**PLEASE DON’T TRY TO PRINT THIS OUT – IT ISN’T A STANDARD PAGE SIZE – READ ON A SCREEN**

Still in progress

These notes are to give you some background information and reading if you want to get a bit informed before you give the Heading for Extinction talk. They are not meant to be read out! There are too many, for a start, and it would take too long. You can précis them any way you want (see the transcript of the video for one example – but it is only an example, not a prescription – of what to say).

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| **Slide** | **Content** | **Notes and references** |
| ~~1~~ | ~~Blurb~~ |  |
| 2 | Title | Have this slide on the screen while people are gathering, prior to the talk start |
| 3 | What brings you here today | Thank the audience for coming here today and facing the truth about the climate and ecological crisis.  Explain that there will be two breaks this evening when people can share their thoughts & feelings with their neighbour(s). Invite people to introduce themselves to each other and explain why you’ve come here tonight (Give them 2-3 min to do this) |
| 4 | XR brief note | Explain briefly what Extinction Rebellion is about and say that this will be dealt with in a lot more detail in the second part of the talk. Perhaps take this opportunity to explain a little about who *you* are, how/why you yourself became involved etc. |
| 5 | Overcome denial | Explain that we as a society have been in collective denial about the ecological crisis: practically everybody know that there is a problem, or that there may be a problem, but as a society we aren’t acting on it – but we need to start acting on it, rather urgently.  This denial happens for a number of complex reasons – if you want to delve into the background a bit, this book has some good info: Washington, H., & Cook, J. (2010). Climate change denial: Heads in the Sand. London: Earthscan. |
| 6 | Emotions | It is good to acknowledge at this point that there are a number of emotions that come into play when people confront the ecological crisis; exactly which ones depend on the person’s own background, experiences and personality. Some people react with fear and anxiety, some with grief and sadness, some with anger, some intellectualise it away, some just deny it or build a wall so they don’t have to think about it. Mention at this point that Extinction Rebellion has developed what it calls a “Regenerative” or “Regen” culture that acknowledges that emotions are a vitally important part of life and that recognising emotions and being mindful of them is necessary to tackle the task ahead of us, and to allow us all to support each other. In particular, recognising that someone else’s emotions might be different is very important – especially when faced with a “climate change denier”. Extinction Rebellion takes the view that it isn’t fruitful to try and break down people’s defences if they are in full denial, but rather to focus efforts on the people who either already accept the facts or are at least willing to examine them. (Most people who have come to the talk are probably in this category). |
| 7 | 2 parts | Explain very briefly that there are two parts to the talk: the first part which explains the problem, and the second part that explains our plan to tackle this problem. Warn them that the first part is difficult to hear but that the second part will be more uplifting! |
| 8 | Part1 | Part 1 |
| 9 | Life support and 2 sides | We need to remember that the Earth is our only life support system. There is “No planet B” as some people put it – this is it, for us and our lives and our children’s lives and the future of our species. Everything that we need for survival is contained on the surface of this planet, in the air and in the “biosphere” – the oceans and the land that supports us. |
| 10 | Destroying | We are destroying the Earth’s climate, its ecology, and our future.  You could mention at this point that climate and ecology are very intertwined – people tend to think of Extinction Rebellion as climate change activists but actually, ecological destruction and loss of biodiversity is an equally important part of our mission. They both affect each other – when the climate changes, plants and animals can’t always adapt (in fact usually *won’t* adapt – we are seeing species loss already as species can’t tolerate the heat and also can’t relocate fast enough to cooler locations ); conversely, when biosystems change then this can affect the climate. For example, deforestation can make a region much more arid. We will be coming back to this later. |
| 11 | Climate | Let’s start with climate |
| 12 | Greenhouse1 | The Earth’s atmosphere contains a number of gases – not just oxygen, which is essential for us of course, but also nitrogen which is inert (doesn’t do much) and carbon dioxide (CO2 for short) and methane, which are carbon-based gases. There are also other gases such as nitrous oxide and water vapour. Several of these gases – carbon dioxide (CO2), methane and water vapour are *greenhouse gases* – they let visible light through but not lower energy infra-red light (which is a kind of heat). This means that visible sunlight from the sun can pass through the air to reach the Earth’s surface, but when that light hits the Earth and loses energy and turns to infra-red light it can’t get back out again – it is trapped as heat by the greenhouse gases and the Earth warms up.  We have actually known about this for a long time (see interesting article by John Mason on <https://skepticalscience.com/two-centuries-climate-science-1.html> ):   * In the 1820s Joseph Fourier worked out that the Earth, given its size, ought to be a ball of ice and he proposed that the reason it isn’t is that the atmosphere keeps it warm. * 1856 Eunice Foote was the first to suggest that changing the proportion of carbon dioxide in the atmosphere would change its temperature, in her paper 'Circumstances affecting the heat of the sun's rays' at the American Association for the Advancement of Science conference, in which she wrote “An atmosphere of that gas would give to our Earth a high temperature; and if as some suppose, at one period of its history the air had mixed with it a larger proportion [of CO2] than at present, an increased temperature from its own action as well as from its own weight must have necessarily resulted.” * In the 1860s the Irish physicist and mountaineer John Tyndall became curious about the evidence of past ice ages and why the ice might have disappeared, and proposed that changes in the composition of the atmosphere could be responsible. He did some detailed quantitative experiments and found that water vapour, CO2 and methane are (among other gases) heat-trapping. * In the 1890s Svante Arrhenius calculated the degree of warming that rises from various gases at various concentrations, and showed that CO2, methane and water vapour are all selectively absorbing of infrared (heat) radiation, and thus create a greenhouse effect. Water vapour is actually the dominant greenhouse gas due to its abundance. He and Arvid Högbom also quantified the influence of changes in the concentration of CO2 in the atmosphere on the temperature of the Earth's surface, and calculated that human-caused emissions could in theory have effects on the Earth’s temperature. * In the 1950s, Charles Keeling set up a recording station on the top of the Hawaiian volcano Mauna Loa, far from any contamination by pollution, and began measuring atmospheric CO2. As the years went by the graph of his data showed a clear upwards curve, the so-called “[Keeling curve](https://upload.wikimedia.org/wikipedia/commons/thumb/c/c5/Mauna_Loa_CO2_monthly_mean_concentration.svg/640px-Mauna_Loa_CO2_monthly_mean_concentration.svg.png?1565852890096)”, which continues to rise exponentially.   • Arrhenius S (1896) On the influence of carbonic acid in the air upon the temperature of the ground. Philos Mag J Sci 41:237–276. [pdf](https://drive.google.com/open?id=1DTh65AtWacBOU505-yRgDmswf46cPox1)  • Foote E (1856) Circumstances affecting the heat of the sun’s rays. In: The American Journal of Science and Arts (Gray A, Agassiz L, Gibbs W, eds), pp 382–383. New York: G.P. Putnam & Co. [pdf](https://drive.google.com/open?id=1POh-vEan0BMMS1mXU2Z1f6vHhB__WmR-)  • Hulme M (2009) On the origin of ‘the greenhouse effect’: John Tyndall’s 1859 interrogation of nature. Weather 64:121–123. [pdf](https://drive.google.com/open?id=11wqmO66PS6xeVBRXZhN1jivqlopsJMVD) [This is quite interesting and not too technical]  • Rodhe H, Charlson R, Crawford E, Cycle TC (1997) Svante Arrhenius and the greenhouse effect. Ambio 26:19–22. [pdf](https://drive.google.com/open?id=1wIA4LggpvmLIqfDQZAVsf6wA6byrg9Tt)  • Tyndall J (1861) I. The Bakerian Lecture. On the absorption and radiation of heat by gases and vapours, and on the physical connexion of radiation, absorption, and conduction. Philos Mag 22:169-194 and 273–285. [pdf](https://drive.google.com/open?id=1oFeB3JLoSZ6YEnj2wV9FLQPvTVLQ7Nxe) |
| 13 | Greenhouse2 | These 19th century scientists were right. The problem we face today is that the products of our industry and agriculture have been pumping huge amounts of greenhouse gases, often called carbon emissions, into the atmosphere. Two of the big drivers of carbon emissions are agriculture and industry, needed to produce food and consumer products. Agriculture increases the level of atmospheric greenhouse gases because it requires the cutting down of forests, which remove carbon from the atmosphere, and because cattle produce vast amounts of methane, which is a carbon gas mostly produced by living organisms such as bacteria. Bacteria in the guts of cows release vast quantities of methane.  In the 1800s the industrial revolution began, when machines were invented and also when it was discovered that the Earth’s crust holds vast amounts of fossil fuels – oil, natural gas and coal. Over the ensuing two centuries we have unearthed and burnt enormous quantities of fossil fuels to power our machinery – so carbon that was drawn out of the air and locked in the crust by living things which died and were buried over millions and millions of years is being released back into the atmosphere over a period of only a few hundred years. |
| 14 | Hockey stick graph | This graph shows just how dramatic is the effect that the industrialisation of civilisation has had on levels of atmospheric CO2. For about the last 12000 years (only 2000 are shown here) the atmospheric CO2 level has been relatively stable at around 280 parts per million (ppm). This level is a “dynamic equilibrium” which means that it remains stable because the amount of CO2 production (mostly from the actions of living things, with a contribution from geologic processes such as volcanic activity) is balanced by the processes that remove it from the air – chemical reactions with rocks (called “weathering”), being dissolved in the oceans, being locked up by plants who use it to create their organic matter, etc.  However, notice what happens at the right end of the graph, over the last 200 years since the industrial revolution began. Levels of CO2 are increasing steeply – so much so that this striking shape is often called the “hockey stick curve” because it resembles the sharp bend of a hockey stick. This curve is an exponential curve, which means that not only is it increasing, but the rate of increase is itself increasing. Another word for this might be “skyrocketing.” We are, by our industrial actions, catapulting ourselves out of the stable equilibrium we existed in for the entirety of settled (agricultural/industrial) human existence.  This curve is so shocking that a number of “climate deniers” tried to discredit the climate scientist who first reported it, Michael Mann. However his data have since been validated by intensive follow-up measurements and there is no doubt about their veracity. Current levels of atmospheric CO2 are now at around 415ppm which are levels we have not seen in all of human history (since humans evolved).  Mann ME, Bradley RS, Hughes MK (1999) Northern hemisphere temperatures during the past millennium : inferences, uncertainties, and limitations. Geophys Res Lett 26:759–762. [pdf](https://drive.google.com/open?id=1qNyE7fOfXNFYxb0D9vhEzJOczIDXk3oF) |
| 15 | Temps | Needless to say, and exactly as predicted back in the 19th century by Fourier, Tyndall, Arrhenius, Hogborn etc, under the influence of the increased atmospheric carbon gases, the Earth is warming. This graph shows how surface ocean temperatures since 1880 are increasing at an exponential rate, pretty much in parallel with the exponential increase in atmospheric CO2  You might like to show this video from NASA which shows graphically how the Earth has warmed in recent years: <https://climate.nasa.gov/climate_resources/101/video-global-temperature-variation/>  Graph from NASA/Goddard Institute for Space Studies, available from the 2016 NASA briefing on <https://www.giss.nasa.gov/research/news/20160719/> |
| 16 | IPCC | What does this mean for us?  The Intergovernmental Panel on Climate Change is a group of scientists and other experts; funded by the UN and set up in 1988 to consider the implications of the then-newly-recognised “greenhouse effect”.  They work by examining the published scientific literature and determining what the scientific consensus is about various issues, issuing summary reports every few years (the fifth, in 2018, being the most recent).  In their latest report the IPCC consider that anything beyond 1.5 degrees would have catastrophic consequences & in many cases irreversible effects on the planet & human societies, with a recommendation for CO2 emissions to reach net zero by 2050 globally. Currently they are still increasing, as we just saw.  The heads of most world governments agreed in the Paris Agreement to aim to keep global temperature increases below 2°C, even though the IPCC recommended 1.5 degrees. The Paris Agreement is also not legally binding. When US President Trump came to power he withdrew the US from the agreement.  • See IPCC special report for policymakers <https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf>  • Masson-Delmotte et al (eds.). In Press. IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [pdf](https://drive.google.com/open?id=1v5iacZBcVAWCl3f8sGyjvrkdHW1o2vrD)  • IPCC 2018: summary for policymakers [pdf](https://drive.google.com/open?id=1BTgPjLK6nxRhs9PRc5ZUtI_ylhi9GDqN)  • Raftery, A. E., Zimmer, A., Frierson, D. M. W., Startz, R. & Liu, P. Less than 2 °C Warming by 2100 unlikely. Nat. Clim. Chang. 7, 637–641 (2017). Raftery AE, Zimmer A, Frierson DMW, Startz R, Liu P (2017) Less than 2◦ C warming by 2100 unlikely. Nat Clim Chang 7:637–641. [pdf](https://drive.google.com/open?id=1zlzasA_wcc3uJhDXlUbjszoTsoTD2TV0) |
| 17 | Why the fuss about 1.5C | The temperatures being discussed by the IPCC don’t on the face of it seem all that alarming because 1.5 degrees is not very much – you could change the thermostat in your house by 1.5 degrees and barely notice any difference. This is possibly one reason that the public and politicians have been slow to recognise the scale of the problem. This graph shows what the problem actually is with 1.5 degrees – it’s not the average (mean) temperature itself, but what happens at the extremes – the tails of the distribution of temperatures. This graph shows a stylised distribution – let’s say it is the average maximum summer temperature in London, or the average temperature in the Arctic in winter, or the number of countries that are hot vs. cold – the principle remains the same. If you shift the average (the peak, middle value) of the curve in the “hot” direction by a small amount, you can see that this has a very big effect on the extremes – there is much less of the curve in the cold zone and much more in the hot zone – so hot days in London will increase greatly in frequency for example (see the yellow arrow). Or we will develop more regions in the world like Death Valley that are too hot for most life. So the worry is not so much about the average but about the extremes.  Note that this graph doesn’t take into account another likely effect of global heating which is that the graph not only shifts to the right but also spreads out – gets more variable – so that the upper range gets even hotter.  Image credit: Kate Jeffery |
| 18 | Earth’s temp across the ages | When you talk about global heating, sometimes people say “Well, the Earth has had several warm periods in the past, what’s the big fuss?”  It’s true that there *have* been warmer periods in the Earth’s past. However, these warm periods have not been while human civilisation has been around. This is a graph of the last 500 million years of temperatures – that’s about the period of time over which we’ve had large complex life-forms on Earth and as you can see we have had some warm periods. The green line is the present-day temperature. But you can see that for the last 11000 years – during the formation of human civilisation – we’ve had a very stable climate called the *Holocene*. The temperature has been very temperate – we have ice at the poles, we have heat at the tropics but most of the Earth is inhabitable and stable. As a result, we’ve been able to develop agriculture and cities, and we’ve been able to spread out and cover the surface of the Earth.  The last time that temperatures were 1.5 or 2 degrees higher than they are now was 130000 years ago, long before human civilisation. And then the last time before *that* that it was *more* than 2 degrees – 3 degrees or 4 degrees – was some number of *millions* of years ago – before humans even evolved. So human civilisation has *not* existed in a warm Earth, and we don’t know if it can. That’s the big unknown – we are pushing ourselves out of the Holocene into uncharted territory.  This graph from Wikipedia <https://upload.wikimedia.org/wikipedia/commons/thumb/5/5f/All_palaeotemps.svg/1000px-All_palaeotemps.svg.png>  If you want to delve further into this there are some other things to consider. The oscillations in climate in the past million years show that climate is inherently unstable – it suddenly flips from one state to another, between glacial periods and warm (interglacial) periods like the one we’re in now. These flips in the past were caused by so-called orbital parameters – changes in the relationship of the Earth to the sun – but these parameters interact with factors on the Earth. For example, for some unknown reason the period of the oscillations suddenly changed (over one cycle) from 41 000 to 100 000 years, although the Earth didn’t suddenly change its orbit. These types behaviour, when a system suddenly and unpredictably changes from one state to another, are called chaotic, and climate is a chaotic system (weather is another one). The worry is that because of this hidden tendency to instability, when we push the climate far outside its current parameters we might flip into something unexpected. These sudden changes do not form part of current modelling predictions because – due to their chaotic nature – they are inherently unpredictable. However the notion that there might be “tipping points” where the warming Earth suddenly transitions, fast and unstoppably, to a *much* warmer Earth has caused considerable concern. Some, and Extinction Rebellion are among them, think that even the *risk* of unknown tipping points should be enough to galvanise us into action. We don’t take risks in other areas of life (hence our huge raft of safety legislation) so why are we doing it with this, the biggest risk we have ever faced? It doesn’t make much sense.  You might also like to watch climate scientist James Hansen’s TED talk: <https://www.ted.com/talks/james_hansen_why_i_must_speak_out_about_climate_change#t-1046295> |
| 19 | Global effects | What are the effects of global heating?  We are already seeing global effects, in the form of extreme weather events that are occurring more and more frequently. These examples show:  Floods following a Feb. 2019 deluge in Queensland, Australia, in which 500 000 cattle are estimated to have died <https://www.bbc.co.uk/news/world-australia-47274662>  People in the Indian city of Chennai, queuing for water delivered by tanker after a drought caused the city’s water supply to dry up <https://edition.cnn.com/2019/07/12/india/india-chennai-water-crisis-train-intl/index.html>  The aftermath of the California wildfires of 2018: <https://www.wikiwand.com/en/2018_California_wildfires>  The aftermath of cyclone Idai: <https://edition.cnn.com/2019/03/26/africa/mozambique-drone-footage-cyclone-idai-intl/index.html> It was followed a month later by cyclone Kenneth: <https://www.bbc.co.uk/news/av/world-africa-48081592/cyclone-kenneth-wipes-out-mozambique-villages> |
| 20 | UK effects | Although the UK is in a cooler part of the world, and actually quite near the North pole (kept warmer than it “should” be due to warm water brought up from the tropics by the gulf stream) we are also experiencing the effects of unusual weather patterns and an increase in extreme weather events:  2004 Heatwave killed 70,000 Europe-wide: Robine, Jean-Marie; Cheung, Siu Lan K.; Le Roy, Sophie; Van Oyen, Herman; Griffiths, Clare; Michel, Jean-Pierre; Herrmann, François Richard (2008). Death toll exceeded 70,000 in Europe during the summer of 2003. Comptes Rendus Biologies 331 (2): 171–178. [pdf](https://drive.google.com/open?id=1761DjRekxdLlHIYr3MVfRpDXg0Jf3Srx)  2014 Worst rainfall in 248 years: UK Met Office official blog <https://blog.metoffice.gov.uk/2014/02/06/uks-exceptional-weather-in-context/>  2019 Announcement that Welsh village of Fairbourne to be decommissioned: <https://www.theguardian.com/environment/2019/may/18/this-is-a-wake-up-call-the-villagers-who-could-be-britains-first-climate-refugees>  2018: Hottest summer on record in UK: <https://www.bbc.co.uk/news/uk-45399134> (note: since this slide was made, 2019 has broken the record)  Rise in heart failure etc: <https://www.theguardian.com/society/2018/aug/03/deaths-rose-650-above-average-during-uk-heatwave-with-older-people-most-at-risk>  Vegetable yields down: <https://www.theguardian.com/business/2018/jul/27/heatwave-pushes-up-uk-fruit-and-vegetables-prices-as-yields-fall> |
| 21 | What happens… | What happens if we do nothing? |
| 22 | Consequences | The consequences of “business as usual” are not good:  • Accelerating sea level rise: Meehl GA, Washington WM, Collins WD, Arblaster JM, Hu A, Buja LE, Strand WG, Teng H (2005) How much more global warming and sea level rise? Science 307:1769–1773. [pdf](https://drive.google.com/open?id=1A16lAk0yKGQJYis33lDwgSVVy8IpqltI)  • Coastal flooding & storm surges: Wahl T, Jain S, Bender J, Meyers SD, Luther ME (2015) Increasing risk of compound flooding from storm surge and rainfall for major US cities. Nature Climate Change 5:1093–1098. [pdf](https://drive.google.com/open?id=1A2U1mF1Asmtcbn6XTcMsU2u8zU5BwJwf)  • Wildfires: Westerling AL, Hidalgo HG, R. CD, Swetnam TW (2006) Warming and earlier spring increase western U.S. forest wildfire activity. Science 1161:940–944. [pdf](https://drive.google.com/open?id=1nL-mBVGt7d0U6TwW1WCm27ESPVwgYMgQ)  • Heat stress: From Tuvalu to Townsville: Climate Change Impacts on Health in Australia and the Asia Pacific. Policy advice for Governments in Australia <http://glham.org/from-townsville-to-tuvalu/>  • Famine: <https://www.wfp.org/climate-change/climate-impacts>; see also Myers SS, Smith MR, Guth S, Golden CD, Vaitla B, Mueller ND, Dangour AD, Huybers P (2017) Climate change and global food systems : Potential impacts on food security and undernutrition. Annual Review of Public Health 38:259–277. [pdf](https://drive.google.com/open?id=1dYLL3pmoPxs12NRfXm1Hwfr_upDPrcjy)  • War: Mach KJ, Kraan CM, Adger N, Buhaug H, Burke M, Fearon JD (2019) Climate as a risk factor for armed conflict. Nature 571:193–197. [pdf](https://drive.google.com/open?id=1614wfAVjCZy0ZQaewszbuEQp4mRewtf4) |
| 23 | Amplifiers | Not only is there concern about what will happen on our current trajectory, there is also considerable concern that the changing climate will itself trigger additional changes that amplify the initial warming, such that our current predictions are actually an underestimate (this is leaving aside the issue of tipping points, although these could contribute to reaching one).  There are numerous processes that cause such feedbacks.  Two important examples are:   1. Reduced heat reflection due to ice loss at the poles. Right now, the bright white ice caps reflect sunlight away, whereas the deep blue ocean absorbs heat. As the ice melts and this reflection (called “albedo”) decreases, the rate of temperature increase will accelerate. This effect is already evident and contributes to the much higher rate of heating we are seeing at the poles. 2. Release of carbon from melting permafrost in the arctic. There are large amounts of carbon dioxide and methane locked in stores under permafrost and sea ice around the arctic; since methane is a much more potent greenhouse gas than C02 (over short timescales) the potential release of this methane has caused considerable concern. While the rate of melting permafrost has increased in recent years, it still contributes only a small amount to global methane emissions. However, should warming temperatures cause the rate of emissions to accelerate substantially in the future, melting permafrosts would pose a major risk to global climate stability. The impact of this risk can be abated by reducing anthropogenic methane emissions, but such a reduction needs to happen as soon as possible to be effective.   • Christensen TR, Arora VK, Gauss M, Höglund-isa L (2019) Tracing the climate signal : mitigation of anthropogenic methane emissions can outweigh a large Arctic natural emission increase. Sci Rep 9:1–8. [pdf](https://drive.google.com/open?id=1_cIqJnEplkIL4MBbpdmjwCop5bd6eSTP)  • Ruppel CG, Kessler JD (2017) The interaction of climate change and methane hydrates. Rev Geophys:126–168. [pdf](https://drive.google.com/open?id=1K8Uq-UlnFLyZyOfHiJYWuGGtyK6fb13M)  • Saunois M, Bousquet P, Poulter B, Peregon A, Ciais P, Canadell JG, Dlugokencky EJ, Etiope G, Bastviken D (2016) The global  methane budget 2000 – 2012. Earth Syst Sci Data, 8:697–751. [pdf](https://drive.google.com/open?id=11Z7XeHHSQLz4N4KueV9zwXlCDTLcZXAv)  • Schaefer K, Lantuit H, Romanovsky VE (2014) The impact of the permafrost carbon feedback on global climate. Environ Res Lett 9:085003. [pdf](https://drive.google.com/open?id=1CojdU8o_fedUNXLRc-e6ODmhf2-zoZYP)  • James RH, Bousquet P, Bussmann I, Haeckel M, Kipfer R, Leifer I, Niemann H, Ostrovsky I, Piskozub J, Rehder G, Treude T (2016) Effects of climate change on methane emissions from seafloor sediments in the Arctic Ocean : A review. Limnol Oceanogr 61:283–299. [pdf](https://drive.google.com/open?id=17oUD1rOZmEb114j8iiQ4ury-K50JdL_P) |
| 24 | Hothouse | As mentioned earlier, a worry is that because of these amplifiers and feedback loops, there may be a point of no return (tipping point) for the climate after which even if we stop producing further emissions, the changes will continue under their own steam for some time. When we look at climate changes in the past, for example during the sequence of ice ages we have had in the last million years, we see that the climate goes from cold to warm very quickly but from warm back to cold very slowly. This suggest that whatever factors have triggered the start warming have unleashed additional factors that propel temperature increases very quickly. And it should be noted that “quickly” in the past has meant “over thousands of years”. What we are doing today, with our industrial emissions, is much faster than any natural process at any time in the past. This potential instability is very worrying.  • Mora C, Frazier AG, Longman RJ, Dacks RS, Walton MM, Tong EJ, Sanchez JJ, Kaiser LR, Stender YO, Anderson JM, Ambrosino CM, Fernandez-silva I, Giuseffi LM, Giambelluca TW (2005) The projected timing of climate departure from recent variability. Nature 502:183–187. [pdf](https://drive.google.com/open?id=1ayZ2QnBmcSCX2g8TMF-9XG-TlZ8m9MD5)  • Steffen W, Rockström J, Richardson K, Lenton TM, Folke C, Liverman D (2018) Trajectories of the Earth system in the Anthropocene. Pro 115:8252–8259. [pdf](https://drive.google.com/open?id=19C8T_lju1OKzdA6iMgYeZCaTnjShZfUJ)  • Xu W, Ramanathan V, Victor D (2018) Global warming will happen faster than we think. Nature 564:30–32. [pdf](https://drive.google.com/open?id=1oALRvSuwqyZ5dLAZoxoEjND7SXYM_mtC) |
| 25 | Only half | As mentioned earlier, climate is only half the story surrounding human destruction of the biosphere. |
| 26 | Ecology | We turn now to ecology – to the web of living things that inhabits the surface of the planet and on which we depend for our survival – for the production of oxygen for us to breathe, the balancing of CO2 to maintain our stable climate, and production of food.  The impact of human activity has been so great that evidence of our existence is likely to be stamped into the fossil record dramatically all over the planet. This has led scientists to recently formally declare that we have triggered the start of a new geological epoch, the *Anthropocene*.  Carrington D (2016) The Anthropocene epoch: scientists declare dawn of human-influenced age. Guard 29 Available at: <https://www.theguardian.com/environment/2016/aug/29/declare-anthropocene-epoch-experts-urge-geological-congress-human-impact-earth>. |
| 27 | Land/ocean | The surface of the Earth is two-thirds ocean and one-third land, and both are important for biosphere stability and health. We’ll start with land. |
| 28 | Agriculture | In order to support our huge and growing population (currently 7.5 billion; projected to reach 10 billion by 2050 at current rates) we have developed high-intensity agriculture to enable maximisation of crop yields. This entails widespread deforestation to clear space for crops; use of machinery to enable farming of large areas; pesticides and herbicides to eliminate competing organisms, and transportation of food across vast distances of the planet, so that a consumer in London can eat an avocado from Mexico with little effort. Agriculture is associated with huge emissions, partly directly (methane from cows, CO2 from transportation and other fossil fuel use as well as burning) and partly indirectly from reduced carbon drawdown from deforestation (more on this in the next slide).  This is having enormous effects on the planet. The IPCC has just released a special report called Climate Change and Land in which they lay out the consequences of our agriculture and other land use. Among the notable findings of their report are:   * Human use directly affects more than 70% (likely 69-76%) of the global, icefree land surface * Agriculture currently accounts for ~70% of global fresh-water use * Soil erosion from agricultural fields is between 10 and 100 times higher than the soil formation rate * Agriculture, forestry and other land use activities account for around 23% of our greenhouse gas emissions [note this is complicated to work out because there are complex effects in both directions: increased plant growth in some areas causes CO2 to be removed from the air etc]   • Arneth A et al. (2019) IPCC Special Report Climate Change and Land: Summary for Policymakers. [pdf](https://drive.google.com/open?id=1oIbOcW82Kvkwg3w4uQLQyYw1qe81Q-p5) |
| 29 | Deforestation | Forests are extremely important ecosystems that have vast effects on the earth’s climate and biodiversity, and so stripping these away has profound consequences for the health and stability of the biosphere. Trees build their mass from carbon taken in as carbon dioxide and metabolised – so they draw down a large amount of carbon. In fact, when trees first evolved around 360 million years ago they had such a large effect on atmospheric CO2 that they triggered an ice age. These days, the world’s forests play an important part in stabilising greenhouse gases at the level that until recently has been keeping us in a temperate state.  Another big effect of trees is that they create a local microclimate, by releasing moisture into the air in a process known as *transpiration*. This means that even in hot climates, heavily forested regions often have a high level of rainfall – they are rainforests. Once this cycle is broken by deforestation then the land becomes savannah, which is much drier, and can eventually become desert. One this has happened it is hard to re-establish forest because moisture has been lost from the region. It is thought that Australia was once heavily forested – now it is almost entirely desert.  • Nobre AD (2014) The Future climate of Amazonia. The Future Climate of Amazonia, Scientific Assessment Report. Sponsored by CCST-INPE, INPA and ARA. São José dos Campos, Brazil. [pdf](https://drive.google.com/open?id=167MNKe4BQJuUhdNEZ1MJvzlY4GYbxtzL) |
| 30 | Desert | Rosenfeld D, Rudich Y, Lahav R (2001) Desert dust suppressing precipitation : A possible desertification feedback loop. Proc Natl Acad Sci U S A 98:5975–5980. |
| 31 | Ocean1 | Bigg, G. R., Jickells, T. D., Liss, P. S. & Osborn, T. J. The role of the oceans in climate. Int. J. Climatol. 23, 1127–1159 (2003).  Sabine, C. L. et al. The oceanic sink for anthropogenic CO2. Science 30(5), 367–371 (2004). |
| 32 | Ocean2 | Fabry, V. J., Seibel, B. A., Feely, R. A. & Orr, J. C. Impacts of ocean acidification on marine fauna and ecosystem processes. *ICES J. Mar. Sci.***65**, 414–432 (2008).  Winder, M. & Sommer, U. Phytoplankton response to a changing climate. *Hydrobiologia***698**, 5–16 (2012). |
| 33 | 6th mass extinction | Measurements of global biodiversity are showing that we are experiencing a dramatic decline in species worldwide as a result of human activity, including the climate heating and habitat destruction we have just looked at.  In May 2019, a global body snappily called the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) produced a report suggesting that 1 million species are threatened with extinction.  This rate of extinction has been estimated as being 100 times more than the expected, "background" extinction rate (Ceballos et al., 2015), leading scientists to conclude that we are entering a period known as the 6th mass extinction.  The 5 previous mass extinctions were also due to dramatic changes in greenhouse gases in the atmosphere – even the asteroid event that killed the dinosaurs may have induced its global effects via volcanic activity and greenhouse gas emissions from the “Deccan traps” eruptions (Schoene et al, 2015).  While life as a whole adapted to these changes, individual species generally did not. Furthermore, these previous changes occurred over thousands or millions of years, while the warming we are currently experiencing is at a rate not seen even in the worst previous extinction event (Cui et al 2013). It is a major cause of species loss as populations fail to adapt and are lost. For example, Australia’s coral reefs, home to a quarter of all fish species, have experienced major “bleaching” die-off events in recent years and almost 20% are now dead.  IPBES webpage <https://www.ipbes.net/>  IPBES Q&A <https://www.ipbes.net/news/million-threatened-species-thirteen-questions-answers>  Coral reef loss <http://www.worldwatch.org/node/5960>  • Ceballos G, Ehrlich PR, Barnosky AD, García A, Pringle RM, Palmer TM (2015) Accelerated modern human-induced species losses: Entering the sixth mass extinction. Sci Adv:9–13. [pdf](https://drive.google.com/open?id=1i_2og2hkA9pe4GVHZiIOHmySmaMG01Ka)  • Cui Y, Kump LR, Ridgwell A (2013) Initial assessment of the carbon emission rate and climatic consequences during the end-Permian mass extinction. Palaeogeogr Palaeoclimatol Palaeoecol 389:128–136. [pdf](https://drive.google.com/open?id=1DYuDdgp6HQPEE-f5zhTns654JDgQ4V9W)  • Schoene B, Samperton KM, Eddy MP, Keller G, Adatte T, Bowring SA, Khadri SFR, Gertsch B (2015) U-Pb geochronology of the Deccan Traps and relation to the end-Cretaceous mass extinction. Science 347:9–12. [pdf](https://drive.google.com/open?id=1QoA8AhtsfCT4ccGzUuw-tJJM7YlMSoLw)Bar-On YM, Phillips R, Milo R (2018) The biomass distribution on Earth. Proc Natl Acad Sci 115:6506–6511.  • Sánchez-bayo F, Wyckhuys KAG (2019) Worldwide decline of the entomofauna : A review of its drivers. Biol Conserv 232:8–27. [pdf](https://drive.google.com/open?id=1E4KstwsXb0LtinHJggKE6sz-xnMvK0q5) |
| 34 | Animals |  |
| 35 | Food web | • Zhang L, Takahashi D, Hartvig M, Andersen KH (2017) Food-web dynamics under climate change. Proc R Soc L B Biol Sci 284:20171772.  • Ullah H, Nagelkerken I, Goldenberg SU, Fordham DA (2018) Climate change could drive marine food web collapse through altered trophic flows and cyanobacterial proliferation. PLOS Biology (2018). |
| 36 | Break |  |
| 37 | Neighbour |  |
| 38 | Part 2 |  |
| 39 | Why didn’t you |  |
| 40 | Moral obligations |  |
| 41 | Beautiful planet |  |
| 42 | How can we not? |  |
| 43 | Globally |  |
| 44 | Locally |  |
| 45 | None of this |  |
| 46 | Structural problems |  |
| 47 | New approach |  |
| 48 | Change the rules |  |
| 49 | Civil resistance | This slide shows three famous figures from civil resistance movements of the past.  Mahatma Gandhi employed non-violent civil resistance to free India from British rule and lead it to independence. |
| 50 | Elements of resistance |  |
| 51 | Introducing XR |  |
| 52 | Global XR |  |
| 53 | Achievements |  |
| 54 | 3 demands | 1. Tell the truth about the ecological crisis and declare a climate emergency 2. Greenhouse gas net-zero & halting of biodiversity loss by 2025   Currently our emissions by sector are:  Aviation accounts for around 5% of global warming when accounting for both CO2 and climate effects at altitude <https://www.icsa-aviation.org/wp-content/uploads/2018/10/ICSA-statement-on-IPCC.pdf>  The construction industry accounts for around 30% emissions  (<https://www.designingbuildings.co.uk/wiki/Intergovernmental_Panel_on_Climate_Change_IPCC>)   1. Citizens’ assembly on climate and ecological justice |
| 55 | Why 2025? | Smith et al (2019) say “…if carbon-intensive infrastructure is phased out at the end of its design lifetime from the end of 2018, there is a 64% chance that peak global mean temperature rise remains below 1.5 °C. Delaying mitigation until 2030 considerably reduces the likelihood that 1.5 °C would be attainable even if the rate of fossil fuel retirement was accelerated.”  However, 2025 is going to be challenging: see <https://science.sciencemag.org/content/360/6396/eaas9793.abstract>  It should also be noted that even after we zero our emissions (assuming we ever do), 25% CO2 that we add to the atmosphere will remain there after 1000 years (Joos et al, 2013)  • Davis SJ et al. (2018) Net-zero emissions energy systems. Science (80- ) 360:eaas9793. [pdf](https://drive.google.com/open?id=1H7FMPASTd9y57IZQm81IyWHQ35n8qVJA)  • Joos F et al. (2013) Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: A multi-model analysis. Atmos Chem Phys 13:2793–2825. [pdf](https://drive.google.com/open?id=1ju23ZBZadRBKoqMB0LudaJbYRQo1wb60)  • Smith CJ, Forster PM, Allen M, Fuglestvedt J, Millar RJ, Rogelj J, Zickfeld K (2019) Current fossil fuel infrastructure does not yet commit us to 1.5 °C warming. Nat Commun 10:1–10 [pdf](https://drive.google.com/open?id=1S3uTndSp_cnOL-OTm1CKKlHfIm2oTQVp) |
| 56 | Car cliff |  |
| 57 | What is a CA? |  |
| 58 | Flowchart |  |
| 59 | Reasons for CA |  |
| 60 | How we work |  |
| 61 | Non-violent |  |
| 62 | Lennon |  |
| 63 | De-centralised |  |
| 64 | Groups |  |
| 65 | Core activity = actions |  |
| 66 | Actions - local |  |
| 67 | Actions - national |  |
| 68 | Support |  |
| 69 | Arrest | Note that NVDA training should be undertaken before putting oneself in a compromised position, and a personal decision taken only after that. |
| 70 | How you could contribute |  |
| 71 | Why get involved |  |
| 72 | How to join |  |
| 73 | Thank you |  |
| 74 |  |  |
| 75 | Biomass | Drawing courtesy of Guillaume Lavanchy based on data by Bar-On et al (note that this is just for mammals, and it relates to the biomass, which is roughly speaking the total amount of flesh).  Bar-On YM, Phillips R, Milo R (2018) The biomass distribution on Earth. Proc Natl Acad Sci 115:6506–6511. |
| 76 |  |  |