Climate change for history teachers

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A note on how the video was produced

First, a PowerPoint presentation, with animations, was produced. Each slide was then put into its own PowerPoint file. Unfortunately, when it comes to producing videos from PowerPoint, Microsoft and PowerPoint indicate that many things are possible, when in fact they are not. I was using PowerPoint 2016, on Windows 10, and some googling revealed I was not alone in experiencing problems.

The problem occurs in the step when the .mp4 video file is produced, using an export function within PowerPoint. If a slide is long, with a long audio narrative and many animations, the .mp4 file is clearly corrupted. The visuals will tend to move faster than the audio, resulting in animations appearing before the audio describes them, and the tail end of the audio being cut within the .mp4 video. Essentially the video ends up being shorter than it should be.

There are two complementary ways of dealing with this. One is not to produce a single slide with too many animations. Around 50 click-prompted animations seemed to be roughly the maximum possible without producing very weird misalignments between the video and audio in the final video. The second remedy occurs within the separate and freely available Shotcut app described further down.

The steps for producing an .mp4 video per one-slide PowerPoint file is as follows. Produce the audio for the slide via Insert > Audio > 'Record Audio'. At that stage simply read from the script (what appears below) without worrying about the animations. Importantly, after producing the audio, one needs to go into the Animations Pane and make sure the audio is the first item, and that it is prompted by a click. Then go to File > Export and 'Create a Video'. Select 'Full HD', and then 'Record a Video'. De-select 'Narrations, ink and laser pointer', and then begin the process. During the process, click your way through the animations, making sure you time that with the audio you hear. The very first click initiates the audio. After the entire process is over, respond Yes to the question of whether you want to save the new slide timings, then click 'Create Video', selecting .mp4.

If you make more than one attempt at generating the .mp4 video, it seems important to clear previous attempts. Do this by going to 'Slide show', then Record, then Clear then 'Clear timings on all slides'.

Finally, I used the free and rather nice Shotcut app to correct misalignments that had crept in between the video and the audio channels, remove quiet 'dead space' at the start of each mp4, and join the various .mp4 files. I read a Shotcut manual to obtain a general sense of the workings of the app. The most difficult thing was to work out how to align the video and audio channels. For a specific .mp4 video, within the Shotcut timeline, I would need to right-click and select 'Detach Audio'. Then I would right-click on the video and select Properties. Next I would adjust Speed. For instance, if visual elements were appearing too soon, I would slow down the speed to, say, 0.99.

The video draws largely from an article I published through the history teaching journal, *Yesterday & Today* in 2024. The journal is based at the University of Pretoria, and no subscription is needed to access articles. This article is Gustafsson (2024) in the references. My approach has been not to repeat references already in Gustafsson (2024). Thus most sources can be found within that article.

Slide 1. Introduction

Slide 1 ►[2 to 4 (1 is the audio object)] Hi. I'm Martin Gustafsson, a former secondary school history teacher, currently an education economist with ● Stellenbosch University in South Africa and the producer of this series of videos. There is not a lot on how to deal with climate change in the history class. In fact, many think that climate change is just a matter for the ● geography and ● science class. I'll explain why the historical aspect of climate change is important and interesting.

[5 to 10] My approach is to link ● climate change to how ● poverty rates have changed over time, as this is an important link. ● There is considerably less poverty today ●, at least in percentage terms, than there was up to around ● 1800, largely because of what the ● Industrial Revolution did to humanity, a process which in turn fundamentally changed our relationship with the atmosphere, and the Earth's climate.

[11] We have reached a point where further changes in the climate threaten to ● *worsen* poverty in future, in other words undo the gains we have seen in the last two centuries.

[12] So, ● climate change and poverty, two inter-related phenomena.

[13] These videos will include statistics and graphs. History teachers often don't deal a lot with numbers, but with this video I hope to convince you that a better use of historical statistics, even at the secondary school level, which is the level I'm aiming at here, is both fun and beneficial. I do also go a little bit into ● how the statistics are produced, which in itself is interesting. The script to the videos, plus detailed references to sources, are available through a link below this video.

[14 to 15] The videos draws a lot from ● this journal article of mine published in 2024 ● in this South African journal dealing largely with the teaching of history. This journal is open access, so you can easily access it online.

[16 to 19] ● I've broken the content down into five periods. ● In the current video, there's 'Up to 1700', basically the pre-industrial era and then '1700 to 1820' on the beginnings of industrialisation. The ● second video also deals with two periods: a long '1820 to 1950' period, when among other things poverty declined a lot in certain parts of the world, and a much shorter '1950 to 1985' period, when poverty declined further as de-colonisation and a Green Revolution set in. Finally, ● a third video looks at the last few decades, '1985 to 2020', a time when the science of climate change became clear, and we also saw inequality worsen.

Slide 2. Up to 1700: A world of tiny elites within a stable natural environment 1500 > 1565

[2 to 5 (1 is the audio object)] Up to around 1700: A world of tiny elites within a stable natural environment. I'm going to talk about the centuries before 1700, partly by explaining how different that period was to the 300 or so years we've experienced since 1700. We've just seen that poverty rates dropped a *lot* after 1800. ● Before then, despite changes in the fortunes of ● various pre-industrial empires, certain things changed very little. It has been estimated that for almost two thousand years around ● 80% of people could be considered *extremely* poor, compared to some ● 8% today. And that 80% seemed to change very little, though obviously it would have changed a bit.

[6] So, what is meant by ● 'extremely poor'? And how do we know what percentage of the world's population was poor?

[7 to 14] A key person here is the British economic historian ● Angus Maddison. He *estimated* average income per person ● going back to the year zero. Of course, for most of this period most people didn't use money, and it was only in the twentieth century that countries built up ● statistical systems to measure the income of their populations. So how would one know the average income per person ● *here*? Maddison's approach was to use historical sources on ● how people were producing food, ● how they lived, and ● how much they ate, to work out roughly what their income would have been ● *if* money had been used.

[15 to 18] Of course, this kind of accounting is rough, and many have criticised the details of Maddison's methods. Yet overall, the evidence suggests that in pre-industrial times people were on average far worse off in terms of food and materials than what they are today. But extreme poverty would be experienced differently today to a thousand years ago. Back then it would have been more difficult to be prepared for difficult weather, ● say a drought, because the use of money as a form of saving was limited. Today, for the ● 55% of humanity living in cities, poverty arises less out of difficult weather, and more out of difficult employment circumstances. Of course, up to around 1700, some ● 20% of people were *not* poor and a *small* part of *that* 20% would have been ● the elite: the ruling class, with considerable power.

[19 to 20] To be absolutely specific, the poverty line used for this graph is one that considers you extremely poor if you have ● less than one US dollar a day to live on, counting the purchasing power of the US dollar in 1985. This is a standard that has been used widely by the ● United Nations, hence it is interesting to try apply this standard to past centuries.

[21 to 31] In some ways things were actually better in previous centuries than now. A project started around 2013 by economists such as the ● French Thomas Pikkety, and known as the ● World Inequality Lab, has shown quite clearly that for the world as a whole inequality ● *worsened* between 1800 and 1900, then after ● 1900 the world became a bit more equal, but then from around ● 1980 inequality began worsening again. Hmm. There are many ways of measuring inequality. For example, we can think of what percentage of *all* income is earned by the ● richest 10% of the population. In a completely *equal* society, that 10% of the population would of course earn ● 10% of all income. But in reality, to take the United States as an example, there ● around 46% of all income is earned by the richest 10%[1]. This type of inequality has been getting worse since around 1980 in the world, even though poverty rates have declined. ● How can poverty rates decline ● if inequality is rising, you may ask. Well, if the *total* amount of income grows enough, or if ● the cake grows enough, then those with least could end up with more cake, even if the proportion of the cake they have is less.

[32] What is also interesting is that ● archaeologists have looked at certain graves from around 1000 years ago and drawn conclusions around how unequally *wealth* was distributed back then. They have found that wealth inequality is worse today than it was 1000 years ago.

[33 to 35] So, ● back here the world was more equal than it is today, but ● the percentage of people who were poor was much greater ●.

[36 to 49] I'm going to place two more vital historical trends into this graph, apart from the poverty rate. One is ● carbon dioxide emissions from the burning of fossil fuels[2]. Ever since we invented ● fire, ● around 350,000 years ago, humans have emitted ● carbon dioxide into the atmosphere. But for most of human history, we were not burning ● *fossil* fuels like coal or oil. We were burning ● mostly wood. This means we maintained a more or less stable carbon cycle. ● In the carbon cycle[3], ● things are burnt, releasing carbon dioxide into the atmosphere, ● but then plants, through photosynthesis, absorb that carbon dioxide. The levels

[1] Chancel *et al*, 2021: 229.
[2] Data for graph from PRIMAP-hist data discussed in Gustafsson (2024).
[3] Carbon cycle graphic from Intergovernmental Panel on Climate Change (2013: 471).

of carbon dioxide in the atmosphere remain more or less stable. ● But as soon you start extracting a lot of coal and oil, or fossil fuels, from beneath the ground, and burn ● *that*, the carbon cycle gets upset and we end up pushing more carbon dioxide into the atmosphere than can be absorbed by, say, plants and the oceans. Here are the numbers. ● Up to around 1600 or 1700 we burnt almost no fossil fuels. Today we burn a lot, and so we talk about the problem of emitting around ● 37 billion tonnes of carbon dioxide a year. Here I am simplifying things a bit. ● For instance, if you also count methane emissions, the situation gets a bit worse. You could say that one reason there was so much poverty over most of this period is that we didn't know how to extract fossil fuels, burn them, and hence create stronger economies and more overall income.

Continuation of Slide 2

[2 to 7 (1 is a necessary placeholder)] Moving to the third and final trend, the red curve shows how the ● human population increased dramatically ● in the last 200 or so years[4]. ● Two thousand years ago there were only around 190 million people in the *entire* world. That's a bit less than the population of Brazil today. That number did not change much until here ●. Today the world's population is ● over 8,000 million, or eight billion. Again, in many ways it was our inability to exploit fossil fuels, and create the industries and technologies that come out of that, which kept the human population fairly low for so many centuries. Many children died of diseases which could not be treated, and even those who survived childhood lived relatively short lives[5]. ●

[8 to 9] So, we see that ● highly unusual things happened to poverty rates, emissions by people and the human population after 1800, and especially after 1900. These things were all connected to the Industrial Revolution in some way. There are a *few* points even in our ● *pre*-industrial history where historians have uncovered unusual global impacts involving these factors.

[10 to 11] The ● 1600 eruption of the Huaynaputina volcano in Peru pushed a lot more carbon dioxide into the atmosphere, which resulted in strange weather patterns, disruptions to agriculture, and famine, ● for instance in Russia.

[12 to 18] ● European colonisation in the Americas, like colonisation in other parts of the world, meant ● viruses and bacteria were introduced into populations who had no resistance to them, resulting in widespread deaths. Deaths from previously unknown diseases in the Americas in the ● 1500s were so extensive that many farms were abandoned, natural vegetation took over, and the ● carbon cycle for the entire world was slightly disrupted ● according to data analysed by these researchers. As a result, carbon dioxide levels in the atmosphere during the approximately ● 200 years before the start of the Industrial Revolution were *slightly lower* than they would have been without the colonisation of the Americas. This also meant ● temperatures around the world were lowered slightly. This is the opposite of the climate change we see currently, but the dynamics are similar.

[19 to 24] ● But the big changes came with the Industrial Revolution. It all started with our ability to ● mine coal in better, but often more dangerous, ways. And as you have probably already read, the Industrial Revolution started in ● Britain. Coal has been used around the world as a fuel for thousands of years, but in a limited way, due to very basic mining methods. ● In 1600 around 10% of Britain's energy came from coal, mostly coal that was easily available near the surface. Nearly all the rest of Britain's energy came from burning

[4] Values for the two millennia draw from the Our World in Data page titled 'How has world population growth changed over time?' (accessed October 2024).
[5] What I had wanted to display was life expectancy for age 15 over time, but unfortunately global historical estimates of this seem not to exist.

wood, and the energy used by animals and humans, who did work that would gradually be taken over by machines powered by fossil fuels. ● By 1700 50%, of Britain's energy was coming from coal, and then by ● 1900 it had become 95%. After 1900 the figure dropped a bit as coal was to some extent replaced by other fossil fuels, in particular oil.

Slide 3. 1700 to 1820: Technological foundations of the Industrial Revolution

[2 to 7 (1 is the audio object)] 1700 to 1820. The technological foundations of the Industrial Revolution. I'm pretty sure you've heard of the importance of new technologies such as the ● steam engine in bringing about the Industrial Revolution. Steam engines, employed in for instance ● spinning machines and ● locomotives, required vast quantities of ● coal. It became possible to mine coal more economically during this period because ways of ● 'sinking', or making, vertical mine shafts improved. This also made mining far more dangerous. The additional coal that could be mined also made ● steel production easier.

[8 to 9] Fortunately, for those of us wanting to put numbers to early industrialisation, ● many different researchers have looked at the growth in the use of coal and in technologies such as the steam engine to estimate the emissions of greenhouse gases, the most important of which has been carbon dioxide, per country over time. The particular data that I'll use to build this graph is the ● PRIMAP-hist data, which goes back to 1750. These data are freely available in Excel, and could easily be used in the secondary school history classroom. I would say these data provide us with perhaps the best picture possible of how quickly the Industrial Revolution unfolded in different countries across the world.

[10 to 20] I've already referred to total carbon dioxide emissions for the world. We saw earlier that this came to ● 37 billion, or 37,000 million tonnes in around 2020. 200 years before that, back in 1820, this figure was much much lower, at just ● 60 million tonnes, or ● 0.2% of what we see today. ● But it had been increasing from almost nothing. ● In 1700 the figure was just 10 million, according to PRIMAP-hist ●. According to the data, ● Britain was by far the biggest emitter during the early years of industrialisation. But it was not completely alone. ● By 1820 Belgium was the second-largest emitter. ● The United States was still a tiny player at this stage. By 1820, there was in fact almost no industrialisation of the fossil fuel kind outside Western Europe. But if we look at later years in the data we'll see that in ● 1890 the United States became the world's biggest emitter of carbon dioxide, while in ● 2005 China replaced the United States. This reflects in many ways how economic power has shifted around the world.

[21 to 28] Let's look a bit more closely at what was happening in Britain. We don't have good poverty data for this period, but what we do know is that the population of Britain increased ● from 8 million here to ● 18 million here. By the way, in 2024 the population of the country was ● 68 million ●. I get these historical population figures from another nice set of data that could be used in the classroom, though they are a bit more difficult to navigate than the PRIMAP-hist data. ● I'm referring to the History Database of the Global Environment, or HYDE. So we see the population in Britain increased by ● 125%. For the rest of the world the increase was ● 63%. So the population in Britain increased around twice as fast as in the rest of the world over this period. This was no accident. Early industrialisation in Britain came with some improvements in the standard of living of many people, even if those who benefitted most from the process were a relatively small class of ● capitalist industrialists, the owners of the mines, factories, and so on. But across the population as a whole more children survived to adulthood as a result of slightly better living conditions. It was in fact this type of population increase which encouraged the movement of many British people to British colonies around the world.

[29 to 34] ● At the time, there were worries about smoke pollution from the increased burning of coal, for instance in factories. Remember, we are dealing with a period when

electricity did not exist yet, so smoke pollution would have been something many had to suffer. This pollution caused, among other things, lung problems for both the rich and the poor. Specifically, things like ● soot and ● sulphur dioxide released when coal is burnt is harmful to humans. But what no-one talked about, because it was basically invisible, was the emission of ● carbon dioxide. Though we know today that carbon dioxide in the atmosphere is largely responsible for climate change, a bit more of this gas in the atmosphere has no direct negative effects on human health. We would have to wait almost two centuries before discovering the effects of this invisible carbon dioxide on the climate. ● So here's a question: Is carbon dioxide pollution? ● Most experts would in fact agree that the answer is no, because slightly higher levels of carbon dioxide in the atmosphere pose no *immediate* danger for human health. Yet these higher levels of carbon dioxide can nonetheless kill indirectly, through climate change, which can include for instance floods. All this can be a bit confusing.

Slide 4. 1820 to 1950: Economic growth, more democracy and poverty reduction

[2 to 4 (1 is the audio object)] 1820 to 1950: Economic growth, more democracy and poverty reduction. This period saw lots of political change, much of it aimed at spreading the benefits of industrialisation more widely across society, and limiting economic exploitation by small elites. ● Democracy, socialism and communism and opposition to colonisation all became important concepts in the political debates. Of course, ● the French Revolution happened just before this period, yet many key political changes across the world occurred during this ● 1820 to 1950 period.

[5 to 19] Let me introduce another dataset history students may like: the ● V-Dem dataset. Of the various datasets I'm using in this video, V-Dem is probably the easiest for history students to get into, because it deals with a matter virtually all school history textbooks look at in one way or another: the rise and fall of democracy across countries. V-Dem goes back to the year 1789, the year of the French Revolution, and is produced by a team of researchers at a university in Sweden, who gather information from almost 4,000 experts across virtually all countries of the world. ● 51 countries have data for the period ● 1820 to 1950. I'm going to focus on just ● 12 of these countries. The data gives each country ● a score in each year, depending on things like whether people can criticise the government, how fair elections are, and whether the government *itself* follows the law. So the data recognise that democracy is not a yes-no thing. Among countries which many would call democratic some are in reality more democratic than others. Among the 12 countries I have chosen, ● Britain, France and the United States displayed relatively high levels of democracy. ● France experienced sudden ups and downs. ● This up was the brief Second Republic, after ● a king was deposed and ● before an emperor took over. During the ● First and especially the ● Second World War democracy suffered in France. ● Here we see the rights of women to vote in Britain and the USA improving. But the USA's relatively low score ● here, compared to say Britain, was largely because until the ● 1965 Voting Rights Act things such as literacy tests were widely used to prevent many black and native American people from voting.

[20] ● But by 1950 a few other big countries had seen improvements in the level of democracy: Japan, Brazil and India.

[21 to 27] ● One thing that assisted the fight for more democracy was better education. For example, the percentage of adults able to read in Britain increased from ● 53% here to ● 90% here, mainly because ● more and more children received some schooling. For the whole world, the figure increased from ● 12% to about ● 36%[6]. Having more people reading and writing is also good for us historians wanting to look back in time. ● There were more reports, newspapers and statistical tables being produced in this period, meaning from around

[6] Our World in Data.

1820 it begins becoming much easier to calculate numbers for certain things, and to measure change over time numerically.

[28 to 39] Part of the reason I selected ● these 12 countries is that it's easy to obtain inequality and poverty data on them ● for these years from a separate dataset by the two economic historians Bourguignon and Morrisson – I'm going to call them ● B&M from here on. Their work has in turn been used by the people at the ● World Inequality Lab I referred to earlier and by ● Martin Ravallion in this huge book dealing largely with the history of poverty. ● Ravallion has referred to the period 1800 to 1950 as the First Poverty Enlightenment, when the global poverty rate declined from ● 85% to ● 55%. How fast is that? ● The difference is 30 percentage points. ● And that happened over 150 years. ● 30 percentage points divided by 150 years is 0.2. So on average poverty declined by ● 0.2 percentage points a year. Ravallion talks about a *Second* Poverty Enlightenment beginning around 1950, and as we'll see a bit later beyond that point poverty declined even faster.

[40 to 47] ● But back to my 12 countries. ● I've used the B&M data to calculate the poverty rates of the 12 countries for 1820 and for 1950. I used the ● one-dollar-in-1985 standard I spoke about previously. This graph shows the result. At least ● 70% of the population was extremely poor in all the 12 countries in 1820. But by ● 1950 there were large differences across countries. ● Countries which industrialised faster saw the fastest declines in poverty. But now, is there a graph we can use to show nicely, for the 12 countries, both ● the democracy and ● poverty trend at the same time. I want to get an idea of how democracy may have helped to reduce poverty.

Continuation of Slide 4

[2 to 23 (1 is the audio object)] ● The graph we need is an X-Y, or scatter, graph. Let me begin with ● Japan. ● In 1820, about 78% of people were poor, and ● the democracy score was low, at 0.015. ● The samurai were still powerful, and ordinary people were to a large extent forced to follow them. By 1950, however, ● Japan's democracy score had improved to 0.365. ● Japan had a parliament and an elected prime minister. ● And poverty had declined to 60% of the population. This was just before Japan became one of the world's rich countries. If we consider ● all countries, what do we see? ● There is a kind of path that most countries followed, from ● less democracy, more poverty, here, to ● more democracy less poverty here. Some countries moved very little, ● especially China, which during this period hardly moved in this graph at all. And of course some countries moved a lot. But some countries followed a path that deviated from the general path a bit. ● We see that in the United States, where even after the abolition of slavery Americans of African origin did not enjoy equal voting rights, democracy advanced, but not by as much as it could have. ● We also see that Russia saw less poverty, ● but almost no movement when it came to democracy. People in this communist country enjoyed about as much freedom and democracy in 1950, compared to Russia under the ● Tsar in 1820. But poverty dropped a lot, to ● 49% by 1950. ● India, which gained independence from Britain shortly before 1950, experienced almost the opposite of Russia. In the case of India, ● independence came with considerable democracy. ● But poverty remained at around 80% for the entire 1820 to 1950 period, in part because industrialisation was limited in India. The ● colonising power, Britain, made sure that India remained strongly reliant on industry in Britain.

[24 to 25] At this point some of you may be asking. ● But didn't the borders of India change between 1820 and 1950? When the data talks about 'India' what place is being referred to? Similar questions could be asked about other countries. The approach of ● B&M is to take the country as existing in 2000 and to estimate what happened through history in that same geographical territory, even if political borders changed.

[26 to 34] ● Let's return to our graph covering just democracy. Earlier on I mentioned that the ● World Inequality Database people found that ● up to 1900 the world became more unequal, but that ● after 1900 there was gradually a return to more equality. Do we see such a pattern if we use the ● B&M data for our 12 countries? Roughly, we do. Here we see ● the percentage of all income earned by the richest 10% of people. In some very unequal countries, such as ● Turkey and Brazil, the B&M data basically say this type of inequality did not change. Look at ● Russia, though. The Russian Revolution changed Russia from a very unequal country to an exceptionally equal one. But, as we saw in the previous graph, ● 49% of the Russian population was still considered poor in 1950. So low inequality, but with considerable poverty.

[35 to 41] ● To recap, we've looked at a few indicators from this period: ● level of democracy; ● poverty rates; and ● level of inequality. To finish off, let's bring in one last indicator: ● carbon dioxide emissions per capita. This we can get from dividing ● total CO_2 emissions by the population. Earlier on, I discussed good data sources for both emissions and population. And let's look at the relationship between ● emissions per capita and poverty.

[42 to 61] ● There were countries with ● little change in the poverty rate over these 130 years, and with ● very low emissions per person. These countries did see spectacular changes on these measures, but nearly all of that happened *after* 1950. ● Egypt, Turkey, Brazil and Mexico saw some change, but it was limited. ● Japan saw a bit more change: we've already seen the percentage of the population considered extremely poor ● dropped from 78% to 60%. The average carbon dioxide emissions per person went from almost ● zero to 1.2 tonnes. ● Russia's reductions in poverty were largely because of rather rapid industrialisation in the ● early Soviet era, and this meant ● more emissions. Then there's ● France, and Britain. And finally ● the United States, which among our 12 countries saw the ● lowest level of poverty by 1950, but also by far ● the highest emissions per capita, at just under 16 tonnes per capita in 1950. To help us understand the meaning of *one* tonne of carbon dioxide, ● artists have produced images like this. The one tonne of CO_2 would fit into ● this blue box. In the case of the United States, on average each person was emitting around 16 boxes like this by 1950. Why did emissions in the United States climb so high, considerably more so than in ● Britain, which had also reached a low poverty rate by 1950? The answer is in part that ● the discovery of oil in the United States meant oil was cheap, ● many could afford big cars, travel distances were long, ● and there was limited investment in public transport.

Slide 5. 1950 to 1985: An acceleration in poverty reduction

[2 to 12 (1 is the audio object)] On to our next and second-last historical period in this video. 1950 to 1985: An acceleration in poverty reduction. ● I mentioned previously that 1800 to 1950 has been referred to as the First Poverty Enlightenment, a period when poverty declined by 0.2 percentage points a year, largely due to economic progress linked to ● industrialisation, but also thanks to ● more democracy which helped to spread wealth and income a bit more equally within societies. Poverty started dropping even faster ● after 1950, in what has been called the Second Poverty Enlightenment. Here additional factors not really seen before 1950 include the following. ● De-colonisation, particularly in Asia and Africa, which for many, though not all, newly independent countries meant development and some prosperity. ● The increasing emancipation of women, not just in terms of their right to vote, but also in terms of their freedom to work where they wanted, contributed directly to economic development. And also very importantly, the ● Green Revolution, involving the invention and widespread use of ● modern fertilisers, pesticides and irrigation systems, meant there was a lot more food available. This Green Revolution made a big difference to the lives of billions of farmers and urban people depending on food from rural areas. The leading scientists in this Green Revolution included the ● American Norman Borlaug, the ● Chinese Yuan Longping and the ● Indian M.S. Swaminathan.

[13] There's a specific reason why I'm using ● 1985 as a cut-off for this period. Up to around 1985, scientists remained fairly unsure of how industrial and agricultural change were affecting the levels of carbon dioxide in the atmosphere, and the risk of future climate change.

[14 to 21] During this period ● economic data improved even further. More and more places in the world had ● national statistical offices and ● central banks compiling data on what was happening in the economy, and on ● international trade. We'll see why data on international trade is so important for understanding emissions. ● International trade was increasing rapidly in this period. ● In 1950 8% of everything being produced in the world was traded between countries. ● By 1985 this had increased to 14%. ● And by 2020 the figure would reach around 25%[7].

[22 to 30] ● Let's focus on these 11 countries. Here we see the ● average CO_2 emissions per person. ● Here's the 16 tonnes per person for the USA we saw previously. This is not for 1950, though, but for ● 1959. I'll explain in a moment why I'm using 1959 here, and why I'm calling this ● 'territorial'. ● Next, the values for roughly the end of my period, though these are actually ● 1990 values. ● I've sorted the 11 countries by their 1990 values. ● We see how emissions per person increased, as the average person became better off and was able to consume more things, such as energy and electricity. And, we see the enormous differences between countries when it comes to per person emissions.

[31 to 45] Now here is the interesting thing. We say all these values are *territorial* because they indicate emissions produced in the territory of each country. This is easy to understand. If a ● factory in Germany produces emissions, those emissions are counted as German emissions. ● But let us say that Germany puts that factory in Brazil, but then exports all the, say, ● cars produced by that factory back to Germany. If we use a territorial approach, then the emissions from the factory become ● Brazilian emissions. *But*, if we want to talk about a fair distribution of emissions, should we completely ignore the fact that those cars produced in Brazil by a German company are used by Germans, not Brazilians? Many would argue no. In fact, many would argue that ● the most important thing is not *where* emissions are produced, but ● who benefits from the final product, or who consumes that product. This is the consumption approach to emissions – see the yellow bars in the graph. Some talk about this as the ● carbon footprint approach. If we use the consumption approach, we see interesting differences for 1990, compared to the territorial approach. Look at ● South Africa and South Korea, for instance. If we use a territorial approach, then emissions per capita were ● 33% higher in South Africa than South Korea in 1990. But if we use the ● consumption approach, South Korea's value is 38% higher than South Africa's. Why? Well, South Africa has for many years supplied a lot of metals, such as ● iron and steel, for the world. Processing these metals uses a lot of ● electricity, which in South Africa has been mostly based on ● coal. So a lot of South Africa's ● *territorial* emissions are actually emissions produced because of mining products which are exported to the rest of the world. To put it very very simply, ● products linked to high emissions from countries like South Africa are exported to richer countries, like South Korea, where quite high levels of *consumption* are seen.

[46 to 51] Now, even if it's fairer to use a ● consumption approach than a territorial approach, in most international negotiations ● the territorial approach is used. This is because it is much, much easier to calculate. Using the consumption approach involves very complex analysis of trade. It can get really complex if you consider that ● platinum from South Africa could be exported to ● Japan to produce a car, which is then exported to the ● USA, meaning the emissions from the ● South African production of the platinum should actually be counted under the USA's emissions. And this is putting it simply, because a Japanese car is made up of materials from all over the world.

[7] From the Our World in Data page titled 'Trade and Globalization' (accessed April 2025).

[52] ● The statistics used for this graph come from the very important work done every year by the Global Carbon Budget group of scientists. This is why I had to use 1959 and 1990, as these were convenient years in the statistics they publish.

To sum up, in this period we saw more international trade, which is a key part of globalisation. While trade could be considered yet another factor that accelerated poverty reduction, it made it more difficult to understand the responsibility for emissions, and to decide on what a fair sharing across countries of this responsibility might look like.

Slide 6. 1985 to 2020: The science of climate change and worsening inequality 1500

[2 to 12 (1 is the audio object)] Our final period is 1985 to 2020. We'll begin by examining the situation in ● 1985 in a few parts of the world, with a focus on three statistics. In this kind of dot graph we can actually with one dot capture three statistics. Let's take China, as an example. In 1985 ● the population was a little over one billion. ● Income per person was quite low, at around 2600 US dollars, counting the purchasing power of a dollar in the US in 2011. Then the third thing. Total carbon dioxide emissions. ● This is represented by the area of the China circle. The number is around two billion tonnes, but let's not worry too much about that. The important thing is that in ● 1985 China' emissions were smaller than those for Europe or the USA, ● and greater than those for Africa and India. By the way, these bubbles, or dots, don't cover the whole world. I wanted to focus on a few key countries and regions. We see that in 1985 ● emissions from Europe and the USA were quite high. Why? Not really because there were so many people in these places. ● The USA had 238 million people at the time, compared to China's one billion. But emissions were high in the USA and in Europe to a large extent because these parts of the world were quite rich, ● and people could afford to have cars, travel around, heat fairly big houses, and so on. We'll come back to this graph later and see where all these bubbles were 35 years later, in 2020. But before we do that, we're going to look at what happened when it comes to, firstly, ● our knowledge about the effects of emissions and, secondly, ● the growth of international organisations and agreements aimed at limiting the harm of these emissions.

[13 to 22] For governments and other organisations to start taking action on climate change, there had to be enough knowledge about how the climate worked, and how fast humans were changing the climate. Not everyone would agree that ● 1985 is when our knowledge became sufficiently clear, but roughly it was around here. Already in ● 1958 an American scientist called Charles Keeling started measuring carbon dioxide levels in the atmosphere, using instruments placed on top of a volcano in Hawaii. So since then we have known that ● CO^2 in the atmosphere is increasing fairly quickly[8]. But we didn't know what the effect of this would be. ● Then in 1979 this important report by a group of American scientists was released[9]. It was just 22 pages long, but summarised and evaluated work various scientists had been doing on a vital question. What was going to happen to the climate as a result of having more CO^2 in the atmosphere? ● This report concluded that if we double the CO^2 levels in the atmosphere, or increase it by 100%, the average temperature of the air around us is most likely to increase by 3 degrees Celsius. This is a change which would influence many things, including ● rainfall and, through melting ice, ● even sea level rises. ● We haven't doubled CO^2 levels yet, but by 2020 we had increased it by 45% since pre-industrial times, so we are halfway to doubling it. ● This little 22 page report eventually led to the United Nations ● establishing a body in 1986 whose name soon became the Intergovernmental Panel on Climate Change, or IPCC. The IPCC is today the most important body looking at climate change, and involves thousands of scientists around the world. This is why I'm saying here that the knowledge about modern climate change became widely accepted in around 1985.

[8] Graphing of data from https://gml.noaa.gov/ccgg/trends.
[9] Charney *et al*, 1979.

[23 to 28] So, we know about the problem. What do we do about it? In ● 1997 virtually all the national governments of the world met in Kyoto, Japan and came up with an agreement called the Kyoto Protocol. According to this agreement, the countries of the world which, to put it simply, had become rich thanks to industrialisation and a lot of emissions, ● agreed that by 2012 their emissions would be no higher than what they had been emitting in 1990. ● The 36 rich countries signing the agreement can be seen here. One rich country is of course missing: the ● United States. The US government decided not to participate in the Kyoto Protocol, because it was worried that the agreement would make it difficult to improve the average income of Americans even further. The US also used the argument that non-rich countries such as ● China, India and Brazil should also agree to control their emissions in some way. The position of the United States was strongly criticised by most of the rest of the world, including other rich countries. Let's remember that the US was at the time still the world's biggest emitter. And perhaps the world was disappointed because so many of the top scientists who helped us understand climate change were from the US. One last point: ● Canada was initially in, but then stepped out.

[29 to 31] Something that makes it easier for governments to ignore international agreements on climate change is what is called ● climate change denial. Though almost all scientists agree that emissions caused by humans have created the risk of very serious climate change, there are ● people who have argued against this, basically saying that climate change is not something we should worry too much about. Such messages are often popular, and it is easy to understand why. It is difficult for many to accept that we have to ● spend money changing things now, and perhaps consume less of certain things, to make things easier for future generations.

[32 to 39] Okay, what happened to emissions following Kyoto? ● The CO^2 picture looks like this. Here I'm using the PRIMAP-hist data I used previously. The original Kyoto targets were for ● 2012, but these were ● extended for a few more years. ● We can see that the 36 rich countries which did say they would try to reach targets, and let's remember that countries not reaching their targets could ● pay a fine, did see emissions in 2019 which were about 20% lower than in 1990. ● For the United States, which did not agree to any targets, emissions went *up* a bit, by 2%. And then we see that China and the rest of the world, which had not emitted so much in the past, ● were now emitting more and more as they industrialised and tried to catch up to rich countries in their level of development. ● For the world as a whole, annual CO^2 emissions went *up* between 1990 and 2019 by a whole 66%.

[40] ● Three important things happened here when it comes to the numbers and knowledge we have on climate change.

[41] ● In 2001, the IPCC came out with new report, 3000 pages in all if you include appendices, where among other things they presented *new* analysis of how climate change could worsen *poverty* around the world, if we didn't control things properly. The report made it clear that climate change was very likely to worsen poverty across the world.

[42 to 47] ● In 2006, the IPCC came up with a standard method for countries to calculate their annual emissions. This is not an easy task. ● There are no instruments that measure, say, how much carbon dioxide is coming out of a city every day, from thousands of cars, factories, and so on. ● Instead, you have to take how much fuel is being purchased, ● how much steel, cement, and so on is being produced, and then calculate emissions from that. Today almost all countries produce what are called ● 'greenhouse gas inventories', which are available on the website of ● this United Nations body.

Continuation of Slide 6

[2 to 11 (1 is the audio object)] ● And then in 2011 more reliable historical emissions numbers became available, based on work that looked at how industrialisation happened in different countries across the world. This is why we now have ● the data I've looked at earlier in these videos of emissions going back to 1750. These historical emissions are not just important for understanding history. They are very important for calculating what are known as ● national carbon budgets. Different researchers have worked out how much each country can emit in total in the industrial era, without causing too much climate change for the world. To put it very simply, a country's carbon budget is bigger if its population is larger. If you are a country such as Britain or the United States, you've actually already used up your budget. For instance, at the start of the industrial revolution the ● USA's budget in what we can call the carbon bank ● was around 100 billion tonnes of CO^2. ● But if you add up the CO^2 emissions produced by the USA between 1750 and 2020, using our PRIMAP-hist data, we find that 417 billion tonnes have already been emitted[10]. What does this mean? ● They've used up their credits. ● It means that the USA and other rich countries, should stop emitting now, or as absolutely soon as possible, and have an important responsibility when it comes to assisting latecomers in the industrialisation process emit as little as possible through new technologies. If you're a country such as China, even if emissions may be high you haven't used up all your budget yet, basically because you started the industrialisation race quite late. ● You can imagine there is a lot of disagreement over how to use national carbon budgets in the international negotiations, and how to calculate these budgets. But they are a very important part of the current climate politics. Some have used the term ● atmospheric colonisation. Countries like Britain colonised much of the world, but they also colonised the atmosphere in the sense that they used up their own budget and then turned to using the carbon budgets of other, mostly poorer, countries.

[12 to 20] ● Among our last historical milestones is the 2015 Paris Agreement. This agreement ● replaces the Kyoto Protocol. Its main aim is to make sure that the average temperature of the air around us does not ● get more than 1.5 degrees Celsius hotter than it was when the industrial revolution began. This agreement is different from Kyoto in two important ways. ● First, it says all countries in the world should try to limit emissions, not just rich countries. Poorer countries should enjoy more flexibility, because they have emitted less in the past, but they all need to have targets for limiting emissions. ● The second big difference is that the Paris Agreement doesn't have fines for countries that don't meet their targets. Instead, the idea is that there must be ● a lot of transparency and accountability. Basically that means no-one should hide their emissions, and countries that do not take their targets seriously should be exposed, basically ● shamed. Once again, the United States has not been willing to participate, ● While the Obama government of the USA signed the Paris Agreement, ● the Trump government took the USA out of the agreement.

[21 to 33] ● We've looked at inequalities across countries. To end off this timeline, we'll go just a couple of years beyond 2020, ● to 2022. ● The 2022 World Inequality Report we've discussed previously came out with new and interesting information: ● inequalities *within* countries when it comes to footprint. We've seen, for example, that ● emissions in the United States are high. But if you break that down by whose consumptions lie behind those emissions, then you find that the ● 10% of people with the largest ● carbon footprint are responsible for ● 71% of the country's emissions. This inequality is of course closely linked to income inequality. If income is concentrated among a few, then those few will also be able to consume a lot, which influences their carbon footprint in comparison to the rest of the country. According to the World Inequality Report, ● income inequality worsened after around 1980. ● Here we see how responsible the top 10% of emitters in several major countries are for all emissions[11]. ● Here is the 71% for the United States we spoke about. ● South Africa has a long history of inequality, and ● China has become a lot more unequal as

[10] Based on Thompson and Montañez (2023).
[11] Calculated from the annexes of the 2022 World Inequality Report.

the country industrialised. This explains why these two countries are particularly unequal *inside* the country when it comes to the carbon footprint.

[34 to 46] ● That completes our timeline. ● Now let's go back to our bubble graph, where previously we saw the situation for 1985. ● And let's add the bubbles for 2019. ● We've already seen that emissions went up a little in the United States – the size of the bubble got slightly larger. ● Europe, which participated in Kyoto, saw a bit of a decline in emissions. But let's remember that some of this is because things that used to be produced in Europe are now ● imported from places like China. But most of the increase in emissions during this 1985 to 2019 period was outside the USA and Europe. To what extent was this because ● populations increased, something which pushes up emissions, and ● to what extent was it because the average person had more income to use for consumption? For ● India and for ● China the biggest factor pushing up emissions was ● income per person. Though ● Africa experienced some improvements in average income, here the biggest factor pushing up emissions was ● population increase.

Last segment of Slide 6

[2 to 3 (1 is the audio object)] We've reached the end of this series of videos. To end off, let's see ● a 2023 clip of the Secretary-General of the United Nations, Antonio Guterres. ● Clearly, history is one way we can get to understand this problem better, so we can ask our leaders for the right things, become leaders ourselves, and take action individually, wherever possible.

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