is obvious that in future adaptation will continue, and is likely not only to be a beneficial response to climate change but the only successful one available. Thirty years of policy experience has shown that preventing global emissions from rising, or the climate from changing, is not going to be feasible. Meanwhile, a solid body of research has shown that adaptation to past weather and climate variations has been successful at, for instance, reducing the mortality impacts of heat waves and allowing farmers to benefit from changing growing conditions.

It is also apparent, however, that adaptation and mitigation cannot be assumed to be complements. Pursuit of aggressive emission reduction targets involves raising energy costs and lowering real incomes, both of which directly limit peoples' ability to take adaptive measures to respond to climate variations, whether natural or manmade. At some point a choice of focus will need to be made. Policy-makers must confront this imperative and make a specific priority of avoiding mitigation measures that harm peoples' ability to undertake defensive adaptation measures to address future weather and climatic variations. MLI

About the author

Ross McKitrick holds a Ph.D. in economics from the University of British Columbia (1996) and is a professor of economics at the University of Guelph in Guelph, Ontario. He is the author of *Economic Analysis of Environmental Policy* published by the University of Toronto Press in 2010. He has been actively studying climate change, climate policy, and environmental economics since the mid-1990s. He built and published one of the first national-scale Computable General Equilibrium models for analyzing the effect of carbon taxes on the Canadian economy in the 1990s. His academic publications have appeared in many top journals including the *Journal of the Royal Statistical Society, Proceedings of the National Academy of Science, Journal of Geophysical Research, Climate Dynamics, Journal of Environmental Economics and Management, The Canadian Journal of Economics, Canadian Public Policy, Energy Economics, Journal of Forecasting, Climatic Change, Climate Change Economics and Environmental Economics and Policy Studies*. He has also written policy analyses for the Fraser Institute (where he is a senior fellow), the CD Howe Institute, the University of Calgary School of Public Policy, and other Canadian and international think tanks. Professor McKitrick appears frequently in Canadian and international media and is a regular contributor to the *Financial Post* Comment page. In addition to his economics research his background in applied statistics has led him to collaborative work across a wide range of topics in the physical sciences including paleoclimate reconstruction, malaria transmission, surface temperature measurement, and climate model evaluation. MLI

References

Aichele, Rahel, and Gabriel Felbermayr. 2012. "Kyoto and the Carbon Footprint of Nations." *Journal of Environmental Economics and Management* 63, 3 (May): 336-354. Available at https://doi.org/10.1016/j.jeem.2011.10.005 [paywall].

Aichele, Rahel, and Gabriel Felbermayr. 2015. "Kyoto and Carbon Leakage: An Empirical Analysis of the Carbon Content of Bilateral Trade." *The Review of Economics and Statistics* (MIT Press) 97, 1: 104–15. Available at http://www.jstor.org/stable/43554982 [paywall].

Anthoff, David, and Richard S.J. Tol. 2013. "The Uncertainty about the Social Cost of Carbon: A Decomposition Analysis using FUND." *Climatic Change* 117: 515-530. DOI: 10.1007/s10584-013-0706-7 [paywall].

Arent, Douglas J., Richard S.J. Tol, et al. 2014. "Key Economic Sectors and Services." In C.B Field et al. (eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press): 659-708.

Bareille, Francois, and Raja Chakir. 2023. "The Impact of Climate Change on Agriculture: A Repeat-Ricardian Analysis." *Journal of Environmental Economics and Management* 119 (May): 102822 https://doi.org/10.1016/j.jeem.2023.102822 [paywall].

Barreca, Alan, Karen Clay, Olivier Deschenes, et al. 2016. "Adapting to Climate Change: The Remarkable Decline in the US Temperature Mortality Relationship over the Twentieth Century." *Journal of Political Economy* 124, 1: 105–159.

Bezner Kerr, Rachel, Toshihiro Hasegawa, Rodel Lasco, et al. 2022. "Food, Fibre, and Other Ecosystem Products." In H.-O. Pörtner et al. (eds.), *Climate*

Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press): 713–906. Available at https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter05.pdf.

Bobb Jennifer F., Roger D. Peng, Michelle L. Bell, and Francesca Dominici. 2014. "Heat-Related Mortality and Adaptation to Heat in the United States." *Environmental Health Perspectives* 122, 8: 811–816. Available at https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.1307392.

BP. 2022. *Statistical Review of World Energy*. BP. Available at https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

Bressler, R. Daniel. 2021. "The Mortality Cost of Carbon." *Nature Communications* 12: 4467. Available at https://doi.org/10.1038/s41467-021-24487-w.

Carleton, Tamma, Amir Jina, and Michael Delgado, et al. 2022. "Valuing the Global Mortality Consequences of Climate Change Accounting for Adaptation Costs and Benefits." *Quarterly Journal of Economics* 137, 4: 2037-2105. Available at https://doi.org/10.1093/qje/qjac020.

Challinor, Andrew J., Jean Watson, D.B. Lobell, et al. 2014. "A Meta-Analysis of Crop Yield under Climate Change and Adaptation." *Nature Climate Change* 4: 287-291. Available at https://www.nature.com/articles/nclimate2153 [paywall].

Connolly, Kate. 2022. "Germany Completes Construction of Its First Floating LNG Terminal." *The Guardian* (November 15). Available at https://www.theguardian.com/world/2022/nov/15/germany-completes-construction-floating-lng-terminal-liquefied-natural-gas-energy.

Davis, Robert E., Paul C. Knappenberger, Patrick J. Michaels, and Wendy M. Novicoff. 2003. "Changing Heat-Related Mortality in the United States." *Environmental Health Perspectives* 111, 14 (November): 1712–1718.

Dayaratna, Kevin, Ross McKitrick, and Patrick J. Michaels. 2020. "Climate Sensitivity, Agricultural Productivity and the Social Cost of Carbon in FUND." *Environmental Economics and Policy Studies* 22: 433-448. Available at https://doi.org/10.1007/s10018-020-00263-w [paywall].

Doremus, Jacqueline M., Irene Jacqz, and Sarah Johnston. 2022. "Sweating the Energy Bill: Extreme Weather, Poor Households, and the Energy Spending Gap." *Journal of Environmental Economics and Management* 112 (March): 102609. Available at https://doi.org/10.1016/j.jeem.2022.102609.

Global Monitoring Laboratory. Undated. "Trends in Atmospheric Carbon Dioxide." US National Oceanic and Atmospheric Administration. Available at https://gml.noaa.gov/ccgg/trends/.

Global Monitoring Laboratory. 2023. "Carbon Tracker Project CT2022." US National Oceanic and Atmospheric Administration. Available at https://gml.noaa.gov/ccgg/carbontracker/, as of April 18, 2023.

Hausfather, Zeke, and Glen P. Peters. 2020. "Emissions – the 'Business as Usual' Story is Misleading." *Nature* 29 (January). Available at https://www.nature.com/articles/d41586-020-00177-3 [paywall].

Intergovernmental Panel on Climate Change [IPCC]. 2013. *Working Group I Contribution to the Fifth Assessment Report*. Cambridge University Press. Available at https://www.ipcc.ch/report/ar5/wg1/.

Lomborg, Bjorn. 2016. "Impact of Current Climate Proposals." *Global Policy* 7, 1: 109—118. Available at http://onlinelibrary.wiley.com/doi/10.1111/1758-5899.12295/full.

Montel. 2023. "German 20% Coal Surge Threatens Climate Goals – Agora." Montel Group (January 4). Available at https://www.montelnews.com/news/1401925/german-20-coal-surge-threatens-climate-goals--agora.

Nordhaus, William. 2018. "Projections and Uncertainties about Climate Change in an Era of Minimal Climate Policies." *American Economic Journal: Economic Policy* 10, 3 (August): 333–360. Available at https://pubs.aeaweb.org/doi/pdfplus/10.1257/pol.20170046.

Nordio, Francesco, Antonella Zanobetti, Elena Colicino, et al. 2015. "Changing Patterns of the Temperature-Mortality Association by Time and Location in the US, and Implications for Climate Change." *Environment International* 81: 80–86. Available at https://doi.org/10.1016/j.envint.2015.04.009 [paywall].

Pielke, Roger, Jr., and Justin Ritchie. 2020. *Systemic Misuse of Scenarios in Climate Research and Assessment*. Social Sciences Research Network (April). Available at: https://ssrn.com/abstract=3581777.

Ritchie, Hannah, and Max Roser. Undated. "CO_2 Emissions." Our World in Data. Available at https://ourworldindata.org/co2-emissions.

Robson, John. 2019. "Urban Flooding – It's Not about Climate." Climate Discussion Nexus (July 31). Available at https://climatediscussionnexus.com/videos/urban-flooding-its-not-about-climate/

Schelling, Thomas. 1992. "Some Economics of Global Warming." *American Economic Review* 82, 1 (March): 1-14.

United Nations Framework Convention on Climate Change [UNFCCC]. [1998]. "Text of the Kyoto Protocol." UNFCCC. Available at https://unfccc.int/process-and-meetings/the-kyoto-protocol/history-of-the-kyoto-protocol/text-of-the-kyoto-protocol.

Wang, Yan, Francesco Nordio, John Nairn, et al. 2018. "Accounting for Adaptation and Intensity in Projecting Heat Wave-Related Mortality." *Environmental Research* 161 (February): 464—471. Available at https://doi.org/10.1016/j.envres.2017.11.049 [paywall].

Wigley, Tom M.L. 1998. "The Kyoto Protocol: CO_2, CH_4 and Climate Implications." *Geophysical Research Letters* 25, 13: 2285-2288.

Zhu, Zaichun, Shilong Piao, Ranga Myneni, et al. 2016. "Greening of the Earth and its Drivers." *Nature Climate Change* 6: 791-795. Available at https://www.nature.com/articles/nclimate3004 [paywall].

Endnotes

1 This rough calculation may be an underestimate. According to the Carbon Tracker project at the US National Oceanic and Atmospheric Administration (Global Monitoring Laboratory 2023), emission reductions would have to be about 80 percent to stop the concentration of CO_2 from growing further.

2 Nordhaus examines two additional scenarios with even more stringent goals but I will omit discussion of these for brevity.

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