# UNSETTLED

Steven E Koonin

**The Global Warming Policy Foundation**

2021 Annual Lecture

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2021 Annual Lecture, The Global Warming Policy Foundation



## About the lecturer

Steven E Koonin is a theoretical physicist. He was previously Under Secretary for Science in the Department of Energy, during the Obama administration.

## Opening address from Dr Benny Peiser

Good evening, ladies and gentlemen. I am so pleased to see you in person tonight. We've missed you for the last two years.

We are delighted that Professor Steven Koonin has been able to travel from New York to London to deliver the Annual GWPF Lecture tonight. Some of you may have read Steve's best-selling book *Unsettled: What Climate Science Tells Us, What It Doesn't, and Why It Matters*. If you haven't done so yet, please do. It is certainly one of the best books on the current state of climate science and the climate debate – discussing what we know, what we know tentatively and what we don't know.

Essentially, what Steven Koonin has done in his book is to translate the IPCC reports into plain English. He has turned what is an extremely complex, convoluted and highly theoretical document into a reader-friendly book that allows the layman to understand the main findings and conclusions of the IPCC. That's what he has done.

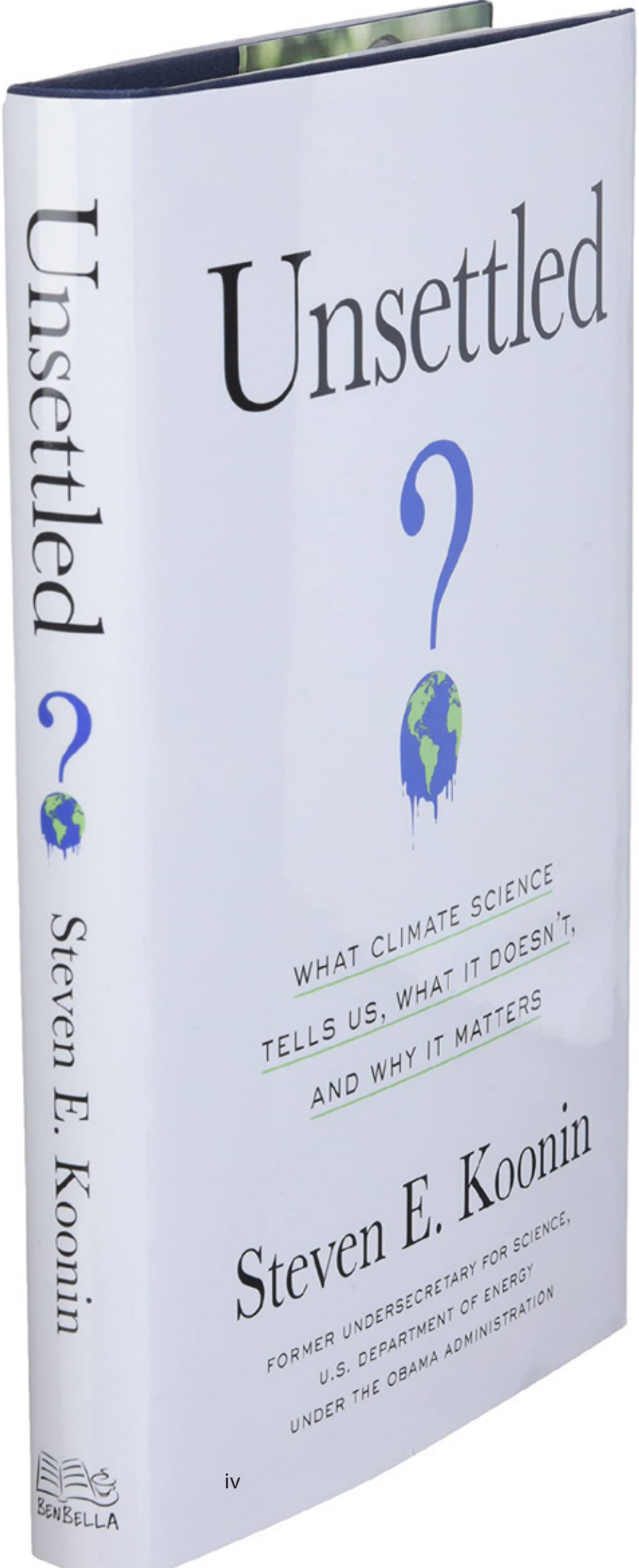
Now, here's the thing. Given that he has essentially tried to explain to ordinary people what these complex documents actually say, why are climate activists so enraged about this and his assessment?

I was trying to find a historical analogy to a situation where someone was using an authoritative document and translating it for everyday use and for ordinary people. And then I remembered the 16th century scholar William Tyndale, who translated the Bible into English. Well, he got into trouble and was eventually burned. What is interesting is that Tyndale rejected the then 99.9% consensus view that the scriptures could only be interpreted by approved clergy. His translation of the Bible allowed lay people to read, analyse and interpret scripture independently.

In fact, anyone found in the possession of an English translation of the Bible faced the death penalty at the time. Tyndale's translation was seen as a genuine threat to the consensus and the leadership of the elite. Of course he took advantage of the new 'social media' – I mean of course the printing press – to disseminate his translation.

Eventually, Tyndale was arrested, he was strangled, and his body was burnt at the stake.

We are, of course, very thankful that after 500 years of progress, eminent scholars accused of being heretics are no longer strangled. Or burned. And certainly not in this room.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FORMER UNDERSECRETARY FOR SCIENCE,
U.S. DEPARTMENT OF ENERGY
UNDER THE OBAMA ADMINISTRATION
BENBELLA

# Unsettled

## 2021 Annual GWPF Lecture by Steven E Koonin

I wanted to start with some thoughts about policy and observations. Policies ultimately express values and priorities. With respect to energy and climate, we need to consider risk tolerance, intergenerational equity, geographical equity and so on, but they must be informed by a clear picture of the scientific certainties and uncertainties. So, let's have a look at what some of our current policymakers say about the science. On his first day in office, President Biden issued an executive order and said, 'I'm going to listen to the science'. Over here, on this side of the pond, we have your PM saying recently, 'It's one minute to midnight on that Doomsday clock and we all need to act now'. On August 9th 2021, when the UN released its most recent scientific assessment – AR6 as it's called – Secretary General Guterres said, 'It's code red for humanity and billions of people are at immediate risk'. Mostly in the United States you have people talking about 'existential threat', 'climate crisis', 'climate catastrophe', 'climate disaster' and so on; not only Mark Carney, who is perhaps familiar on this side of the pond, but also my good friend Ernie Moniz, who was secretary of energy in the second Obama administration, and Bill Gates and so on too. In the Pentagon, General Lloyd Austin has elevated climate crisis to an 'existential national security threat', which means we better take it seriously.

Where are all these folks getting their information from? Well, it starts with the assessment reports that are issued periodically by the UN, and the US government; the UK government does them occasionally as well. The UN Intergovernmental Panel on Climate Change – the IPCC – issued its penultimate assessment report (AR5) in 2014, and by August 9th this year we had AR6. The US issues its national climate assessment every four years. The last came out in 2018, in two volumes: in 2017 the *Climate Science Special Report* and then the rest in 2018. The fifth one is expected in a couple of years.

I can guarantee you that none of the people I just mentioned have ever read them. But when you do read them – and I have – they say important and surprising things. The way I like to characterise it is to paraphrase a quote from *The Princess Bride* movie. One of the characters, Vizzini, keeps saying the word 'inconceivable', and at some point the main character, Inigo Montoya, gets really mad and says, 'You keep using that word. I don't think it means what you think it means'.

So in the case of the climate assessments, I don't think the science says what most people think it says. There are some surprises. Let me give you a couple of salient facts from these reports. At least in the US, despite the fact that the average temperature has indeed gone up since 1960, heatwaves are now no more common than they were in 1900, and the warmest temperatures of the year have not gone up in the past 50 years. That's right there in the *Climate Science Special Report*. The global fire record shows about a 25% decrease since 2003 in the land area burned, and last year was one of the least active years

on record.[1]

Greenland's ice sheet is not melting any more rapidly in recent decades than it was eight decades ago.[2] Again, it's right there in the data. And there's no detectable trend in, or human influence on, tropical cyclones – hurricanes – over the last century.[3] And maybe more surprisingly, when you read the reports of both the UN and the US government, the net economic impact of a warming of up to 6 degrees above pre-industrial temperatures – you remember Paris is aiming at 2 degrees or maybe 1.5 – will be minimal.[4] The statements like these and many others that you can find in the reports belie the canon on climate catastrophe, namely that we've already broken the climate and we need to take drastic action in order to prevent catastrophe.

When the UN report came out August 9th, Guterres said, as I mentioned, it was 'Code red for humanity'. But when you search all 3,942 pages of that report – written by a couple of hundred scientists over three years – you don't find the words 'existential threat', 'climate catastrophe', or 'climate disaster' at all. You find the words 'climate crisis' exactly once, and that's not a scientific finding; it is used in reference to the way in which the media have amped up their coverage. So, how is it that the science – which is pretty good science, or at least as good as any other field I know – gets turned into 'the science' that everybody quotes? And the answer is that it's a long game of telephone. It starts with the fundamental data and the research papers, it goes into these assessment reports, which survey and distil it down, it then goes on to the Summaries for Policymakers in those reports, and then onto the media and the politicians. And as you go through this chain there are ample opportunities to distort or to misinform.

Climate is a 30-year average; weather is what happens every day or every year. They are not the same thing. People confuse climate change with a changing climate. Climate change has come to mean changes due to human influences. The climate changes, as we shall see, for perfectly good reasons on its own. People highlight recent trends without taking historical context into account. We see implausibly extreme emissions scenarios labelled as 'business as usual' in order to amp up the effects of human-caused climate change, and we see minimisation of uncertainties. We see alarming predictions that never come to pass and which everybody forgets, whether it's dying coral reefs or disappearing islands. Disappearing polar bears is another one in recent years.

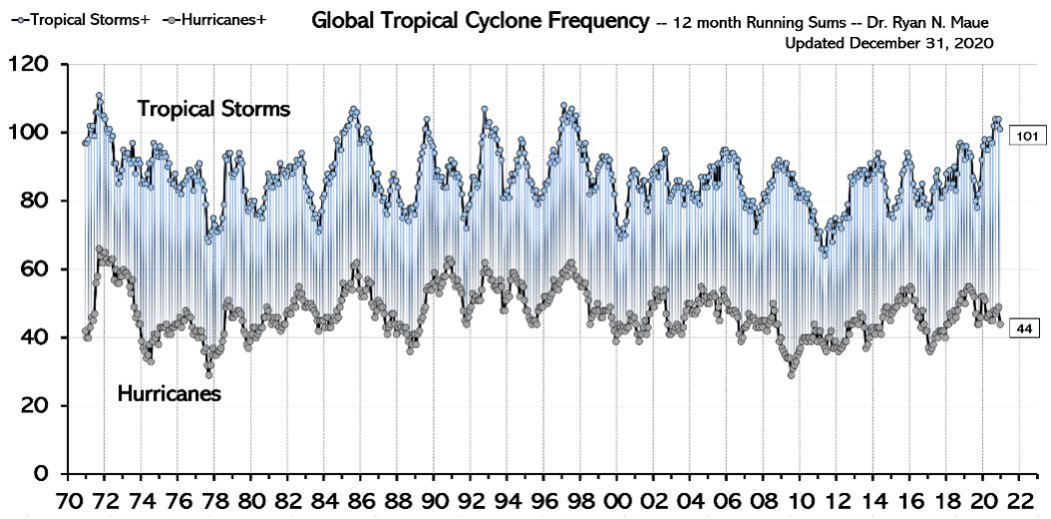
A lot of it is driven by non-expert and activist reports. If you're a reporter covering the climate beat, unless you say something dramatic you're not going to get on the front page. And then there is suppression of legitimate divergence from the consensus. I've seen it myself in the past six months since my book *Unsettled* was published. Nobody wants to listen: fingers in the ears, eyes shut. I wrote the book, as many said, to try to get around this long chain of information. Almost everything in the book is right there in the official reports or in the peer-reviewed

literature, so it's not my science but the official science.

Let me go through a couple of examples. I'll talk first about hurricanes. Figure 1a shows the record of the number of storms over the last 50 years; Figure 1b is a record of hurricane activity, which is, for those of you who are technical, the number of storms weighted by their duration and the square of their wind velocity. While there are lots of ups and downs, there are no long-term trends, and in fact the US government report in 2017 said there's still no confidence that any reported long-term multidecadal-to-centennial trend exists in tropical cyclones. In AR6 it says there's low confidence in most reported long-term trends in tropical cyclones. They did say there is some indication of a strengthening of the fraction of the strongest storms in the last 40 years. That was based on one paper, but then there was a paper published in July which said, 'No, we think that's just natural variability'. So, that little bit at least is still unsettled.

We talk about sea-level rise, which is one of the most iconic threats that are invoked to talk about climate change. Most people don't realise that sea level has been rising for 20,000 years, and during that time it rose 120 metres, as the last glaciers melt-

(a)

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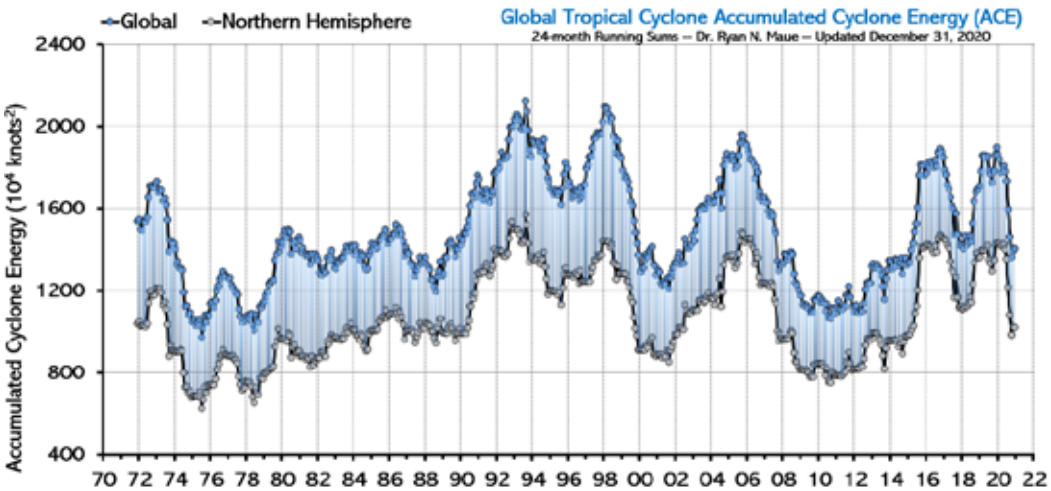
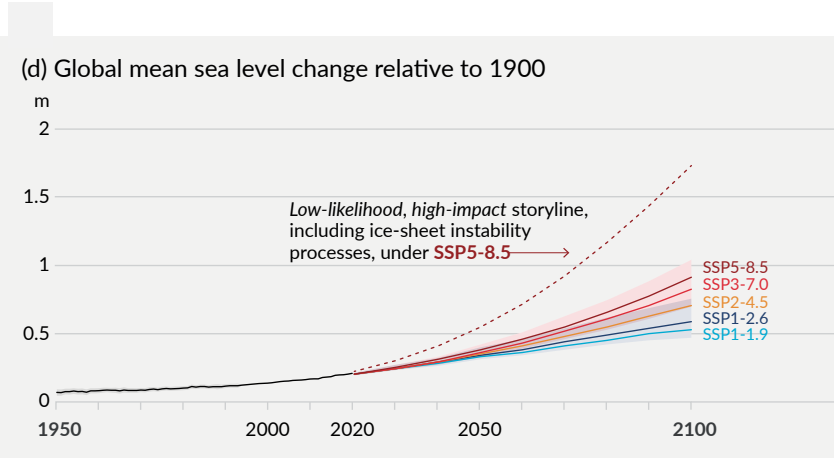



Figure 1: Global hurricane frequency and accumulated cylone energy

Source: http://climatlas.com/tropical/

ed and the water flowed back into the ocean basin. So, the question is not whether sea level is rising, which is a common alarm cry you hear in the media, but in fact whether it has accelerated, say over the last 70 years, under growing human influences? To what extent is that acceleration really anthropogenic as opposed to natural? And, of course, what's going to happen in the next century, say, as human influences grow and greenhouse gases accumulate in the atmosphere? Well, this is a great example of how the UN report is entirely disingenuous and obscures the whole issue. The only place in the report where you can find any notion of the historical data is a figure from the Summary for Policymakers (Figure 2), which shows the data since 1950 (in black) then the projections under various emission scenarios.

Figure 2: AR6 on sea-level rise.

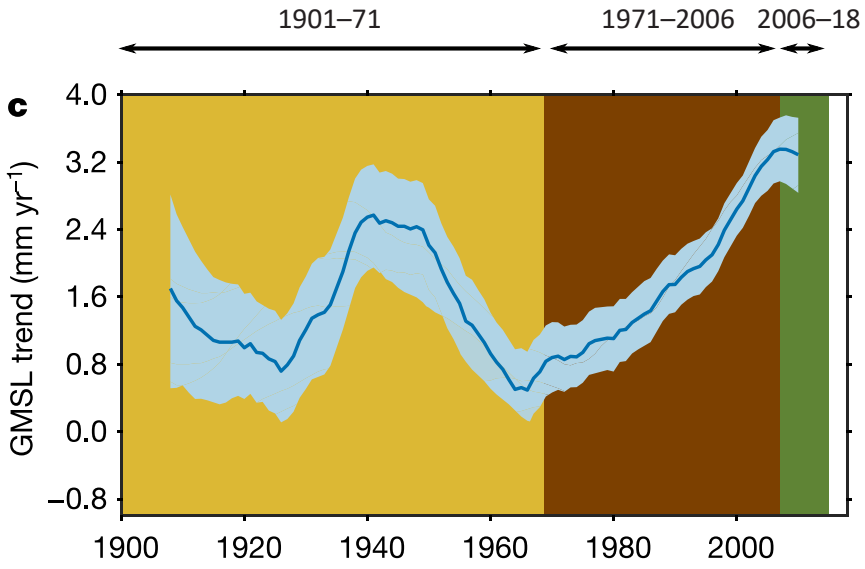



And if you then look at the text, they say, 'Global mean sea level increased by 0.20 m between 1901 and 2018. The average rate of sea-level rise was 1.3 mm per year between 1901 and 1971, increasing to 1.9 mm per year between 1971 and 2006, and further increasing to 3.7 mm per year between 2006 and 2018'. That sounds really scary, right? It's going up faster and faster. Well, if you look at one of the papers that the reports cites approvingly, you find a graph of observed sea-level rise since 1901 (Figure 3). Now look at how the language in the report maps onto the data. The first period, 1901–71 is highlighted in yellow, the second period, 1971–2006 in brown, and the third period, 2006–18 in green. I would have failed one of my students if they had done this. That's why I have been calling for a more rigorous review of these reports: to make sure that they are accurate, complete, unbiased and so on. In fact the IPCC itself admitted in the last report that it is likely that there were similarly high rates of sea-level rise between 1920 and 1950. Exactly why sea level goes up and down, we don't know. It's connected with changes in the melt rate in mountain glaciers, Greenland and so on, but nevertheless you should not obscure the fact that past decades were about as active for sea-level rise as current ones, which detracts from the notion that it's all anthropogenic in recent times.

When you look at the projections for sea-level rise, they're

Figure 3: How AR6 discussed sea-level rise.

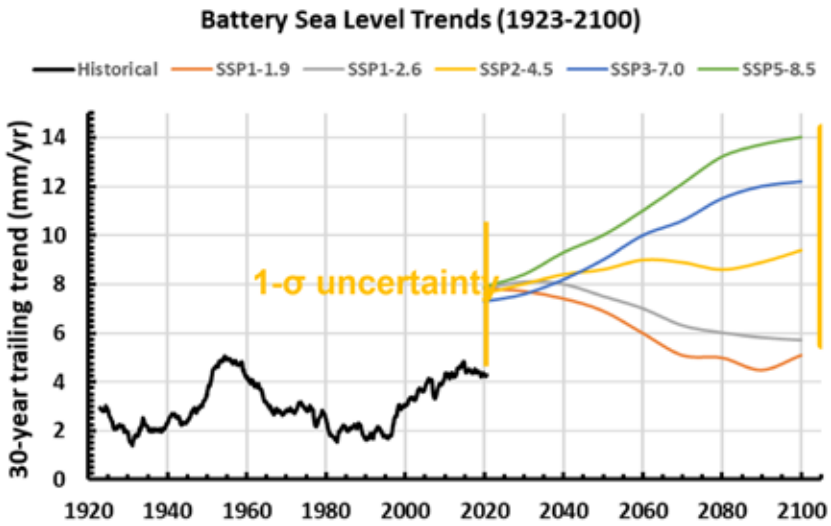
Adapted from Frederikse et al.




also *extraordinary*, if I can be polite. I live in New York City, and so I looked up the Battery, which is the tip of Manhattan. There's a NASA website that gives you the IPCC projections.[5] There's a wonderful map of the globe; you can click on any coastal site and say, 'What is sea level going to do in the future according to the IPCC?' Figure 4 shows the results. The black trace is the historical data for the sea level at the Battery. Surprisingly, the rate goes up and down – it's related to variability in the North Atlantic. In the 1940s it was down at less than 2 mm per year, and in the 1960s it was up to 5 mm per year; then it went down, and now it's going up again. If you had a bet, you'd think it's going to go down again.

Nevertheless, the IPCC gives us projections on the various emissions scenarios (coloured traces), with error bars – the gold vertical bars – representing one-sigma uncertainty. They're all completely disconnected with what we see currently. And as my friend Will Happer would have said, 'I'll bet my house that none of that comes to pass'. In fact, the researchers know that. This is

Figure 4: Highly discordant local projections of sea-level rise.



a quote from a paper in 2019 by Helen Nissan and collaborators at Columbia University, firmly in the mainstream of climate scientists.

> The use of these climate models to guide local practical actions is unwarranted. The models are unable to represent future conditions with the degree of spacial temperament probabilistic precision with which they're often provided, giving a false impression of confidence to users.

So, they're saying, 'Don't pay attention'. Nevertheless, the IPCC is out there putting out this stuff.

I want to talk about extremes now, and one should remember that climate plays out over decades. What happens in one year, or even a few years, is not climate. In order to illustrate that, I want to talk about 'denial'. Not science denial, but the River Nile in Egypt. If you go to Cairo, you can find Roda Island in the centre of the city, and on the southern tip of that island is a structure that was built in the middle of the 7th century by the Egyptians in order to measure the height of the Nile river. The image opposite shows what it looks like on the inside. It's a tall vertical chamber with three outlets to the river, and a central column marked in cubits to measure the height of the water. Needless to say, it was very important to Egyptian civilisation, not only for agriculture but also for taxation, since whoever was running Egypt would tax depending upon what the agricultural yield was in a given year. The Egyptians were very diligent about keeping records, and so we're fortunate to have a very long dataset, in this case the minimum height of the Nile river going from the middle of the 7th century up to sometime in the middle of the 14th century, year by year. When you look at that record (Figure 5), there are two remarkable things. One is how much it goes up and down every year. There are some years where it's up to 5 m or so, and then the next year it's down to 1 m or less. So, it's highly variable; that's weather. If you take a

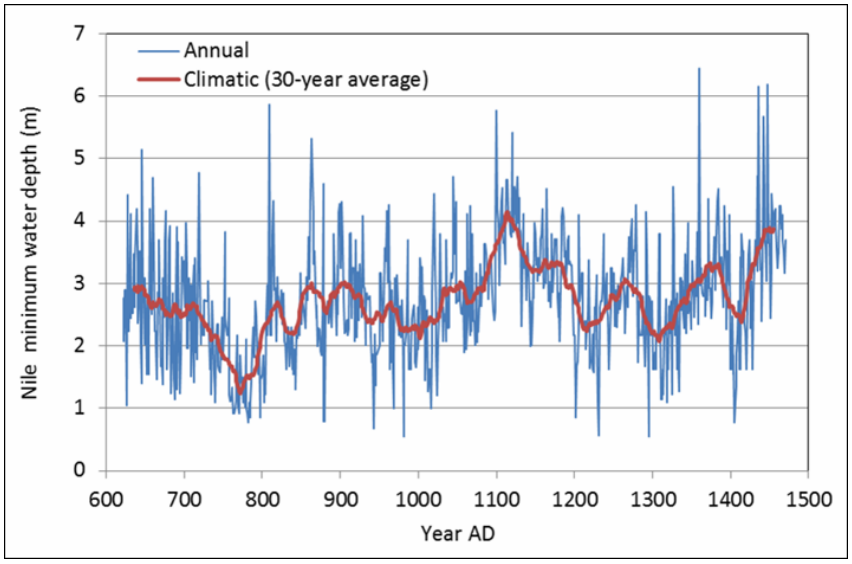



Figure 5: The Roda nileometer record.

The Roda Nileometer

30-year average, as indicated by the red trace, it looks smoother, but nevertheless, there are large fluctuations. Looking at that onset of low water from the middle of the 7th century for about 100 years, I can imagine that there was some medieval climate panel screaming, 'New normal, new normal,' and urging prayers and sacrifices. Of course, if they'd just waited 100 years, it came back up, and a couple of hundred years later, it was even higher. NASA is doing the same thing. In 2006, they published a new story, 'Lake Victoria's Falling Waters'. (The Nile's height is determined mostly by Lake Victoria in the summer.) Then, in 2020, they announced 'Lake Victoria's Rising Waters'. So, this should give us a little bit of humility in trying to project at least regional climates. Global climate's a different story.

Let me talk about extremes a little bit. We saw historic heatwaves in the US Northwest this past summer, but if you look at the data, it was a singular occurrence. Figure 6 is a chart of the number of daily records in 674 US stations in black, and 26 stations in Oregon and Washington State in the US Northwest. There is no long-term trend, so whatever happened last summer was a singular event. If we saw it 10 times in the next 10 years, then we can start to talk about climate, but not now.

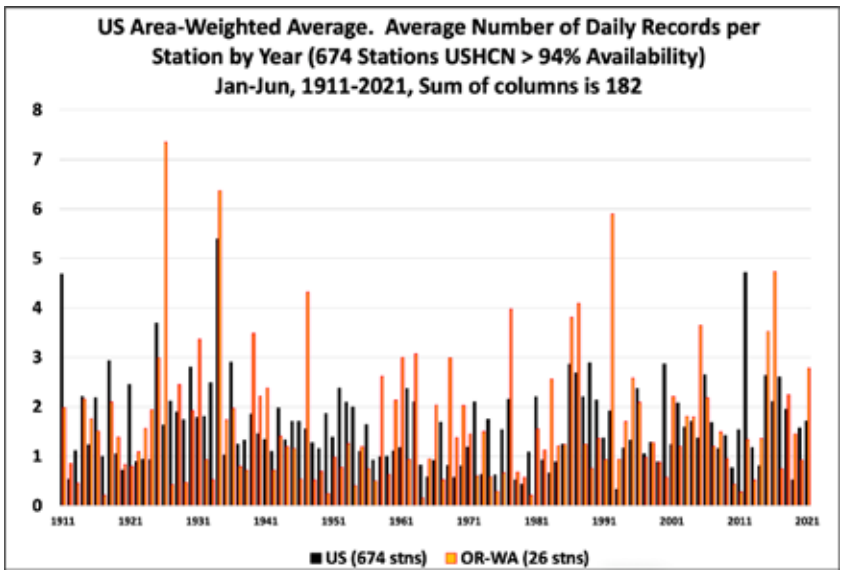



Figure 6: Daily temperature records in the US and US Northwest.

Similarly for precipitation extremes. AR6 says, in fact, extreme precipitations are increasing on the land over the globe. That's true, and in the US, you can see the fraction of the US that is subject to extreme precipitations has gone up over the last century from 10% to 15% or so (Figure 7). I live in New York City, and in September of this past year we had a record one-hour rainfall in Central Park. Of course, I was interested to examine the historical record. How unusual was it? Figure 8, to their credit, was published in the *New York Times*. It shows record one-hour precipitations in Newark, New Jersey since 1960, and you can see that event that happened on September 1st – in the upper right – was in fact singular. There is no clear trend in

the data. I couldn't find one-hour data going back further, but I could find one-day data, and so Figure 9 shows the 16 rainiest days in the Central Park, Manhattan record. You can see the most recent event, September 21st 2021, is that red circle, but there are four other days in the record that were rainier, and 1879 saw the rainiest day.

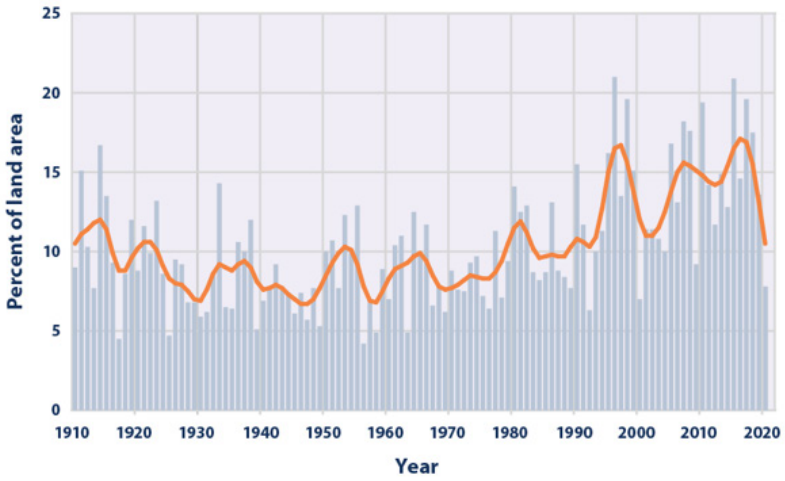



Figure 7: Percentage of US subject to extreme precipitation.

Source: https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation.

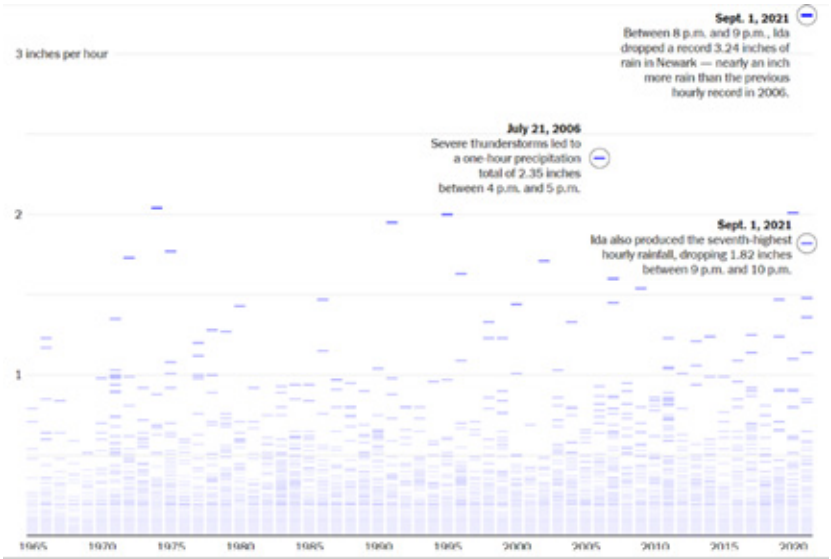



Figure 8: Extreme daily rainfall in Newark, New Jersey.

Source: https://www.nytimes.com/2021/09/02/climate/new-york-rain-climate-change.html.

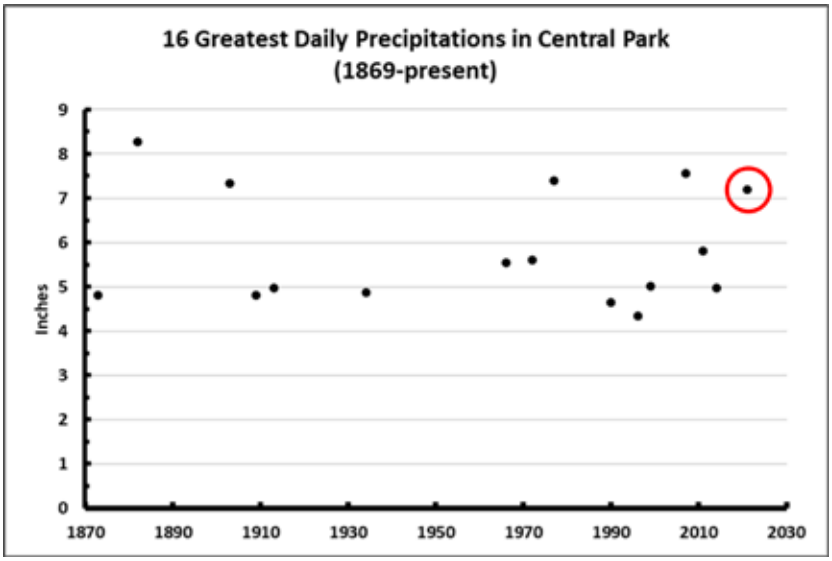



Figure 9: Extreme daily rainfall in Central Park.

So, we tend to forget weather. We have a very poor memory. In the US, there was a severe drought in 1955, and one of the news magazines, *Time* or *Newsweek*, said, 'This drought will be long remembered'. In fact, it was forgotten after a year or two. So, weather is not climate.

I want to say a word about droughts in the US Southwest. Figure 10 shows the drought severity index – up is wet and down is dry – for about 1,000 years in this area. We get this mostly from tree ring data. What's remarkable again is that there is lots of variation from year to year. But there are some periods of multiple decades where it was very dry, and we know that those episodes clobbered civilisations. The Anasazi, for example, in New Mexico, got wiped out because of a drought around 1100.

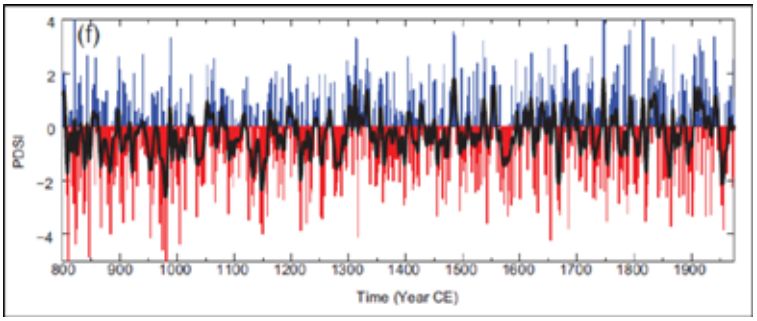



Figure 10: Drought severity in the US south-west.

In California, over the last century, we do have, of course, good data. Figure 11 shows the same kind of data, and you can see that, over the last couple of decades, California has been moving into drought. Whether this is anthropogenic or whether it's natural variability is still, I believe, up for grabs.

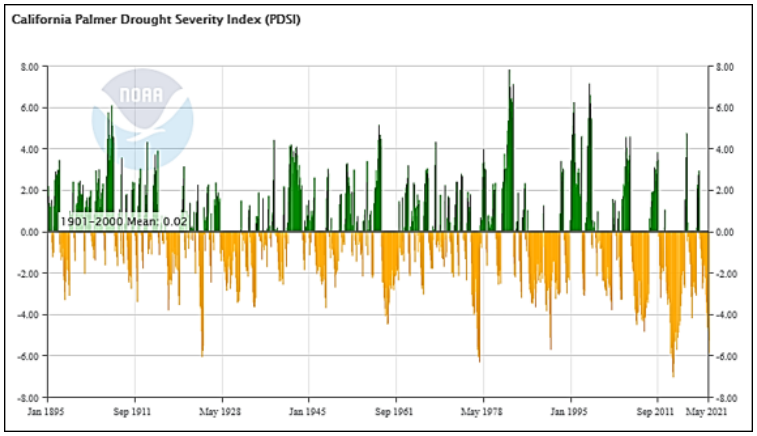


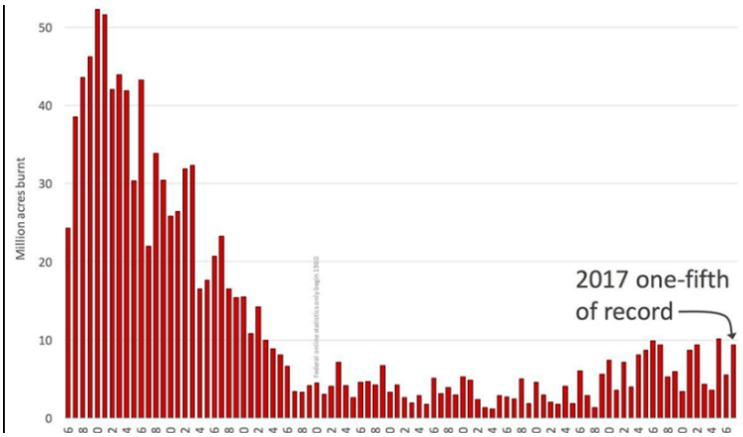

Figure 11: Drought severity in California.

Source: https://www.ncdc.noaa.gov/cag/statewide/time-series

Fires are often blamed on drought, which is in turn blamed on human influences, but if you read the US government report from a couple of years ago, state-level fire data over the 20th century indicate that the area burned decreased from 1916 to 1940, was at a minimum, and then increased again. Figure 12 shows the data from the US government. This is the amount of forest fire area burned over the US from 1926 to 2017. You see there was a peak in the late '20s and early '30s, and then it fell dramatically, even as the US was warming. It hit a minimum, and

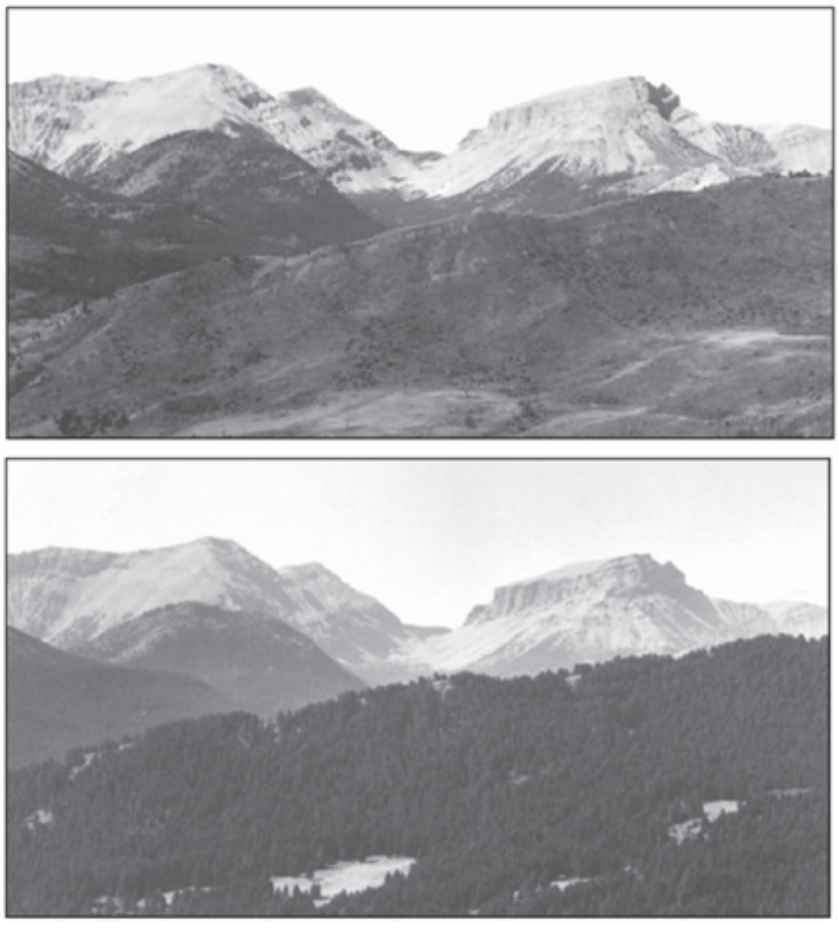
Figure 12: US Forest area burned

Caution is required over the early years of the record.




then it went up again. How could that be? It was warming, and the fires went down. The answer is Smokey the Bear – the US Forest Service started a deliberate policy of fire exclusion, which lasted until the late 20th century, and then they started to relax again. When you do that, you get before and after pictures like Figure 13. These are the same scene in a national park in Montana. The early picture from 1900 shows what the landscape looked like. The bottom picture is from 1981: if you don't let fires burn, you develop lots of trees, and you lose that beautiful mosaic of the landscape, where there are clear patches that prevent fires from spreading. So, it's not surprising that when it gets dry, you're going to see fires. So, the recent fires owe something to some combination of forest management and also development – there are more people in the forest than ever before. We

Figure 13: Montana, 1900 vs 1981



have towns like Paradise, California, in the middle of the forest. We've got drought conditions – whether it's natural or anthropogenic is up for grabs – but there are certainly things we can do to mitigate any fires.

Let me talk about the economic impact of warming. This really surprised me when I figured it out and understood it. The National Climate Assessment in 2018 said 'climate change is projected to impose substantial damages on the economy. Hundreds of billions of dollars by the end of the century'. To back that up, they give you the data shown in Table 1, right out of the report. This is another remarkable dataset. The more you study it, you wonder, 'What were they thinking?' Sector by sector, starting with labour, mortality, freshwater fish, harmful algal blooms, it shows the annual damages at the end of the century, 2090, compared to under an extreme emissions scenario, and then the last column, how much of those damages you would

Table 1: Projected economic damage from global warming in the US.

| Annual Economic Damages in 2090 | | |
|---|---|---|
| Sector | Annual damages under RCP8.5 | Damages avoided under RCP4.5 |
| Labor | $155B | 48% |
| Extreme Temperature Mortality◊ | $141B | 58% |
| Coastal Property◊ | $118B | 22% |
| Air Quality | $26B | 31% |
| Roads◊ | $20B | 59% |
| Electricity Supply and Demand | $9B | 63% |
| Inland Flooding | $8B | 47% |
| Urban Drainage | $6B | 26% |
| Rail◊ | $6B | 36% |
| Water Quality | $5B | 35% |
| Coral Reefs | $4B | 12% |
| West Nile Virus | $3B | 47% |
| Freshwater Fish | $3B | 44% |
| Winter Recreation | $2B | 107% |
| Bridges | $1B | 48% |
| Munic. and Industrial Water Supply | $316M | 33% |
| Harmful Algal Blooms | $199M | 45% |
| Alaska Infrastructure◊ | $174M | 53% |
| Shellfish* | $23M | 57% |
| Agriculture* | $12M | 11% |
| Aeroallergens* | $1M | 57% |
| Wildfire | −$106M | −134% |

avoid. This chart is remarkable for the granularity with which they think they can project 70 years forward, for the precision with which they quote the numbers – that first number in the labour sector is 155 billion, not 153 and not 157, but 155! – and then finally, they give you no baseline. They say we could avoid 48% of those damages if we reduce emissions, but you've got to figure that the labour sector's probably half the economy. That's $10 trillion today, even more in 2090, and so this is in the noise.

Nevertheless, we get these wonderful headlines in the US papers. Even Fox News says 'grim economic consequences', etc. Figure 14a shows economic damages to the US – the IPCC has a similar graph for the global impact – as a function of temperature change. Unfortunately, it's in Fahrenheit, but 9 degrees Fahrenheit would be 5 degrees Centigrade warming relative to today, 6 degrees relative to pre-industrial. You can see it's a few percent.

Bjørn Lomborg has a similar graph, of more recent data from a variety of models (Figure 14b). A few percent for a few

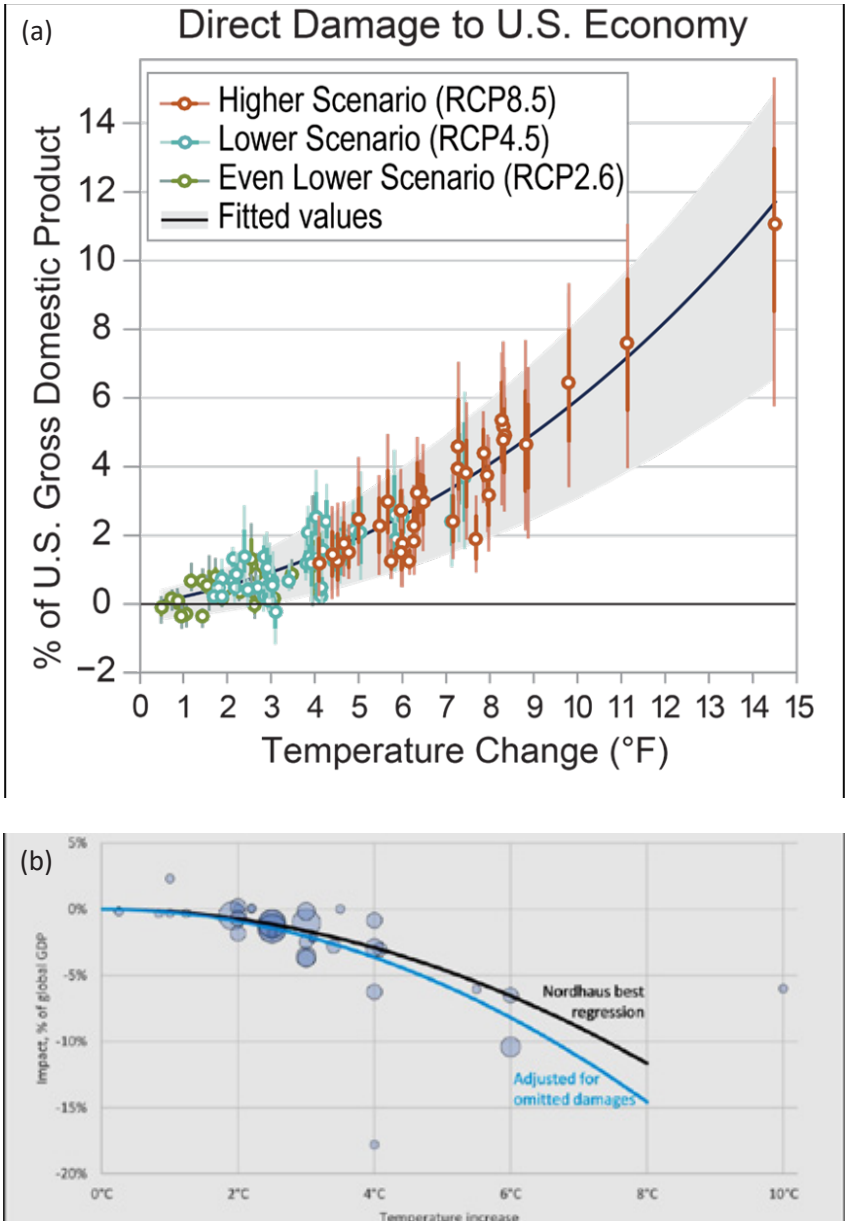



Figure 14: Climate change damage

(a) to the US economy[6] and (b) to the global economy in 2100.[7]

degrees is what you should keep in mind. But it's at most a bump in the road. The IPCC says in AR5 that 'climate change is only a small factor among many others that are more important in determining what the economy is going to do'.

In fact, you can make a little graph (Figure 15). This shows the US economy today at $20 trillion, growing at 2%, and then if you impose a 4% climate impact at the end of the century, or even a 10% impact, it's a few years' worth of delay, 70 or 80 years from now, in economic growth. Why doesn't anybody talk about this? Is this really the climate crisis? I'd love to have somebody like Bill Gates or Ernie Moniz on the stage and ask him, 'What's going on?' People will say, 'Don't believe this,' but then I say, 'But that's the official report. If you don't believe it, we should have a better scrub of these reports'.

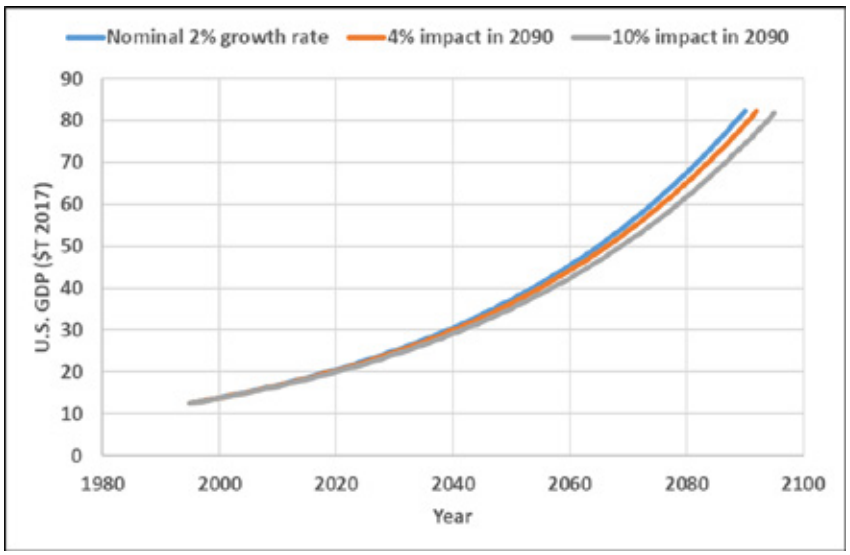
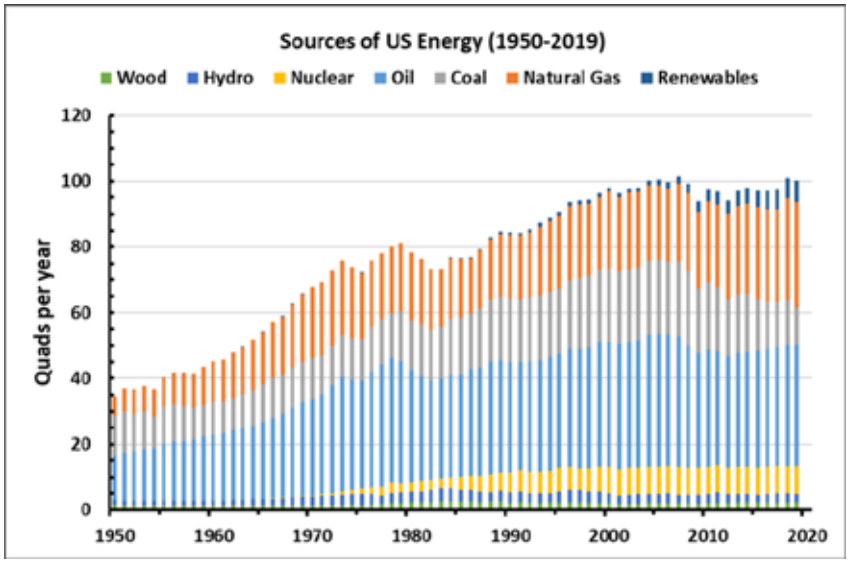



Figure 15: Climate change's effect on growth of the US economy.

Let me turn to more recent events as my last major chapter and talk about COP26 a little bit. We physicists are trained in part to think about fundamentals, not get lost in the details. So when we talk about physical systems, it is conservation of energy or the Second Law of Thermodynamics, say, that determine what will happen. Looking at the situation with that fundamental perspective, net-zero by 2050 is a fantasy; even by 2070 or 2075, I would say it is extraordinarily unlikely. As you listen to the political leaders, or read the news, it feels like Wile E. Coyote being chased off a cliff by the Road Runner. The general principles say he's going to fall, and he's just realised that, and is really worried. That's what COP26 is like.

Let me talk separately about the developed world, and then the developing world. The general principle is that energy is crucial for modern society. It's ubiquitous; it touches everything. It's provided by complicated systems that very few of us have taken the trouble to understand. Those systems are highly reliable because we have proven the hardware and developed the procedures. Energy systems change slowly. Figure 16 shows the US energy supply over 70 years. It takes decades to change.

Figure 16: Sources of US energy, 1950–2019.




Renewables are that last little bit in blue. Eventually, they'll get more important and grow, but it's going to take decades. They change slowly because of that need for reliability. Things need to operate with one another; vehicles and fuels need to be compatible. It takes a lot of money to build these systems, they last for a long time, there are many stakeholders, and so when you try to change them, it takes a long time, because everybody has different opinions. People will say efficiency can help, but William Jevons, one of my British heroes from the 19th century, reminded us that just because you make something more efficient doesn't mean you're going to use less of it. So, my bottom line here is that ill-conceived changes in the energy system, done rapidly, are going to be very disruptive: to the economy, to employment, to behaviour, to politics. You are seeing this already in this country. We're starting to see it in the US. I think if one goes too far, too fast, there's going to be a backlash. Remember that the US is only 13% of global emissions, the UK is about one-tenth of that. People are going to say, 'Why are we doing all of this again?' It's coming.

If we look at the developing world – 6 billion people – energy demand is extraordinarily well-correlated with economic wellbeing. As these people improve their lives, they're going to need more energy, about 50% more by 2050 than the world uses today. Today, fossil fuels are the most convenient and reliable way of meeting that demand, and in fact the rest of the world now dominates global emissions and will do that even more so in the coming decades. Countries have a near-term compelling interest in getting that energy. If you're threatened by a wolf, you're not too worried about your cholesterol. It is the short term that really matters, and so India, China – pick your favourite big, developing country – are all saying, 'We need the energy, and we'll worry about this emission stuff some other time'.

I think you could make a very good case that to say countries cannot get this energy in the most convenient way that

they can is immoral, unless you're willing to pay for it, and we've seen how far that works.

If you want to decarbonise, there is an optimal pace. William Nordhaus won the Nobel Prize in Economics in 2018 for the realisation that if you go too fast, you incur cost from disruption, and you incur cost by deploying immature technology. But if you go too slow, you incur greater risk, however that might be, from growing anthropogenic influences. So, there's an optimum, and when he wrote his Nobel lecture, the optimum path was to let the world go to 3 or more degrees of warming by 2100 – not 1.5 or 2 degrees. Of course, as this started to gain prominence, lots of other people weighed in and said, 'You did it wrong, and the real answer is 1.5 degrees.' But we'll get a pretty good sense over the next decade of how well we adapt and at what rate we should be decarbonising. I would assert that because the impacts are so small, we've got time.

Adaptation will be the dominant response. Whatever you think the world should do, the world is going to adapt, and that's the best way it's going to respond to a changing climate. Adaptation is agnostic; it doesn't matter whether the changes are human-caused or natural. It is proportional. If the climate changes more, we'll adapt more. If less, we'll adapt less. It's also local, and so far more easy to implement. People are willing to pay for local measures in the here and now. It's very hard to get them to pay for something that is an uncertain threat two generations away, and halfway around the world. It's also autonomous. It's what we do. We humans are wonderful at adapting. And it's very effective. Of course, it's a lot easier to adapt if you're richer, than if you're poorer, and so one might argue that the best thing we can do is to help developing countries move along, strengthen their institutions, and become more prosperous and resilient. It's also a lot easier if you know what you're adapting to, but as I told you, projections of regional climates are not very good.

A couple of closing thoughts. We must not 'Gruberise' climate science. You're in the UK, so you may not get the allusion. Jonathan Gruber is a Professor of Economics at MIT. He's still on the faculty. He was one of the principal architects of the Obamacare Act, 'The Affordable Care Act'. I know healthcare is not so much of an issue here in the UK – you have the NHS – but it is a big deal in the US. (I know, my tongue was in my cheek.)

Now look at what he said, after it was all over.

> 'The lack of transparency is a huge political advantage. It was really, really critical to getting the Affordable Care Act passed…At least one of the key provisions was a very clever basic exploitation of the lack of economic understanding of the American voter'.

I can tell you, as an educator and as someone who's advised on science, that is just *so wrong*. When you misrepresent the science to persuade rather than inform, you take away the right of the public and the politicians to make fully informed decisions,

you distract from more urgent needs, of which we have so many that are more immediate, more real, and more tractable. You tarnish science inputs to other important policy matters; Covid is the most outstanding example. Then you terrify young people, and this is so bad. So, that's why we wrote the book.

What about the recommended course going forward. I can't be all negative – I've got to at least talk about what positive things we can do. The first thing we can do is get authoritative bodies – the Royal Society, the US National Academies – to stand up and say, 'There is no climate crisis. This is an issue. We can deal with it in due course, but let's all relax a little bit'. We need better representations of the science for non-experts, and as some of you know, I have long advocated for Red Team reviews of the reports. Better observations, better understanding of cost, a greater focus on adaptation. We have no framework for thinking about adaptation, we don't have good estimates of the cost. Of course, as I mentioned, help the developing countries. Developing demonstrations of emissions-light technologies? Absolutely. Fission, I put on the top of the list, and it's reassuring, actually, to see this country, the Germans, the US, start to put nuclear power higher on the agenda in terms of research. We really need to get small reactors underway. I co-convened a US–UK workshop on grid-level storage in the spring; there will be a report coming out soon.

I can tell you that we need a lot of research before we can think about an all-renewable grid that's reliable. Let us formulate some graceful decarbonisation pathways, that respect the technology, the economics, the regulation, the behaviour. Nobody has done that. The current plans for decarbonisation are one-dimensional, put together either by politicians or – if you'll excuse me – academics, who have no sense of the real world. We need to do this, and we need to implement them as necessary.

I'll just close with the thought that precipitous climate action can be much more dangerous than any climate change you can imagine.

Thank you for your attention.

## Notes

1. N Andela et al. *Science* 2017; 356: 1356–1362.
2. T Frederikse et al. *Nature* 2020; 584: 393–397.
3. CSSR Section 9.2; AR5 WGI Section 2.6.3; Knutson et al., BAMS (2019).
4. AR5 WGII, Chapter 10; NCA2018, Figure 29.3; Tol (2018).
5. https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool
6. NCA2018 vol II, Figure 29.3.
7. Technological Forecasting and Social Change 2020; 156: 119981.

## About the Global Warming Policy Foundation

People want to see policies that enhance human wellbeing and protect the environment; policies that don't hurt, but help. The Global Warming Policy Foundation (GWPF) is committed to providing a platform for educational research and informed debates on these important issues.

In order to make progress and advance effective policy assessments, it is essential to cultivate a culture of open debate, tolerance and learning. Our aim is to raise standards in learning and understanding through rigorous research and analysis, to help inform a balanced debate amongst the interested public and decision-makers.

We aim to create an educational platform on which common ground can be established, helping to overcome polarisation and partisanship. We aim to promote a culture of debate, respect, and a hunger for knowledge.

## ANNUAL LECTURES

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|---|---|---|
| 2010 | Vaclav Klaus | The Climate Change Doctrine |
| 2011 | George Pell | One Christian Perspective on Climate Change |
| 2012 | Fritz Vahrenholt | Second Thoughts Of An Environmentalist |
| 2013 | John Howard | One Religion Is Enough |
| 2014 | Owen Paterson | Keeping The Lights On |
| 2015 | Patrick Moore | Should We Celebrate Carbon Dioxide? |
| 2016 | Matt Ridley | Global Warming versus Global Greening |
| 2017 | Tony Abbott | Daring to Doubt |
| 2018 | Richard Lindzen | Global Warming for the Two Cultures |
| 2019 | Michael Kelly | Energy Utopias and Engineering Reality |
| 2020 | Frank Furedi | Narratives of Existential Threats in the Climate and Covid Era |
| 2021 | Steven E Koonin | Unsettled |

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