A CRITICAL DECADE

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INTRODUCTION[1]

Humanity has reached a critical decade

A new report, published on 14 March, 2021 in the Royal Swedish Academy of Sciences' journal Ambio, points out that humanity is hurtling towards destruction unless we have the collective wisdom to change course quickly. Here is a link to the article:

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The Ambio article was written as part of the preparation for a meeting of Nobel Prize winners to discuss the state of the planet. The virtual meeting was held on April 26-28, 2021.

We must achieve a steady-state economic system

A steady-state economic system is necessary because neither population growth nor economic growth can continue indefinitely on a finite earth. No one can maintain that exponential industrial growth is sustainable in the long run except by refusing to look more than a short distance into the future.

Of course, it is necessary to distinguish between industrial growth, and growth of culture and knowledge, which can and should continue to grow. Qualitative improvements in human society are possible and desirable, but resource-using and pollution-producing industrial growth is reaching its limits, both because of ecological constraints and because of the exhaustion of petroleum, natural gas and other non-renewable resources, such as metals. The threat of catastrophic climate change makes it imperative for us to stop using fossil fuels within very few years.

Entropy is a measure of disorder. Our present economic system is unidirectional and entropic: Low-entropy resources are converted into high-entropy waste, a unidirectional process. By contrast, to be sustainable in the long run, a process must be cyclic, like the growth and regeneration of a forest.

[1]This book uses some of my previously published book chapters, but much new material has been added.

We must decrease economic inequality

In his Apostolic Exhortation, "Evangelii Gaudium" Pope Francis said: "In our time humanity is experiencing a turning-point in its history, as we can see from the advances being made in so many fields. We can only praise the steps being taken to improve people's welfare in areas such as health care, education and communications. At the same time we have to remember that the majority of our contemporaries are barely living from day to day, with dire consequences. A number of diseases are spreading. The hearts of many people are gripped by fear and desperation, even in the so-called rich countries. The joy of living frequently fades, lack of respect for others and violence are on the rise, and inequality is increasingly evident. It is a struggle to live and, often, to live with precious little dignity.

"Just as the commandment 'Thou shalt not kill' sets a clear limit in order to safeguard the value of human life, today we also have to say 'thou shalt not' to an economy of exclusion and inequality. Such an economy kills. How can it be that it is not a news item when an elderly homeless person dies of exposure, but it is news when the stock market loses two points? This is a case of exclusion.

"Can we continue to stand by when food is thrown away while people are starving? This is a case of inequality. Today everything comes under the laws of competition and the survival of the fittest, where the powerful feed upon the powerless. As a consequence, masses of people find themselves excluded and marginalized: without work, without possibilities, without any means of escape."

The social epidemiologist Prof. Richard Wilkinson, has documented the ways in which societies with less economic inequality do better than more unequal societies in a number of areas, including increased rates of life expectancy, mathematical performance, literacy, trust, social mobility, together with decreased rates of infant mortality, homicides, imprisonment, teenage births, obesity and mental illness, as well as drug and alcohol addiction.

We must also remember that according to the economist John A. Hobson, the basic problem that led to imperialism was an excessively unequal distribution of incomes in the industrialized countries. The result of this unequal distribution was that neither the rich nor the poor could buy back the total output of their society. The incomes of the poor were insufficient, and rich were too few in number. Thus governments were forced to look for markets in the less developed parts of the world.

We must break the power of corporate greed

When the United Nations was established in 1945, the purpose of the organization was to abolish the institution of war. This goal was built into many of the articles of the UN Charter. Accordingly, throughout the world, many War Departments were renamed and became Departments of Defense. But the very name is a lie. In an age of nuclear threats and counter-threats, populations are by no means protected. Ordinary citizens are just hostages in a game for power and money. It is all about greed.

Why is war continually threatened? Why is Russia threatened? Why is war with Iran threatened? Why fan the flames of conflict with China? Is it to "protect" civilians? Absolutely not! In a thermonuclear war, hundreds of millions of civilians would die horribly everywhere in the world, also in neutral countries. What is really being protected are the profits of arms manufacturers. As long as there are tensions; as long as there is a threat of war, military budgets are safe; and the profits of arms makers are safe. The people in several "democracies", for example the United States, do not rule at the moment. Greed rules.

As Professor Noam Chomsky has pointed out, greed and lack of ethics are built into the structure of corporations. By law, the Chief Executive Officer of a corporation must be entirely motivated by the collective greed of the stockholders. He must maximize profits. If the CEO abandons this single-minded chase after corporate profits for ethical reasons, or for the sake of humanity or the biosphere or the future, he (or she) must, by law, be fired and replaced.

We must leave fossil fuels in the ground

The threat of catastrophic climate change requires prompt and dedicated action by the global community. Unless we very quickly make the transition from fossil fuels to 100% renewable energy, we will reach a tipping point after which uncontrollable feedback loops could take over, leading to a human-caused 6th geological extinction event. This might even be comparable to the Permian-Triassic event, during which 96% of all marine species and 70% of terrestrial vertebrates became extinct.

Arctic sea-ice is melting at an increasingly rapid rate, because of several feedback loops. One of these feedback loops, called the albedo effect, is due to the fact that white snow-covered sea-ice in the Arctic reflects sunlight,

while dark water absorbs it, raising the temperature and leading to more melting.

Another feedback loop is due to the fact that rising temperatures mean that more water is evaporated. The water vapor in the atmosphere acts like a greenhouse gas, and raises the temperature still further.

If we consider long-term effects, by far the most dangerous of the feedback loops is the melting of methane hydrate crystals and the release of methane into the atmosphere, where its effects as a greenhouse gas are roughly twenty times great as those of CO2.

When organic matter is carried into the oceans by rivers, it decays to form methane. The methane then combines with water to form hydrate crystals, which are stable at the temperatures which currently exist on ocean floors. However, if the temperature rises, the crystals become unstable, and methane gas bubbles up to the surface.

The worrying thing about methane hydrate deposits on ocean floors is the enormous amount of carbon involved: roughly 10,000 gigatons. To put this huge amount into perspective, we can remember that the total amount in world CO_2 emissions since 1751 has been only 337 gigatons.

Hope for the future comes from the exponential growth of renewable energy. Governments and banks must aid this growth, and they must end the support that they give to fossil fuel corporations.

Ecological Economics

In the future, ecology must be incorporated into economic theory. The human economy is a part of the global environment, rather than the reverse. Human society cannot prosper while the environment suffers. Economists must acknowledge this fact. We need a new economic system, one that has both a social conscience and an ecological conscience.

Our Planet, Our Future. An Urgent Call to Action

Here is a link to the full statement, signed by 126 Nobel Laureates and other experts:

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1.7 Our Planet, Our Future. An Urgent Call to Action

Nobel Prize Laureates and Other Experts Issue Urgent Call for Action After *Our Planet, Our Future* Summit

This statement was inspired by the discussions at the 2021 Nobel Prize Summit, issued by the Steering Committee and co-signed by 126 Nobel Laureates and experts.

Below is the full text.[1]

Preamble

The Nobel Prizes were created to honor advances of "the greatest benefit to humankind." They celebrate successes that have helped build a safe, prosperous, and peaceful world, the foundation of which is scientific reason.

"Science is at the base of all the progress that lightens the burden of life and lessens its suffering." Marie Curie (Nobel Laureate 1903 and 1911)

Science is a global common good on a quest for truth, knowledge, and innovation toward a better life. Now, humankind faces new challenges at unprecedented scale. The first Nobel Prize Summit comes amid a global pandemic, amid a crisis of inequality, amid an ecological crisis, amid a climate crisis, and amid an information crisis. These supranational crises are interlinked and threaten the enormous gains we have made in human progress. It is particularly concerning that the parts of the world projected to experience many of the compounding negative effects from global changes are also home to many of the world's poorest communities, and to indigenous peoples. The summit also comes amid unprecedented urbanization rates and on the cusp of technological disruption from digitalization, artificial intelligence, ubiquitous sensing

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and biotechnology and nanotechnology that may transform all aspects of our lives in coming decade.

"We have never had to deal with problems of the scale facing today's globally interconnected society. No one knows for sure what will work, so it is important to build a system that can evolve and adapt rapidly." Elinor Ostrom (Nobel Laureate 2009)

The summit has been convened to promote a transformation to global sustainability for human prosperity and equity. Time is the natural resource in shortest supply. The next decade is crucial: Global greenhouse gas emissions need to be cut by half and destruction of nature halted and reversed. An essential foundation for this transformation is to address destabilizing inequalities in the world. Without transformational action this decade, humanity is taking colossal risks with our common future. Societies risk large-scale, irreversible changes to Earth's biosphere and our lives as part of it.

"A new type of thinking is essential if mankind is to survive and move toward higher levels." Albert Einstein (Nobel Laureate 1921)

We need to reinvent our relationship with planet Earth. The future of all life on this planet, humans and our societies included, requires us to become effective stewards of the global commons - the climate, ice, land, ocean, freshwater, forests, soils, and rich diversity of life that regulate the state of the planet, and combine to create a unique and harmonious life-support system. There is now an existential need to build economies and societies that support Earth system harmony rather than disrupt it.

Our Planet

"It seems appropriate to assign the term *Anthropocene* to the present." Paul Crutzen (Nobel Laureate 1995)

Geologists call the last 12,000 years the Holocene epoch. A remarkable feature of this period has been relative Earth-system stability. But the stability of the Holocene is behind us now. Human societies are now the prime driver of change in Earth's living sphere - the biosphere. The fate of the biosphere and human societies embedded within it is now deeply intertwined and evolving together. Earth has entered a new geological epoch, the Anthropocene. Evidence points to the 1950s as the onset of the Anthropocene - a single human lifetime ago. The Anthropocene epoch is more likely to be characterized by speed, scale, and shock at global levels.

Planetary health

The health of nature, our planet, and people is tightly connected. Pandemic risk is one of many global health risks in the Anthropocene. The risks of pandemics are now greater due to destruction of natural habitats, highly networked

societies, and misinformation.

The COVID-19 pandemic is the greatest global shock since the Second World War. It has caused immense suffering and hardship. The scientific response in the face of catastrophe, from detection to vaccine development, has been robust and effective. There is much to applaud. However, there have been clear failings. The poorest and most marginalized in societies remain the most vulnerable. The scale of this catastrophe could have been greatly reduced through preventive measures, greater openness, early detection systems, and faster emergency responses.

Reducing risk of zoonotic disease like COVID-19 requires a multi-pronged approach recognizing "one health" - the intimate connections between human health and the health of other animals and the environment. Rapid urbanization, agricultural intensification, overexploitation, and habitat loss of large wildlife all promote the abundance of small mammals, such as rodents. Additionally, these land-use changes lead animals to shift their activities from natural ecosystems to farmlands, urban parks, and other human-dominated areas, greatly increasing contact with people and the risk of disease transmission.

The global commons

Global heating and habitat loss amount to nothing less than a vast and uncontrolled experiment on Earth's life-support system. Multiple lines of evidence now show that, for the first time in our existence, our actions are destabilizing critical parts of the Earth system that determine the state of the planet.

For 3 million years, global mean temperature increases have not exceeded 2^oC of global warming, yet that is what is in prospect within this century. We are on a path that has taken us to 1.2^oC warming so far - the warmest temperature on Earth since we left the last ice age some 20,000 years ago, and which will take us to $> 3^oC$ warming in 80 years.

At the same time, we are losing Earth resilience, having transformed half of Earth's land outside of the ice sheets, largely through farming expansion. Of an estimated 8 million species on Earth, about 1 million are under threat. Since the 1970s, there has been an estimated 68% decline in the populations of vertebrate species.

Inequality

"The only sustainable prosperity is shared prosperity." Joseph Stieglitz (Nobel Laureate 2001)

While all in societies contribute to economic growth, the wealthy in most societies disproportionately take the largest share of this growing wealth. This

trend has become more pronounced in recent decades. In highly unequal societies, with wide disparities in areas such as health care and education, the poorest are more likely to remain trapped in poverty across several generations.

More equal societies tend to score highly on metrics of well-being and happiness. Reducing inequality raises social capital. There is a greater sense of community and more trust in government. These factors make it easier to make collective, long-term decisions. Humanity's future depends on the ability to make long-term, collective decisions to navigate the Anthropocene.

The COVID-19 pandemic, the largest economic calamity since the Great Depression, is expected to worsen inequality at a moment when inequality is having a clear destabilizing political impact in many countries. Climate change is expected to further exacerbate inequality. Already, the poorest, often living in vulnerable communities, are hit hardest by the impacts of climate, and live with the damaging health impacts of energy systems, for example air pollution. Furthermore, although urbanization has brought many societal benefits, it is also exacerbating existing, and creating new, inequities.

It is an inescapable conclusion that inequality and global sustainability challenges are deeply linked. Reducing inequality will positively impact collective decision-making.

Technology

The accelerating technological revolution - including information technology, artificial intelligence, and synthetic biology - will impact inequality, jobs, and entire economies, with disruptive consequences. On aggregate, technological advancements so far have accelerated us down the path toward destabilizing the planet. Without guidance, technological evolution is unlikely to lead to transformations toward sustainability. It will be critical to guide the technological revolution deliberately and strategically in the coming decades to support societal goals.

Acknowledging urgency and embracing complexity

The future habitability of Earth for human societies depends on the collective actions humanity takes now. There is rising evidence that this is a decisive decade (2020-2030). Loss of nature must be stopped and deep inequality counteracted. Global emissions of greenhouse gases need to be cut by half in the decade of 2021-2030. This alone requires collective governance of the global commons - all the living and non-living systems on Earth that societies use but that also regulate the state of the planet - for the sake of all people in the future.

On top of the urgency, we must embrace complexity. Humanity faces rising network risks and cascading risks as human and technological networks grow. The 2020/2021 pandemic was a health shock that quickly cascaded into economic shocks. We must recognize that surprise is the new normal and manage for complexity and emergent behavior.

Our Future

A decade of action

Time is running out to prevent irreversible changes. Ice sheets are approaching tipping points - parts of the Antarctic ice sheet may have already crossed irreversible tipping points. The circulation of heat in the North Atlantic is unequivocally slowing down due to accelerated ice melt. This may further affect monsoons and the stability of major parts of Antarctica. Rainforests, permafrost, and coral reefs are also approaching tipping points. The remaining carbon budget for a 67% probability of not exceeding 1.5^{o}C global warming will be exhausted before 2030. At the same time, every week until 2050, the urban population will increase by about 1.3 million, requiring new buildings and roads, water and sanitation facilities, and energy and transport systems. The construction and operation of these infrastructure projects will be energy and emissions intensive unless major changes are made in how they are designed and implemented.

In 2021, major summits will generate political and societal momentum for action on climate, biodiversity, food systems, desertification, and the ocean. In 2022, the Stockholm+50 event marks the 50th anniversary of the first Earth Summit. This is an important opportunity to reflect on progress to meet the United Nations Sustainable Development Goals (SDGs), due to be completed by 2030. Yet a disconnect exists between the urgency indicated by the empirical evidence and the response from electoral politics: The world is turning too slowly.

Planetary stewardship

"We must break down the walls that have previously kept science and the public apart and that have encouraged distrust and ignorance to spread unchecked. If anything prevents human beings from rising to the current challenge, it will be these barriers." Jennifer Doudna (Nobel Laureate 2020)

Effective planetary stewardship requires updating our Holocene mindset. We must act on the urgency, the scale, and the interconnectivity between us and our home, planet Earth. More than anything, planetary stewardship will be facilitated by enhancing social capital - building trust within societies and between societies.

The question at a global systems level today is not whether humanity will transition away from fossil fuels. The question is: Will we do it fast enough? Solutions, from electric mobility to zero-carbon energy carriers and sustainable food systems, are today often following exponential curves of advancement and adoption. How do we lock this in? The following seven proposals provide a foundation for effective planetary stewardship.

- **POLICY: Complement GDP as a metric of economic success with measures of true well-being of people and nature. Recognize that increasing disparities between rich and poor feed resentment and distrust, undermining the social contract necessary for difficult, long-term collective decision-making. Recognize that the deteriorating resilience of ecosystems undermines the future of humanity on Earth.**

- **MISSION-DRIVEN INNOVATION: Economic dynamism is needed for rapid transformation. Governments have been at the forefront of funding transformational innovation in the last 100 years. The scale of today's challenges will require large-scale collaboration between researchers, government, and business - with a focus on global sustainability.**

- **EDUCATION: Education at all ages should include a strong emphasis on the nature of evidence, the scientific method, and scientific consensus to ensure future populations have the grounding necessary to drive political and economic change. Universities should embed concepts of planetary stewardship in all curricula as a matter of urgency. In a transformative, turbulent century, we should invest in life-long learning, and fact-based worldviews.**

- **INFORMATION TECHNOLOGY: Special interest groups and highly partisan media can amplify misinformation and accelerate its spread through social media and other digital means of communication. In this way, these technologies can be deployed to frustrate a common purpose and erode public trust. Societies must urgently act to counter the industrialization of misinformation and find ways to enhance global communication systems in the service of sustainable futures.**

- **FINANCE AND BUSINESS: Investors and companies must adopt principles of recirculation and regeneration of materials and apply science-based targets for all global commons and essential ecosystem services. Economic, environmental, and social externalities should be fairly priced.**

- **SCIENTIFIC COLLABORATION: Greater investment is needed in international networks of scientific institutions to allow sustained collaboration**

on interdisciplinary science for global sustainability as well as transdisciplinary science that integrates diverse knowledge systems, including local, indigenous, and traditional knowledge.

- **KNOWLEDGE: The pandemic has demonstrated the value of basic research to policymakers and the public. Commitment to sustained investment in basic research is essential. In addition, we must develop new business models for the free sharing of all scientific knowledge.**

Conclusion

Global sustainability offers the only viable path to human safety, equity, health, and progress. Humanity is waking up late to the challenges and opportunities of active planetary stewardship. But we are waking up. Long-term, scientifically based decision-making is always at a disadvantage in the contest with the needs of the present. Politicians and scientists must work together to bridge the divide between expert evidence, short-term politics, and the survival of all life on this planet in the Anthropocene epoch. The long-term potential of humanity depends upon our ability today to value our common future. Ultimately, this means valuing the resilience of societies and the resilience of Earth's biosphere.

Suggestions for further reading

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Chapter 2

OTHER WARNING VOICES

2.1 Guterres warns world leaders

Below are excerpts from an article by Margaret Besheer entitled *Guterres Warns World Leaders They Are Losing Battle Against Climate Change*[1]:

UNITED NATIONS - U.N. Secretary-General Antonio Guterres said at the annual meeting of the General Assembly the world is losing the battle against climate change but that there is still time to reverse the effects of the global phenomenon.

"We are seeing unprecedented temperatures, unrelenting storms and undeniable science," Guterres said. "The world is starting to move - not fast enough but in the right direction - away from fossil fuels and towards the opportunities of the green economy."

Guterres said solutions to what he now calls a "climate crisis" were discussed at the U.N.'s Climate Action Summit on Monday. He noted the need for world leaders to "scale up" the solutions to "keep temperature rise to 1.5 degrees and reach carbon neutrality by 2050."

Guterres has called for the phasing out of fossil fuels and an end to construction of new coal power plants. He has also said it is time to end subsidies to the fossil fuel industry and shift taxes from salaries to carbon - taxing pollution, not people.

Guterres was the first in a series of world leaders involved in some of the most high profile geopolitical issues to speak on the first day of the U.N. General Assembly in New York...

After opening remarks from Guterres, those gathered for the annual meeting also heard from a group that included U.S. President Donald Trump, Turkish President Recep Tayyip Erdogan, Korean President Moon Jae-in and French

[1] https://www.voanews.com/usa/guterres-warns-world-leaders-they-are-losing-battle-against-climate-change

Figure 2.1: **United Nations Secretary General Antonio Guterres addressing the UN General Assembly on September24, 2019.**

President Emmanuel Macron.

The addresses came a day after Swedish teen activist Greta Thunberg scolded world leaders at a U.N. summit calling for climate action, saying people are suffering and dying from the effects of global warming and that all the leaders have are empty words.

"We are in [the] beginning of a mass extinction and all you can talk about is money," said Thunberg, who ignited a youth movement with her Friday school strikes for climate action.

She said the science has been clear for 30 years, and still they are not doing enough.

"You are failing us! But the young people are starting to understand your betrayal," Thunberg said in a voice filled with emotion. "The eyes of all future generations are upon you. And if you choose to fail us, I say we will never forgive you."

The 16-year-old warned the more than 60 presidents and prime ministers gathered in the General Assembly hall for the summit that the youth would not let them "get away with this." She said they draw the line here and now and "change is coming," whether they like it or not.

"Is it common sense to build ever more coal plants that are choking our future?" the secretary-general asked. "Is it common sense to reward pollution

Figure 2.2: **Swedish climate activist Greta Thunberg speaks with other child petitioners from 12 countries who presented a landmark complaint to protest the lack of government action on the climate crisis during a press conference in New York, Sept. 23, 2019.**

Figure 2.3: **Germany's Chancellor Angela Merkel addresses the Climate Action Summit in the United Nations General Assembly, at U.N. headquarters, Sept. 23, 2019.**

that kills millions with dirty air and makes it dangerous for people in cities around the world to sometimes even venture out of their homes?"

India, which has one of the world's highest levels of air pollution, said it would increase its renewable energy capacity to 175 gigawatts by 2022. Prime Minister Narendra Modi highlighted his country's expansion into solar energy.

German Chancellor Angela Merkel, in a rare U.N. appearance, pledged that her country would reduce its carbon emissions by 2030 by 55% compared to its 1990 emissions. She said Germany would be carbon neutral by 2050.

"In 2030 we want to get two-thirds of our energy from renewables," Merkel said. "In 2022, we will phase out the last of our nuclear power plants, and at latest, in 2038, we will phase out coal."...

The U.N. released a report ahead of the summit compiled by the World Meteorological Organization showing there has been an acceleration in carbon pollution, sea-level rise, warming global temperatures, and shrinking ice sheets.

It warns that the average global temperature for the period of 2015 through the end of 2019 is on pace to be the "warmest of any equivalent period on record" at 1.1 degrees Celsius above pre-industrial levels.

The 2015 Paris Climate Agreement, which has been ratified by 186 nations, calls for actions to prevent global temperatures from surpassing 2 degrees, and ideally remain within 1.5 degrees by cutting greenhouse gas emissions. One of the world's biggest emitters - the United States - announced under President Trump that it would leave the pact. The U.S. decision has not stopped climate action at the state, local and private sector levels.

These are the steps that Mr Guterres demanded from the nations of the world:

- Put a price on carbon
- Phase out fossil fuel finance and end fossil fuel subsidies
- Shift the tax burden from income to carbon, and from tax payers to polluters
- Integrate the goal of carbon neutrality (a similar concept to net zero) into all economic and fiscal policies and decisions
- Help those around the world who are already facing the dire impacts of climate change

2.2 An Inconvenient Truth

Albert Arnold Gore Jr. served as the 45th Vice President of the United States from January 1985 to January 1993. He then ran for the office of President, but was defeated by George

W. Bush in a controversial election whose outcome was finally decided by the US Supreme Court[2].

Al Gore is the founder and current Chairman of the Alliance for Climate Protection. He was one of the first important political figures to call attention to the problem of steadily increasing CO_2 levels in the atmosphere and the threat of catastrophic climate change. He produced the highly influential documentary film *An Inconvenient Truth*[3]. Because of his important efforts to save the global environment, Al Gore shared the 2007 Nobel Peace Prize with the Intergovernmental Panel on Climate Change.

Excerpts from Al Gore's Nobel Lecture

...The distinguished scientists with whom it is the greatest honor of my life to share this award have laid before us a choice between two different futures - a choice that to my ears echoes the words of an ancient prophet: "Life or death, blessings or curses. Therefore, choose life, that both thou and thy seed may live."

We, the human species, are confronting a planetary emergency - a threat to the survival of our civilization that is gathering ominous and destructive potential even as we gather here. But there is hopeful news as well: we have the ability to solve this crisis and avoid the worst - though not all - of its consequences, if we act boldly, decisively and quickly.

However, despite a growing number of honorable exceptions, too many of the world's leaders are still best described in the words Winston Churchill applied to those who ignored Adolf Hitler's threat: "They go on in strange paradox, decided only to be undecided, resolved to be irresolute, adamant for drift, solid for fluidity, all powerful to be impotent."

So today, we dumped another 70 million tons of global-warming pollution into the thin shell of atmosphere surrounding our planet, as if it were an open sewer. And tomorrow, we will dump a slightly larger amount, with the cumulative concentrations now trapping more and more heat from the sun.

As a result, the earth has a fever. And the fever is rising. The experts have told us it is not a passing affliction that will heal by itself. We asked for a second opinion. And a third. And a fourth. And the consistent conclusion, restated with increasing alarm, is that something basic is wrong.

We are what is wrong, and we must make it right...

In the last few months, it has been harder and harder to misinterpret the signs that our world is spinning out of kilter. Major cities in North and South America, Asia and Australia are nearly out of water due to massive droughts and melting glaciers. Desperate farmers are losing their livelihoods. Peoples in the frozen Arctic and on low-lying Pacific islands are planning evacuations

[2]Many people believe that Al Gore won the election.
[3]https://www.youtube.com/watch?v=I-SV13UQXdk

of places they have long called home. Unprecedented wildfires have forced a half million people from their homes in one country and caused a national emergency that almost brought down the government in another. Climate refugees have migrated into areas already inhabited by people with different cultures, religions, and traditions, increasing the potential for conflict. Stronger storms in the Pacific and Atlantic have threatened whole cities. Millions have been displaced by massive flooding in South Asia, Mexico, and 18 countries in Africa. As temperature extremes have increased, tens of thousands have lost their lives. We are recklessly burning and clearing our forests and driving more and more species into extinction. The very web of life on which we depend is being ripped and frayed.

We never intended to cause all this destruction, just as Alfred Nobel never intended that dynamite be used for waging war. He had hoped his invention would promote human progress. We shared that same worthy goal when we began burning massive quantities of coal, then oil and methane.

Even in Nobel's time, there were a few warnings of the likely consequences. One of the very first winners of the Prize in chemistry worried that, "We are evaporating our coal mines into the air." After performing 10,000 equations by hand, Svante Arrhenius calculated that the earth's average temperature would increase by many degrees if we doubled the amount of CO2 in the atmosphere.

Seventy years later, my teacher, Roger Revelle, and his colleague, Dave Keeling, began to precisely document the increasing CO2 levels day by day.

But unlike most other forms of pollution, CO2 is invisible, tasteless, and odorless - which has helped keep the truth about what it is doing to our climate out of sight and out of mind. Moreover, the catastrophe now threatening us is unprecedented - and we often confuse the unprecedented with the improbable.

We also find it hard to imagine making the massive changes that are now necessary to solve the crisis. And when large truths are genuinely inconvenient, whole societies can, at least for a time, ignore them. Yet as George Orwell reminds us: "Sooner or later a false belief bumps up against solid reality, usually on a battlefield."...

We must quickly mobilize our civilization with the urgency and resolve that has previously been seen only when nations mobilized for war. These prior struggles for survival were won when leaders found words at the 11th hour that released a mighty surge of courage, hope and readiness to sacrifice for a protracted and mortal challenge.

These were not comforting and misleading assurances that the threat was not real or imminent; that it would affect others but not ourselves; that ordinary life might be lived even in the presence of extraordinary threat; that Providence could be trusted to do for us what we would not do for ourselves.

No, these were calls to come to the defense of the common future. They were calls upon the courage, generosity and strength of entire peoples, citizens of every class and condition who were ready to stand against the threat once

asked to do so. Our enemies in those times calculated that free people would not rise to the challenge; they were, of course, catastrophically wrong.

Now comes the threat of climate crisis - a threat that is real, rising, imminent, and universal. Once again, it is the 11th hour. The penalties for ignoring this challenge are immense and growing, and at some near point would be unsustainable and unrecoverable. For now we still have the power to choose our fate, and the remaining question is only this: Have we the will to act vigorously and in time, or will we remain imprisoned by a dangerous illusion?

Al Gore's TED talk: The Case for Optimism on Climate Change

In 2016, Al Gore gave an important talk to a TED audience[4]. in which he pointed out the an economic tipping point has just been passed. Solar energy and wind energy are now cheaper than energy form fossil fuels. This means that economic forces alone can drive a rapid transition to 100% renewable energy. Investors will realize that renewables represent an unparalleled investment opportunity.

2.3 Climate change denial in the mass media

The Wikipedia article on climate change denial describes it with the following words: "Although scientific opinion on climate change is that human activity is extremely likely to be the primary driver of climate change, the politics of global warming have been affected by climate change denial, hindering efforts to prevent climate change and adapt to the warming climate. Those promoting denial commonly use rhetorical tactics to give the appearance of a scientific controversy where there is none."

It is not surprising that the fossil fuel industry supports, on a vast scale, politicians and mass media that deny the reality of climate change. The amounts of money at stake are vast. If catastrophic climate change is to be avoided, coal, oil and natural gas "assets" worth trillions of dollars must be left in the ground. Giant fossil fuel corporations are desperately attempting to turn these "assets' into cash.

Preventing an ecological apocalypse

Here are some excerpts from an article entitled *Only Rebellion will prevent an ecological apocalypse* by George Monbiot, which was published on April 15 2019 in The Guardian[5]:

No one is coming to save us. Mass civil disobedience is essential to force a political response.

[4]https://www.youtube.com/watch?v=I-SV13UQXdk

[5]https://www.theguardian.com/commentisfree/2019/apr/15/rebellion-prevent-ecological-apocalypse-civil-disobedience

Figure 2.4: **Network administrators have noticed that programs about climate change often have low viewer ratings. Since they see delivering high viewer ratings to their advertisers as their primary duty, these executives seldom allow programs dealing with the danger of catastrophic climate change. The duty to save the earth from environmental catastrophe is neglected for the sake of money. As Al Gore said, "Instead of having a well-informed electorate, we have a well-amused audience".**

Had we put as much effort into preventing environmental catastrophe as we've spent on making excuses for inaction, we would have solved it by now. Everywhere I look, I see people engaged in furious attempts to fend off the moral challenge it presents...

As the environmental crisis accelerates, and as protest movements like YouthStrike4Climate and Extinction Rebellion make it harder not to see what we face, people discover more inventive means of shutting their eyes and shedding responsibility. Underlying these excuses is a deep-rooted belief that if we really are in trouble, someone somewhere will come to our rescue: "they" won't let it happen. But there is no they, just us.

The political class, as anyone who has followed its progress over the past three years can surely now see, is chaotic, unwilling and, in isolation, strategically incapable of addressing even short-term crises, let alone a vast existential predicament. Yet a widespread and wilful naivety prevails: the belief that voting is the only political action required to change a system. Unless it is accompanied by the concentrated power of protest - articulating precise demands and creating space in which new political factions can grow - voting, while essential, remains a blunt and feeble instrument.

The media, with a few exceptions, is actively hostile. Even when broadcasters cover these issues, they carefully avoid any mention of power, talking about environmental collapse as if it is driven by mysterious, passive forces, and proposing microscopic fixes for vast structural problems. The BBC's Blue Planet Live series exemplified this tendency.

Those who govern the nation and shape public discourse cannot be trusted with the preservation of life on Earth. There is no benign authority preserving us from harm. No one is coming to save us. None of us can justifiably avoid the call to come together to save ourselves...

Predatory delay

Here are some excerpts from a May 3 2019 article by Bill Henderson entitled *Neoliberalism, Solution Aversion, Implicatory Denial and Predatory Delay*[6]:

Looking back at the history, that it's not really a failure of human beings and human nature that's the problem here. It's a hijacking of our political and economic system by the fossil fuel industry and a small number of like-minded people. It was our bad luck that this idea that markets solve all problems and that government should be left to wither away crested just at the moment when it could do the most damage.

Despite the urgent need to reduce greenhouse gas emissions globally if we

[6]https://countercurrents.org/2019/05/03/neoliberalism-solution-aversion-implicatory-denial-and-predatory-delay-bill-henderson/

are to lower the risks of catastrophic climate change, wealthy industrialized nations persist with a widespread public silence on the issue and fail to address climate change. This is despite there being ever more conclusive evidence of its severity. Why is there an undercurrent of inaction, despite the challenge of climate change being ever more daunting? One element is denial.

George Marshall discovered that there has not been a single proposal, debate or even position paper on limiting fossil fuel production put forward during international climate negotiations. From the very outset fossil fuel production lay outside the frame of the discussions and, as with other forms of socially constructed silence, the social norms among the negotiators and policy specialists kept it that way.

Global climate leadership is being redefined. There is a growing recognition that you cannot be a climate leader if you continue to enable new fossil fuel production, which is inconsistent with climate limits. If no major producers step up to stop the expansion of extraction and begin phasing out existing fields and mines, the Paris goals will become increasingly difficult to achieve. Wealthy fossil fuel producers have a responsibility to lead, and this must include planning for a just and equitable managed decline of existing production.

The (emissions reduction) curve we've been forced onto bends so steeply, that the pace of victory is part of victory itself. Winning slowly is basically the same thing as losing outright. We cannot afford to pursue past strategies, aimed at limited gains towards distant goals. In the face of both triumphant denialism and predatory delay, trying to achieve climate action by doing the same things, the same old ways, means defeat. It guarantees defeat.

A fast, emergency-scale transition to a post-fossil fuel world is absolutely necessary to address climate change. But this is excluded from consideration by policymakers because it is considered to be too disruptive. The orthodoxy is that there is time for an orderly economic transition within the current short-termist political paradigm. Discussion of what would be safe - less warming that we presently experience - is non-existent. And so we have a policy failure of epic proportions. Policymakers, in their magical thinking, imagine a mitigation path of gradual change, to be constructed over many decades in a growing, prosperous world...

2.4 Showing unsustainable lifestyles in the mass media

Television and other mass media contribute indirectly to climate change denial by showing unsustainable lifestyles. Television dramas show the ubiquitous use of gasoline-powered automobiles and highways crowded with them. just as though there did not exist an urgent need to transform our transportation systems. Motor racing is shown. A program

called "Top Gear" tells viewers about the desirability of various automobiles. In general, cyclists are not shown. In television dramas, the protagonists fly to various parts of the world for their holidays. The need for small local self-sustaining communities is not shown.

Advertisements in the mass media urge us to consume more, to fly, to purchase large houses, and to buy gasoline-driven automobiles, just as though such behavior ought to be the norm. Such norms are leading us towards environmental disaster.

2.5 Alternative media

Luckily, the mass media do not have a complete monopoly on public information. With a little effort, citizens who are concerned about the future can find alternative media. These include a large number if independent on-line news services that are supported by subscriber donations rather than by corporate sponsors. *YouTube* videos also represent an extremely important source of public information.

2.6 Understanding the atmosphere of Venus

James Hansen was born in 1941 in Denison, Iowa. He was educated in physics, mathematics and astronomy at the University of Iowa in the space sciences program initiated James Van Allen. He graduated with great distinction. The studies of the atmosphere and temperature of Venus which Hansen made under Van Allen's supervision lead him to become extremely concerned about similar effects in the earth's atmosphere.

From 1962 to 1966, James Hansen participated in the National Aeronautical and Space Administration graduate traineeship and, at the same time, between 1965 and 1966, he was a visiting student at the Institute of Astrophysics at the University of Kyoto and in the Department of Astronomy at the University of Tokyo. Hansen then began work at the Goddard Institute for Space Studies in 1967. He began to work for the Goddard Institute for Space Studies in 1967. Between 1981 and 2913, he was hear of the Goddard Institute of Space Studies in New York, and since 2014, he has been the director of the Program on Climate Science, Awareness and Solutions at Columbia University's Earth Institute.

Hansen continued his work with radiative transfer models, attempting to understand the Venusian atmosphere. Later he applied and refined these models to understand the Earth's atmosphere, in particular, the effects that aerosols and trace gases have on Earth's climate. Hansen's development and use of global climate models has contributed to the further understanding of the Earth's climate. In 2009 his first book, Storms of My Grandchildren, was published.

James Hansen has refined climate change models, focusing on the balance between aerosols and greenhouse gases. He believes that there is a danger that climate change will become much more rapid if the balance shifts towards the greenhouse gases.

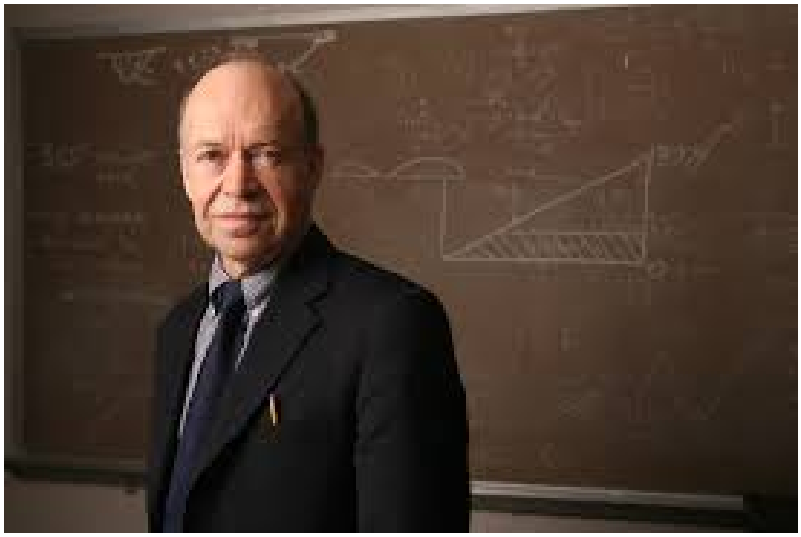

Figure 2.5: **Prof. James Hansen**

Hansen's Congressional testimony leads to broad public awareness of the dangers

In 1988, Prof. Hansen was asked to testify before the US Congress on the danger of uncontrolled climate change. The testimony marked the start of broad public awareness of the seriousness of the danger, and it was reported in a front page article by the New York Times. However, Hansen believes that governmental energy policies still favor fossil fuels. Therefore he has participated in public demonstrations and he was even arrested in 2011 together with more than a thousand other activists for protesting outside the White House.

James Hansen's TED talk and book

In 2012 he presented a TED Talk: *Why I Must Speak Out About Climate Change*. This talk is easily available on the Internet, and it should be required viewing for everyone who is concerned with the earth's future.

Hansen's book, *Storms of My Grandchildren: The Truth About The Coming Climate Catastrophe, and Our Last Chance To Save Humanity* was published in New York by Bloomsbury Publishing in 2009.

2.7 350.org

2.8 The Climate Movement: What's Next?

Here are some excerpts from a recently published article nu Bill McKibben entitled *The Climate Movement: What's Next?* (Common Dreams, July 10, 2019):

I came to climate activism gradually. In 1989, when my book The End of Nature was published, it was the first book on global warming for a general audience. For the next fifteen, I worked mainly as a writer and speaker. That's because I was analyzing the problem incorrectly. In my estimation, we were arguing about the science of climate change. Is it real? How bad is it? How bad will it become? Being a writer, and an academic, I thought the right response seemed clear: shed light on the issue through more books, more articles, and more symposia.

At a certain point, though, I began to realize that we weren't engaged in an argument at all. The scientific debate had already been settled by about 1995, with the first major Intergovernmental Panel on Climate Change (IPCC) report. The scientific community had reached a clear consensus, yet governments did not take action to reduce greenhouse gas emissions. We were in a fight, not a discourse. Like most fights, it was about power and money. Another book or symposium was unlikely to move the needle.

On the other side of the fight stood the fossil fuel industry, with the richest - and hence most politically powerful - enterprises in human history. We weren't going to match them dollar for dollar, or even penny for dollar. History indicates that in such unequal situations, the only option is to build a movement large enough to provide a countervailing force. It has happened before, such as with the movements for women's suffrage, civil rights, and, most recently, marriage equality. Those were all hard fought, but a climate movement is harder because no one has made trillions of dollars being a bigot, but people do make trillions selling coal, oil and gas.

My expanded understanding prompted me to found 350.org, which initially consisted of myself and seven undergraduates. The biggest problem with climate change was that it seemed so large - and we seemed so small next to it. It was hard to feel hope and easy to walk away. Nevertheless, each student took one of the seven continents, and we set out to organize. All over the world, we found people who wanted to act. Our first task was to show that there was a large constituency for action. So, in our first big action in 2008, we managed to coordinate 5,100 simultaneous demonstrations in 181 countries, which CNN called the most widespread day of political action in the planet's history.

We've gone on to organize about 20,000 such rallies, in every country but North Korea. 350.org is still, I believe, the largest group that works solely on climate change, with a not-so-large staff of 120 spread around the world. On the ground, we have found a huge if diffuse movement, made up mostly of indigenous and other frontline communities bearing the brunt of the fossil fuel

industry. Much of our work is thus focused on coordinating the multitude of worthy efforts already underway.

Given the urgency of the climate crisis, we also quickly saw the need to move beyond education to Given the urgency confrontation - hence, in the US, the birth of the continent-wide Keystone pipeline fight. There was already a movement in place in the tar sands of Alberta and on the prairies of Nebraska through which the proposed pipeline would pass. But we nationalized the movement, with demonstrations in DC and pressure on President Barack Obama. So far, the pipeline remains unbuilt. Every project like this around the world (e.g., fracking wells, coal ports, LNG terminals) is a target for opposition. We may not always win, but we always make life harder for the industry.

On another front, we realized that, to be successful, we needed to systematically confront the instruments used to sustain the dominance of fossil fuels. Thus, we launched the divestment movement in 2012 with the goal of reducing the financing for and, more importantly, social acceptance of the extraction of fossil fuels. It has grown much faster than we expected, and it is now the largest anti-corporate campaign of its kind in history, with commitments from endowments and other portfolios worth about $8 trillion. Goldman Sachs said recently that the campaign is the main contributor to driving the prices of coal shares down sixty percent, and Shell said it had become a "material risk" to its business...

We are not going to stop climate change - that is no longer on the menu. Standing on the Greenland ice shelf last summer and seeing it melting was sobering. We're now playing for whether warming is going to reach 2, 3 or 4 ^{o}C, with the latter appearing increasingly likely. That range of temperature rise means we still can decide to sustain a livable civilization. But the window for survival is closing fast.

We must use this moment as crucial leverage to push the planet in a new direction. If we succeed, then we have risen to the greatest crisis humans have ever faced and shown that the big brain was a useful evolutionary adaptation.

2.9 Bill McKibben

Bill McKibben's biography (from the 350.org website)

Bill McKibben is an author and environmentalist who in 2014 was awarded the Right Livelihood Prize, sometimes called the "alternative Nobel". His 1989

book The End of Nature is regarded as the first book for a general audience about climate change, and has appeared in 24 languages; he's gone on to write a dozen more books. He is a founder of 350.org, the first planet-wide, grassroots climate change movement, which has organized twenty thousand rallies around the world in every country save North Korea, spearheaded the resistance to the Keystone Pipeline, and launched the fast-growing fossil fuel divestment movement.

The Schumann Distinguished Scholar in Environmental Studies at Middlebury College and a fellow of the American Academy of Arts and Sciences, he was the 2013 winner of the Gandhi Prize and the Thomas Merton Prize, and holds honorary degrees from 18 colleges and universities. Foreign Policy named him to their inaugural list of the world's 100 most important global thinkers, and the Boston Globe said he was "probably America's most important environmentalist."

A former staff writer for the New Yorker, he writes frequently for a wide variety of publications around the world, including the New York Review of Books, National Geographic, and Rolling Stone. He lives in the mountains above Lake Champlain with his wife, the writer Sue Halpern, where he spends as much time as possible outdoors . In 2014, biologists honored him by naming a new species of woodland gnat - Megophthalmidia mckibbeni - in his honor.

This climate strike is part of the disruption that we need

Here are excerpts from a September 3 2019 article by Bill McKibben, published in Yes Magazine;

Business as usual is what's doing us in.

We live on a planet that finds itself rather suddenly in the midst of an enormous physical crisis. Because we burn so much coal and gas and oil, the atmosphere of our world is changing rapidly, and that atmospheric change is producing record heat. July was the hottest month we've ever recorded. Scientists predict with confidence that we stand on the edge of the sixth great extinction event of the last billion years. People are dying in large numbers and being left homeless; millions are already on the move because they have no choice.

And yet we continue on with our usual patterns. We get up each morning and do pretty much what we did the day before. It's not like the last time we were in an existential crisis, when Americans signed up for the Army and crossed the Atlantic to face down fascism and when the people back home signed up for new jobs and changed their daily lives.

That's why it's such good news that the climate movement has a new tactic. Pioneered last August by Greta Thunberg of Sweden, it involves disrupting business as usual. It began, of course, in schools: Within months, millions

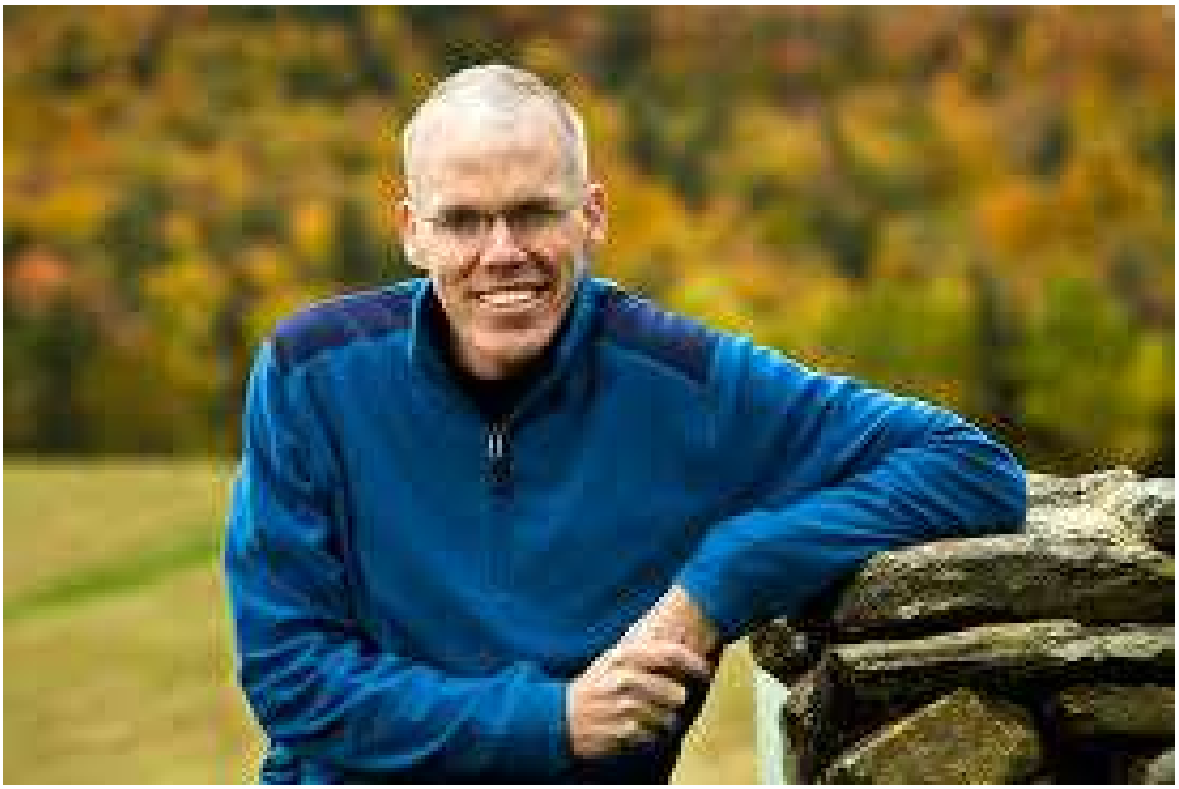

Figure 2.6: **The American author, journalist and environmental activist Bill McKibben (born in 1960) is the founder and leader of 350.org, an important organization that campaigns world-wide for the immediate reduction of CO_2 emissions. Wikipedia writes of him: "In 2009, he led 350.org's organization of 5,200 simultaneous demonstrations in 181 countries. In 2010, McKibben and 350.org conceived the 10/10/10 Global Work Party, which convened more than 7,000 events in 188 countries." After graduating from Harvard in 1982, McKibben worked for five years as a writer for the New Yorker Magazine, after which he produced numerous books on the dangers of climate change. 350.org takes it's name from James Hansen's statement that "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that." (Today the atmospheric CO_2 concentration has exceeded 400 ppm!). In 2014, Bill McKibben and 350.org shared the Right Livelihood Award,which is often called the "Alternative Nobel Prize".**

of young people around the world were striking for days at a time from their classes. Their logic was impeccable: If the institutions of our planet can't be bothered to prepare for a world we can live in, why must we spend years preparing ourselves? If you break the social contract, why are we bound by it?

And now those young people have asked the rest of us to join in. After the last great school strike in May, they asked adults to take part next time. The date is Sept. 20, and the location is absolutely everywhere. Big trade unions in South Africa and Germany are telling workers to take the day off. Ben and Jerry's is closing down its headquarters (stock up in advance), and if you want to buy Lush cosmetics, you're going to be out of luck. The largest rally will likely be in New York City, where the U.N. General Assembly begins debating climate change that week - but there will be gatherings in every state and every country. It will almost certainly be the biggest day of climate action in the planet's history. (If you want to be a part - and you do want to be a part - go to globalclimatestrike.net.)

2.10 Alexandria Ocasio-Cortez

Alexandria Ocasio-Cortez (born in 1989) won a stunning victory in the Democratic Party primary election of June 26, 2018. Although outspent by a factor of 18 to 1 by her opponent (Democratic Caucus Chair, Joseph Crawley), she won the primary by 57% to 42%. Her campaign contributions came from small individual donors, while his came in large blocks, from corporations. Ocasio-Cortez calls for the United States to transition by 2035 to an electrical grid running on 100% renewable-energy production and end the use of fossil fuels. She calls healthcare "a human right", and says: "Almost every other developed nation in the world has universal healthcare. It's time the United States catch up to the rest of the world in ensuring all people have real healthcare coverage that doesn't break the bank".

The Guardian called her victory "one of the biggest upsets in recent American political history", and Senator Bernie Sanders commented "She took on the entire local Democratic establishment in her district and won a very strong victory. She demonstrated once again what progressive grassroots politics can do". The lesson that the US Democratic Party must learn from this is that in order to overthrow Donald Trump's openly racist and climate-change-denying Republican Party, they must free themselves from the domination of corporate oligarchs, and instead stand for honest government and progressive values.

Even before taking her place in the US House of Representatives, with its newly-won Democratic majority, Alexandria Ocasio-Cortez became the leader of a campaign for a Green New Deal. This program takes its inspiration from the massive Federal government program by which Franklin Delano Roosevelt ended the depression of the 1930's. FDR's New Deal built dams, planted forests, and in general to create much needed infrastructure, while at the same time addressing the problem of unemployment by providing jobs. Wikipedia describes FDR's New Deal as follows:

"The New Deal was a series of programs, public work projects, financial reforms and

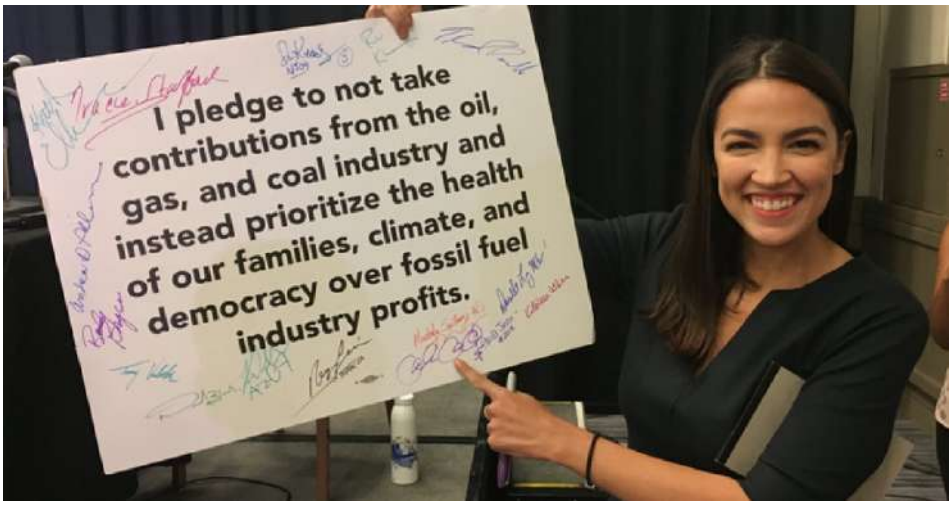

Figure 2.7: **28-year-old Alexandria Ocasio-Cortez (born in 1989) won a stunning victory in the Democratic Party primary election of June 26, 2018. Although outspent by a factor of 18 to 1 by her opponent (Democratic Caucus Chair, Joseph Crawley), she won the primary by 57% to 42%. Her campaign contributions came from small individual donors, while his came in large blocks, from corporations. Ocasio-Cortez calls for the United States to transition by 2035 to an electrical grid running on 100% renewable-energy production and end the use of fossil fuels. She calls healthcare "a human right", and says: "Almost every other developed nation in the world has universal healthcare. It's time the United States catch up to the rest of the world in ensuring all people have real healthcare coverage that doesn't break the bank". The Guardian called her victory "one of the biggest upsets in recent American political history", and Senator Bernie Sanders commented "She took on the entire local Democratic establishment in her district and won a very strong victory. She demonstrated once again what progressive grassroots politics can do". The lesson that the US Democratic Party must learn from this is that in order to overthrow Donald Trump's openly racist Republican Party in the 2020 elections, they must free themselves from the domination of corporate oligarchs, and instead stand for honest government and progressive values.**

regulations enacted by President Franklin D. Roosevelt in the United States between 1933 and 1936. It responded to needs for relief, reform and recovery from the Great Depression. Major federal programs included the Civilian Conservation Corps (CCC), the Civil Works Administration (CWA), the Farm Security Administration (FSA), the National Industrial Recovery Act of 1933 (NIRA) and the Social Security Administration (SSA). They provided support for farmers, the unemployed, youth and the elderly. The New Deal included new constraints and safeguards on the banking industry and efforts to re-inflate the economy after prices had fallen sharply. New Deal programs included both laws passed by Congress as well as presidential executive orders during the first term of the presidency of Franklin D. Roosevelt. The programs focused on what historians refer to as the '3 Rs': relief for the unemployed and poor, recovery of the economy back to normal levels and reform of the financial system to prevent a repeat depression."

Alexandria Ocasio-Cortez believes that the climate emergency that the world now faces is a much more severe emergency than the great depression. Indeed, if quick action is not taken immediately, the long-term effects of catastrophic climate change pose existential threats to human civilization and the biosphere. Therefore she advocates a massive governmental program to create renewable energy infrastructure. Such a program, like FDR's New Deal, would simultaneously solve the problem of unemployment. Money for the program could be taken from the Pentagon's obscenely bloated budget. Ocasio-Cortez has also proposed a 70% income tax for the ultra-wealthy.

According to a January 24 2019 article by Robert R. Raymond, "When polled, 92 percent of registered Democratic voters say they support the Green New Deal. But perhaps more importantly, a full 81 percent of all registered voters support it - a number that includes both Republicans and Democrats."[7]

House Speaker Nancy Pelosi is facing criticism from some climate activists for failing to back a Green New Deal. Last week Pelosi announced the formation of a new Select Committee on the Climate Crisis, headed by long-standing Florida Congressmember Kathy Castor. But the committee is far weaker than what backers of a Green New Deal had envisioned. The committee will not have subpoena power or the power to draft legislation. We speak with Varshini Prakash, founder of the Sunrise Movement, a youth-led climate group that has occupied and lobbied at congressional offices, risking arrest to demand adoption of the Green New Deal and bold climate leadership.

[7]https://truthout.org/articles/the-democratic-party-is-further-to-the-right-than-most-voters/

Figure 2.8: **The Green New Deal advocated by Ocasio-Cortez proposes to use jobs creating renewable energy infrastructure to ensure full employment, in a manner analogous to Roosevelt's New Deal.**

Figure 2.9: **Members of the Sunrise movement in the office of House Majority Leader Nancy Pelosi, protesting against her lack of support for the Green New Deal.**

2.11 Realities of climate change

Predictions of drought in the Stern Review

According to a report presented to the Oxford Institute of Economic Policy by Sir Nicholas Stern on 31 January, 2006, areas likely to lose up to 30% of their rainfall by the 2050's because of climate change include much of the United States, Brazil, the Mediterranean region, Eastern Russia and Belarus, the Middle East, Southern Africa and Southern Australia. Meanwhile rainfall is predicted to increase up to 30% in Central Africa, Pakistan, India, Bangladesh, Siberia, and much of China.

Stern and his team point out that "We can... expect to see changes in the Indian monsoon, which could have a huge impact on the lives of hundreds of millions of people in India, Pakistan and Bangladesh. Most climate models suggest that the monsoon will change, although there is still uncertainty about exactly how. Nevertheless, small changes in the monsoon could have a huge impact. Today, a fluctuation of just 10% in either direction from average monsoon rainfall is known to cause either severe flooding or drought. A weak summer monsoon, for example, can lead to poor harvests and food shortages among the rural population - two-thirds of India's almost 1.1 billion people. Heavier-than-usual monsoon downpours can also have devastating consequences..."

In some regions, melting of glaciers can be serious from the standpoint of dry-season water supplies. For example, melts from glaciers in the Hindu Kush and the Himalayas now supply much of Asia, including China and India, with a dry-season water supply. Complete melting of these glacial systems would cause an exaggerated runoff for a few decades, after which there would be a drying out of some of the most densely populated regions of the world.

Ocean current changes and failure of monsoons

It is expected that climate change will affect ocean currents, and hence also affect monsoon rainfall. We are already experiencing a diversion of the Gulf Stream due to southward currents of cold water from melting ice in the Arctic. This has caused what is known as the *North Atlantic Anomaly*. While most regions of the world are experiencing rising temperatures, the North Atlantic and several northern European countries are exceptions to this rule, and have cooled. Complete failure of the Gulf Stream would lead to much colder temperatures in Europe.

Changes in ocean currents have already lead to the failure of the West African Monsoon, and this has already produced severe food insecurity in West Africa.

In the future, climate-changed ocean currents may lead to failures of monsoons in South-east Asia, and thus damage the food supply of almost two billion people.

Falling water tables around the world

Under many desert areas of the world are deeply buried water tables formed during glacial periods when the climate of these regions was wetter. These regions include the Middle East and large parts of Africa. Water can be withdrawn from such ancient reservoirs by deep wells and pumping, but only for a limited amount of time.

In oil-rich Saudi Arabia, petroenergy is used to drill wells for ancient water and to bring it to the surface. Much of this water is used to irrigate wheat fields, and this is done to such an extent that Saudi Arabia exports wheat. The country is, in effect, exporting its ancient heritage of water, a policy that it may, in time, regret. A similarly short-sighted project is Muammar Qaddafi's enormous pipeline, which will bring water from ancient sub-desert reservoirs to coastal cities.

In the United States, the great Ogallala aquifer is being overdrawn. This aquifer is an enormous stratum of water-saturated sand and gravel under-lying parts of northern Texas, Oklahoma, New Mexico, Kansas, Colorado, Nebraska, Wyoming and South Dakota. The average thickness of the aquifer is about 70 meters. The rate of water withdrawal from the aquifer exceeds the rate of recharge by a factor of eight.

Thus we can see that in many regions, the earth's present population is living on its inheritance of water, rather than its income. This fact, coupled with rapidly increasing populations and climate change, may contribute to a very serious food crisis partway through the 21st century.

Glacial melting and summer water supplies

The summer water supplies of both China and India are threatened by the melting of glaciers. The Gangotri glacier, which is the principle glacier feeding India's great Ganges River, is reported to be melting at an accelerating rate, and it could disappear within a few decades. If this happens,the Ganges could become seasonal, flowing only during the monsoon season. Chinese agriculture is also threatened by disappearing Himalayan

glaciers, in this case those on the Tibet-Quinghai Plateau. The respected Chinese glaciologist Yao Tandong estimates that the glaciers feeding the Yangtze and Yellow Rivers are disappearing at the rate of 7% per year.[8]

Loss of Arctic sea ice

The melting of Arctic sea ice is taking place far more rapidly than was predicted by IPCC reports. David Wasdell, Director of the Apollo-Gaia Project, points out that the observed melting has been so rapid that within less than five years, the Arctic may be free of sea ice at the end of each summer. It will, of course continue to re-freeze during the winters, but the thickness and extent of the winter ice will diminish.

For January 2016, the satellite based data showed the lowest overall Arctic sea ice extent of any January since records begun in 1979. Bob Henson from *Wundergrund* commented: "Hand in hand with the skimpy ice cover, temperatures across the Arctic have been extraordinarily warm for midwinter. Just before New Year's, a slug of mild air pushed temperatures above freezing to within 200 miles of the North Pole. That warm pulse quickly dissipated, but it was followed by a series of intense North Atlantic cyclones that sent very mild air poleward, in tandem with a strongly negative Arctic Oscillation during the first three weeks of the month."

During some periods, Arctic temperatures have been 50^oC above normal for the time of year. Equally alarming is the fact that plumes of methane several km^2 in area have been observed bubbling up from the sea floor in the shallow ice-free seas north of Russia.[9]

Temperature and CO_2 in ice cores

Ice cores from the Greenland and Antarctic ice sheets and from glaciers have yielded valuable data on climate changes as far back as 800,000 years in the past. The ice cores show that there is a close correlation between global temperatures and the CO_2 content of the atmosphere. The cores also show that climatic changes can take place with great rapidity.

An article by Richard B. Alley in the Proceedings of the National Academy of Science (US) [10] Here is an excerpt from the article:

"Ice-core records show that climate changes in the past have been large, rapid, and synchronous over broad areas extending into low latitudes, with less variability over historical times. These ice-core records come from high mountain glaciers and the polar regions, including small ice caps and the large ice sheets of Greenland and Antarctica.

"As the world slid into and out of the last ice age, the general cooling and warming trends were punctuated by abrupt changes. Climate shifts up to half as large as the entire

[8] http://www.commondreams.org/news/2015/08/04/global-glaciers-melting-three-times-rate-20th-century

[9] N. Shakhova et al., *Methane release on the Arctic East Siberian shelf* , Geophysical Research Abstracts, Vol.**9**, 01071, 2007

[10] Proc Natl Acad Sci U S A. 2000 Feb 15; 97(4): 1331-1334. PMCID: PMC34297

difference between ice age and modern conditions occurred over hemispheric or broader regions in mere years to decades. Such abrupt changes have been absent during the few key millennia when agriculture and industry have arisen. The speed, size, and extent of these abrupt changes required a reappraisal of climate stability. Records of these changes are especially clear in high-resolution ice cores. Ice cores can preserve histories of local climate (snowfall, temperature), regional (wind-blown dust, sea salt, etc.), and broader (trace gases in the air) conditions, on a common time scale, demonstrating synchrony of climate changes over broad regions."

Short-term sea level rise

The *National Geographic* recently published an article by Laura Parker entitled "Sea Level Rise Will Flood Hundreds of Cities in the Near Future+."[11] Here are a few excerpts from the article:

"Sea level rise caused by global warming is usually cast as a doomsday scenario that will play out so far into the future, it's easy to ignore. Just ask anyone in South Florida, where new construction proceeds apace. Yet already, more than 90 coastal communities in the United States are battling chronic flooding, meaning the kind of flooding that's so unmanageable it prompts people to move away.

"That number is expected to roughly double to more than 170 communities in less than 20 years.

"Those new statistics, compiled in the first comprehensive mapping of the entire coastline of the Lower 48 states, paint a troubling picture, especially for the East and Gulf coasts, which are home to some of the nation's most populated areas.

"By the end of the century, chronic flooding will be occurring from Maine to Texas and along parts of the West Coast. It will affect as many as 670 coastal communities, including Cambridge, Massachusetts; Oakland, California; Miami and St. Petersburg, Florida; and four of the five boroughs of New York City. The magnitude of the coming calamity is so great, the ripple effects will reach far into the interior."

Just as an iceberg the size of Delaware broke away from an ice shelf in Antarctica Wednesday, July 12, 2017, scientists released findings that up to 668 U.S. communities could face chronic flooding from rising sea levels by the end of the century.

The Union of Concerned Scientists recently published a report entitled "When Rising Seas Hit Home: Hard Choices Ahead for Hundreds of US Coastal Communities"[12] The report states that "Chronic inundation will dramatically alter the landscape and the livability rise of just three feet would submerge the Maldives and make them uninhabitable of many coastal communities." rise of just three feet would submerge the Maldives and make them uninhabitable

[11] http://news.nationalgeographic.com/2017/07/sea-level-rise-flood-global-warming-science/
[12] http://www.ucsusa.org/sites/default/files/attach/2017/07/when-rising-seas-hit-home-full-report.pdf

Island nations threatened by rising oceans

The US National Academy of Sciences predictions from 2009 suggest that by 2100, sea level could increase by anywhere from 16 inches to 56 inches, depending how the Earth responds to changing climate.

The Maldives, consisting of over 1,100 islands to the west of India, is the world's lowest-lying nation. On average the islands are only 1.3 meters above sea level. The 325,000 (plus 100,000 expatriate workers who are not counted in the census) residents of the islands are threatened by rising sea levels. A rise of just three feet would submerge the Maldives and make them uninhabitable. Many island nations in the Pacific are also severely threatened by sea level rise.

Displacement of populations in Southeast Asia

A World Bank press release has stated that "Bangladesh will be among the most affected countries in South Asia by an expected 2^oC rise in the world's average temperatures in the next decades, with rising sea levels and more extreme heat and more intense cyclones threatening food production, livelihoods, and infrastructure as well as slowing the reduction on poverty, according to a new scientific report released today by the World Bank Group.

" 'Bangladesh faces particularly severe challenges with climate change threatening its impressive progress in overcoming poverty,' said Johannes Zutt, World Bank Country Director for Bangladesh and Nepal. 'Bangladesh has demonstrated itself as a leader in moving the climate change agenda forward'"

"In Bangladesh, 40% of productive land is projected to be lost in the southern region of Bangladesh for a 65cm sea level rise by the 2080s. About 20 million people in the coastal areas of Bangladesh are already affected by salinity in drinking water. Rising sea levels and more intense cyclones and storm surges could intensify the contamination of groundwater and surface water causing more diarrhea outbreak."

Important rice-growing river delta regions of Viet Nam will also be lost during the present century.

Effects on the Netherlands, Danish islands, and Venice

Although the Netherlands, the Danish islands and Venice have had many years of experience in coping with floods due to high sea levels and storm surges, these European areas may have difficulties during the present century.

Greenland's icecap is melting much faster than was predicted by the IPCC, and sea level rise may exceed 100 cm. before 2100. Hurricanes are also becoming more severe, as has already been shown by Katrina and Sandy. Future hurricanes hitting Europe's Atlantic coasts will produce dangerous storm surges. In Venice, the danger from hurricanes is less severe, but Venice already experiences severe flooding and the rise of sea levels during the present century may endanger the priceless cultural monuments of the famous ancient city.

Long-term sea level rise

A 2012 article by Jevrejeva, S., Moore, J. C. and Grinsted, A. in the in the Journal of Global and Planetary Change[13] deals with sea level rise until 2500. Of course, the long-term future runs over hundreds of millennia, but nevertheless, the article, entitled "Sea level projections to AD2500 with a new generation of climate change scenarios" is of interest.

The article states that "Sea level rise over the coming centuries is perhaps the most damaging side of rising temperature. The economic costs and social consequences of coastal flooding and forced migration will probably be one of the dominant impacts of global warming. To date, however, few studies on infrastructure and socio-economic planning include provision for multi-century and multi-meter rises in mean sea level...

"We estimate sea level rise of 0.57 - 1.10 m by 2100 with four new RCP scenarios. Sea level will continue to rise for several centuries reaching 1.84 - 5.49 m by 2500. Due to long response time most rise is expected after stabilization of forcing. 200-400 years will require dropping the rate to the 1.8 mm/yr- 20th century average."

According to an article published by the Potsdam Institute for Climate Impact Research [14] "The Greenland ice sheet is likely to be more vulnerable to global warming than previously thought. The temperature threshold for melting the ice sheet completely is in the range of 0.8 to 3.2 degrees Celsius global warming, with a best estimate of 1.6 degrees above pre-industrial levels, shows a new study by scientists from the Potsdam Institute for Climate Impact Research (PIK) and the Universidad Complutense de Madrid. Today, already 0.8 degrees global warming has been observed. Substantial melting of land ice could contribute to long-term sea-level rise of several meters and therefore it potentially affects the lives of many millions of people.

"The time it takes before most of the ice in Greenland is lost strongly depends on the level of warming. 'The more we exceed the threshold, the faster it melts,' says Alexander Robinson, lead-author of the study now published in Nature Climate Change. In a business-as-usual scenario of greenhouse-gas emissions, in the long run humanity might be aiming at 8 degrees Celsius of global warming. This would result in one fifth of the ice sheet melting within 500 years and a complete loss in 2000 years, according to the study. 'This is not what one would call a rapid collapse,' says Robinson. 'However, compared to what has happened in our planet's history, it is fast. And we might already be approaching the critical threshold.'

"In contrast, if global warming would be limited to 2 degrees Celsius, complete melting would happen on a timescale of 50.000 years. Still, even within this temperature range often considered a global guardrail, the Greenland ice sheet is not secure. Previous research suggested a threshold in global temperature increase for melting the Greenland ice sheet of a best estimate of 3.1 degrees, with a range of 1.9 to 5.1 degrees. The new study's best estimate indicates about half as much.

"'Our study shows that under certain conditions the melting of the Greenland ice sheet

[13] Volumes 80-81, January 2012, Pages 14.20

[14] https://www.pik-potsdam.de/news/press-releases/archive/2012/gronlands-eismassen-konnten-komplett-schmelzen-bei-1-6-grad-globaler-erwarmung

becomes irreversible. This supports the notion that the ice sheet is a tipping element in the Earth system,' says team-leader Andrey Ganopolski of PIK. 'If the global temperature significantly overshoots the threshold for a long time, the ice will continue melting and not re-grow - even if the climate would, after many thousand years, return to its preindustrial state- This is related to feedbacks between the climate and the ice sheet: The ice sheet is over 3000 meters thick and thus elevated into cooler altitudes. When it melts its surface comes down to lower altitudes with higher temperatures, which accelerates the melting. Also, the ice reflects a large part of solar radiation back into 'Our study shows that under certain conditions the melting of the Greenland ice sheet becomes irreversible. This supports the notion that the ice sheet is a tipping element in the Earth system,' says team-leader Andrey Ganopolski of PIK.'If the global temperature significantly overshoots the threshold for a long time, the ice will continue melting and not re-grow - even if the climate would, after many thousand years, return to its preindustrial state.' This is related to feedbacks between the climate and the ice sheet: The ice sheet is over 3000 meters thick and thus elevated into cooler altitudes. When it melts its surface comes down to lower altitudes with higher temperatures, which accelerates the melting. Also, the ice reflects a large part of solar radiation back into space. When the area covered by ice decreases, more radiation is absorbed and this adds to regional warming.space. When the area covered by ice decreases, more radiation is absorbed and this adds to regional warming."

Global warming and atmospheric water vapor

A feedback loop is a self-re-enforcing trend. One of the main positive feedback loops in global warming is the tendency of warming to increase the atmospheric saturation pressure for water vapor, and hence amount of water vapor in the atmosphere, which in turn leads to further warming, since water vapor is a greenhouse gas.

Wikipedia's article on greenhouse gases states that, "Water vapor accounts for the largest percentage of the greenhouse effect, between 36% and 66% for clear sky conditions and between 66% and 85% when including clouds."

The albedo effect

Albedo is defined to be the fraction of solar energy (shortwave radiation) reflected from the Earth back into space. It is a measure of the reflectivity of the earth's surface. Ice, especially with snow on top of it, has a high albedo: most sunlight hitting the surface bounces back towards space.

Feedback from loss of sea ice

Especially in the Arctic and Antarctic regions, there exists a dangerous feedback loop involving the albedo of ice and snow. Arctic sea ice is rapidly disappearing. It is predicted that during the summers, the ice covering arctic seas may disappear entirely during the

summers. As a consequence, incoming sunlight will encounter dark light-absorbing water surfaces rather than light-reflecting ice and snow.

This effect is self-re-enforcing. In other words, it is a feedback loop. The rising temperatures caused by the absorption of more solar radiation cause the melting of more ice, and hence even more absorption of radiation rather than reflection, still higher temperatures, more melting, and so on.

The feedback loop is further strengthened by the fact that water vapor acts like a greenhouse gas. As polar oceans become exposed, more water vapor enters the atmosphere, where it contributes to the greenhouse effect and rising temperatures.

Darkened snow on Greenland's icecap

Greenland's icecap is melting, and as it melts, the surface becomes darker and less reflective because particles of soot previously trapped in the snow and ice become exposed. This darkened surface absorbs an increased amount of solar radiation, and the result is accelerated melting.

The methane hydrate feedback loop

If we look at the distant future, by far the most dangerous feedback loop involves methane hydrates or methane clathrates. When organic matter is carried into the oceans by rivers, it decays to form methane. The methane then combines with water to form hydrate crystals, which are stable at the temperatures and pressures which currently exist on ocean floors. However, if the temperature rises, the crystals become unstable, and methane gas bubbles up to the surface. Methane is a greenhouse gas which is 70 times as potent as CO_2.

The worrying thing about the methane hydrate deposits on ocean floors is the enormous amount of carbon involved: roughly 10,000 gigatons. To put this huge amount into perspective, we can remember that the total amount of carbon in world CO2 emissions since 1751 has only been 337 gigatons.

A runaway, exponentially increasing, feedback loop involving methane hydrates could lead to one of the great geological extinction events that have periodically wiped out most of the animals and plants then living. This must be avoided at all costs.

A feedback loop from warming of soils

On October 6, 2017, the journal *Science* published an article entitled *Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world*[15]. The lead author, Jerry Melillo, is an ecologist working at the Marine Biological Laboratory, Woods Hole Massachusetts. In an interview with *Newsweek*, he said: "This self-reinforcing feedback is potentially a global phenomenon with soils, and once it starts it may be very

[15] J.M. Melillo et al., *Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world*, Science, Vol. 358, pp. 101-105, (2017).

difficult to turn off. It's that part of the problem that I think is sobering... We think that one of the things that may be happening is both a reorganization of the microbial community structure and its functional capacity,"

The study reported on three decades of observations of heated sections of a forest owned by Harvard University. The heated sections were 5^oC warmer than control sections.

Drying of forests and forest fires

According to a recent article in *Nature*[16],"Across the American west, the area burned each year has increased significantly over the past several decades, a trend that scientists attribute both to warming and drying and to a century of wildfire suppression and other human activities. Allen suggests that the intertwined forces of fire and climate change will take ecosystems into new territory, not only in the American west but also elsewhere around the world. In the Jemez, for example, it could transform much of the ponderosa pine (Pinus ponderosa) forest into shrub land. 'We're losing forests as we've known them for a very long time,' says Allen. 'We're on a different trajectory, and we're not yet sure where we're going.'

"All around the American west, scientists are seeing signs that fire and climate change are combining to create a 'new normal'. Ten years after Colorado's largest recorded fire burned 56,000 hectares southwest of Denver, the forest still has not rebounded in a 20,000-hectare patch in the middle, which was devastated by an intense crown fire. Only a few thousand hectares, which the US Forest Service replanted, look anything like the ponderosa-pine stands that previously dominated the landscape."

Tipping points and feedback loops

A tipping point is usually defined as the threshold for an abrupt and irreversible change[17]. To illustrate this idea, we can think of a book lying on a table. If we gradually push the book towards the edge of the table, we will finally reach a point after which more than half of the weight of the book will not be not supported by the table. When this "tipping point" is passed the situation will suddenly become unstable, and the book will fall to the floor. Analogously, as the earth's climate gradually changes, we may reach tipping points. If we pass these points, sudden instabilities and abrupt climatic changes will occur.

Greenland ice cores supply a record of temperatures in the past, and through geological evidence we have evidence of sea levels in past epochs. These historical records show that abrupt climatic changes have occurred in the past.

Timothy Michael Lenton, FRS, Professor of Climate Change and Earth System Science at he University of Exeter, lists the following examples of climatic tipping points:

- Boreal forest dieback

[16]http://www.nature.com/news/forest-fires-burn-out-1.11424

[17]Other definitions of tipping points are possible. A few authors define these as points beyond which change is inevitable, emphasizing that while inevitable, the change may be slow.

Figure 2.10: **Indigenous people marching in defense of Mother Earth.**

- Amazon rainforest dieback
- Loss of Arctic and Antarctic sea ice (Polar ice packs) and melting of Greenland and Antarctic ice sheets
- Disruption to Indian and West African monsoon
- Formation of Atlantic deep water near the Arctic ocean, which is a component process of the thermohaline circulation.
- Loss of permafrost, leading to potential Arctic methane release and clathrate gun effect

It can be seen from this list that climate tipping points are associated with feedback loops. For example, the boreal forest dieback and the Amazon rainforest dieback tipping points are associated with the feedback loop involving the drying of forests and forest fires, while the tipping point involving loss of Arctic and Antarctic sea ice is associated with the Albedo effect feedback loop. The tipping point involving loss of permafrost is associated with the methane hydrate feedback loop.

Once a positive feedback loop starts to operate in earnest, change may be abrupt.

Figure 2.11: **Marchers in New York advocation action to prevent catastrophic climate change, September 21, 2014. The march supported the United Nations Climate Change Summit. Worldwide, 600,000 people marched, making this event the largest public climate change action in history.**

The UN Climate Change Summit, September, 2014

Delegates at the United Nations Climate Summit were shown images of the inspiring and heartfelt People's Climate March, which took place on Sunday, September 21st. The organizers of the march had expected 100,000 participants. In fact, more than 400,000 people came, and the march was unique in its artistic brilliance and its ethnic diversity. It was one of 2,600 events in 170 nations. The slogan of the march in New York was "To change everything, we need everyone", and in fact everyone came!

More than 400,000 people participated in New York's People's Climate March, and the march was unique in its artistic brilliance and its ethnic diversity. It was one of 2,600 events in 170 nations.

The Paris Climate Conference, 2015

WE NEED SYSTEM CHANGE, NOT CLIMATE CHANGE! Civil society, excluded from the COP21 conference by the French government, carried banners with this slogan on the streets of Paris. They did so in defiance of tear-gas-using black-clad police. System change has been the motto for climate marches throughout the world. Our entire system is leading us towards disaster, and this includes both economic and governmental establishments. To save human civilization, the biosphere and the future, the people of the world must take matters into their own hands and change the system.[18]

Our present situation is this: The future looks extremely dark because of human folly, especially the long-term future. The greatest threats are catastrophic climate change and thermonuclear war, but a large-scale global famine also has to be considered. All these threats are linked.

Inaction is not an option. We have to act with courage and dedication, even if the odds are against success, because the stakes are so high. The mass media could mobilize us to action, but they have failed in their duty. Our educational system could also wake us up and make us act, but it too has failed us. The battle to save the earth from human greed and folly has to be fought through non-violent action on the streets and in the alternative media.

We need a new economic system, a new society, a new social contract, a new way of life. Here are the great tasks that history has given to our generation: We must achieve a steady-state economic system. We must restore democracy. We must decrease economic inequality. We must break the power of corporate greed. We must leave fossil fuels in the

[18] http://www.commondreams.org/views/2015/12/11/we-are-out-time-we-need-leap
http://www.thenation.com/article/naomi-klein-sane-climate-policies-are-being-undermined-by-corporate-friendly-trade-deals/
http://www.commondreams.org/news/2015/12/08/liberte-not-just-word-klein-corbyn-call-mass-protest-cop21
http://www.truth-out.org/news/item/33982-the-cops-of-cop21-arrests-at-the-paris-climate-talks
http://www.truth-out.org/news/item/33961-climate-change-justice
http://www.countercurrents.org/avery280914.htm

ground. We must stabilize and ultimately reduce the global population. We must eliminate the institution of war. And finally, we must develop a more mature ethical system to match our new technology.[19]

What are the links between the problems facing us? There is a link between climate change and war. We need to leave fossil fuels in the ground if we are to avoid catastrophic climate change. But nevertheless, the struggle for the world's last remaining oil and gas resources motivated the invasion of Iraq, and it now motivates the war in Syria. Both of these brutal wars have caused an almost indescribable amount of suffering.

ISIS runs on oil, and the unconditional support of Saudi Arabia by the West is due to greed for oil. Furthermore, military establishments are among the largest users of oil, and the largest greenhouse gas emitters. Finally, the nearly 2 trillion dollars that the world now spends on armaments and war could be used instead to speed the urgently needed transition to 100% renewable energy, and to help less-developed countries to face the consequences of climate change.

There are reasons for hope. Both solar energy and wind energy are growing at a phenomenal rate, and the transition to 100% renewable energy could be achieved within a very few decades if this growth is maintained. But a level playing field is needed. At present fossil fuel corporations receive half a trillion dollars each year in subsidies. Nuclear power generation is also highly subsidized (and also closely linked to the danger of nuclear war). If these subsidies were abolished, or better yet, used to encourage renewable energy development, the renewables could win simply by being cheaper.[20]

We can also take inspiration from Pope Francis, whose humanitarian vision links the various problems facing us. Pope Francis also shows us what we can do to save the future, and to give both economics and government a social and ecological conscience.

None of us asked to be born in a time of crisis, but history has given great tasks to our generation. We must rise to meet the crisis. We must not fail in our duty to save the gifts of life and civilization that past generations have bequeathed to us.We must not fail in our duty future generations.

[19] http://www.fredsakademiet.dk/library/need.pdf

[20] http://eruditio.worldacademy.org/issue-5/article/urgent-need-renewable-energy
https://www.youtube.com/watch?v=MVwmi7HCmSI
https://www.youtube.com/watch?v=AjZaFjXfLec
https://www.youtube.com/watch?v=m6pFDu7lLV4
https://www.youtube.com/watch?v=MVwmi7HCmSI
http://therightsofnature.org/universal-declaration/

Figure 2.12: **An indigenous girl from South America advocating action to prevent environmental destruction and climate change.**

Figure 2.13: **Native peoples defending nature.**

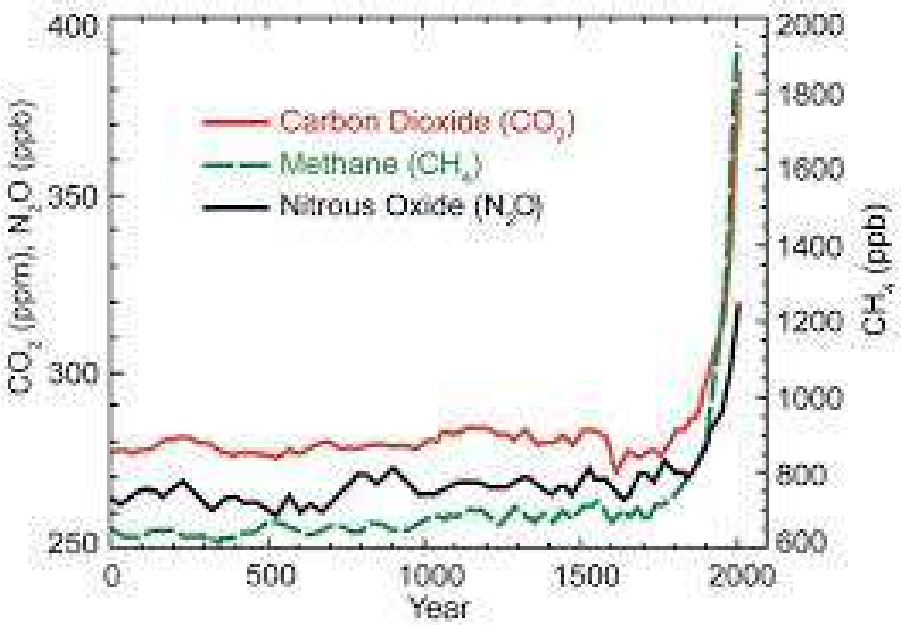

Figure 2.14: **Concentrations of the most important greenhouse gasses plotted as functions of time.**

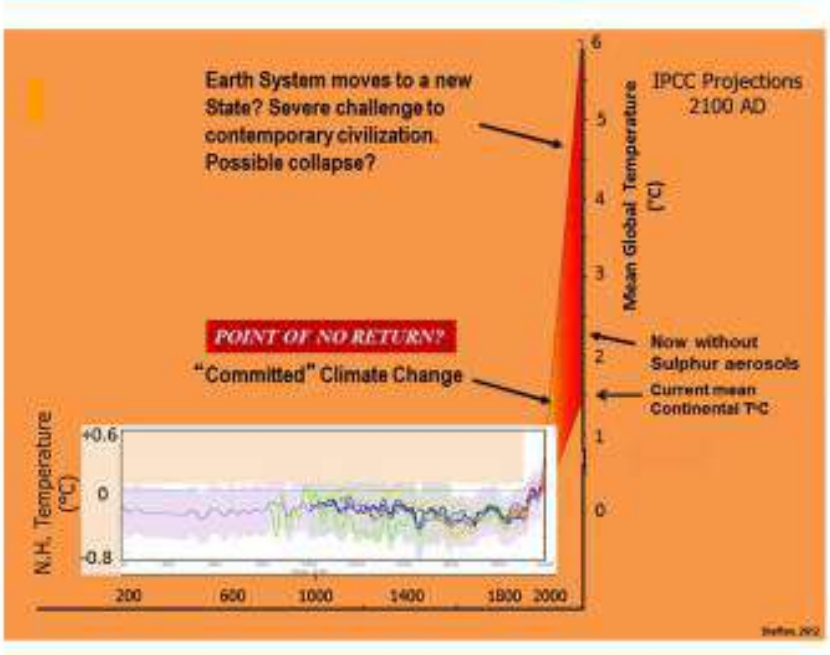

Figure 2.15: **Historical and predicted global temperatures.**

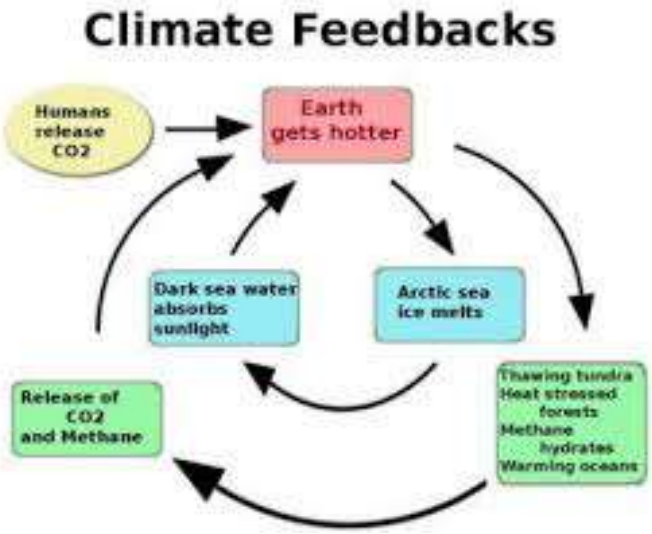

Figure 2.16: **Some of the feedback loops involved in climate change.**

Figure 2.17: **Climate change will produce severe droughts in regions that today produce much of the world's food.**

Figure 2.18: **Rising sea levels are already affecting vulnerable parts of the world.**

2.12 From mall-junkie to environmentalist

Born into a family of social activists

Naomi Klein was born in 1970 in Montreal, Canada. Her parents had moved there from the United States in 1967 to escape from involvement in the Vietnam War, and they described themselves as 'hippies". Naomi's mother is a feminist film-maker, best known for her anti-pornographic film, *Not A Love Affair*. Her physician father, Michael Klein, is a member of Physicians for Social Responsibility, a branch of International Physicians for the Prevention of Nuclear War (Nobel Peace Prize, 1985). According to Naomi Klein herself, as a child and teenager, she found it "very oppressive to have a very public feminist mother". As a reaction, she devoted herself to full-time consumerism, spending much of her time at shopping malls.

Becoming "less of a brat"

Two events made Naomi Klein become (in her own words) "less of a brat". As she was preparing for entry as a student at the University of Toronto, her mother had a stroke, and had to be cared for by the family, including Naomi. To do this, all of the family members had to make sacrifices. The second wake-up call was the 1989 massacre of female engineering students at the École Polytechnique. This came during Klein's first year at the University of Toronto, and it converted her to feminism.

Full-time journalism

During her time as a student at the University of Toronto, Naomi Klein served as editor of the student newspaper The Varsity, to which she also contributed articles. Attracted to journalism as a career, she dropped out of the university after her third year, and became a full-time writer for The Globe and Mail. In 1995 she became the editors of This Magazine. She married Avi Lewis, a well-connected progressive film-maker and television personality with whom she now collaborates.

Naomi Klein's books and films

- *No Logo*, 1999:
- *Fences and Windows*, 2002:
- *The Take*, 2004:
- *The Shock Doctrine: The Rise of Disaster Capitalism*, 2007:
- *This Changes Everything: Capitalism vs. the Climate*, 2014:
- *No Is Not Enough: Resisting Trump's Shock Politics and Winning the World We Need*, 2017:
- *The Battle for Paradise: Puerto Rico Takes on the Disaster Capitalists*, 2018:
- *On Fire: The (Burning) Case for a Green New Deal, September*, 2019:

Naomi Klein's articles

- (July 10, 2015). *A radical Vatican?*. The New Yorker. New York City.
- (September 2004). *Baghdad year zero: Pillaging Iraq in pursuit of a neocon utopia*. Harper's Magazine. New York City: 43-53.
- (November 28, 2011). *Capitalism vs. the Climate: What the right gets - and the left doesn't - about the revolutionary power of climate change*. The Nation. New York City.
- (October 29, 2013). *How science is telling us all to revolt*. New Statesman.
- (November 9, 2016). *It was the Democrats' embrace of neoliberalism that won it for Trump*. The Guardian. Kings Place, London.
- (July 3, 2017). *Daring to Dream in the Age of Trump - Resistance is necessary, but it's not enough to win the world we need*. The Nation. New York City.
- (August 3, 2018). *Capitalism Killed Our Climate Momentum, Not, "Human Nature"*. The Intercept.

Figure 2.19: **Naomi Klein's 2014 book, *This Changes Everything: Capitalism vs. the Climate*, was called "the most momentous and contentious environmental book since *Silent Spring*" by New York Times book reviewer Rob Nixon.**

Figure 2.20: **Poster for the film version of *This Changes Everything*, produced and directed by Naomi Klein's husband, Avi Lewis.**

2.13 Naomi Klein on the urgency of the Green New Deal

A recent article by journalist Naomi LaChance describes a meeting at the Sanders Institute (founded by Senator Bernie Sanders and his wife Jane) at which the famous author and activist Naomi Klein and others spoke about the scope and urgency of the Green New Deal. Here are some excerpts from the article:

Progressive journalist and activist Naomi Klein urged sweeping change that tackles the climate crisis, capitalism, racism and economic inequality in tandem on Friday in Burlington, Vt. If that seems challenging, add the fact that the clock is ticking[21] and there might not be another chance.

"We need to have started yesterday", Klein said at the three-day Sanders Institute Gathering on a panel moderated by environmental activist Bill McKibben. "What all of us who follow the science know is that we just can't lose these four years", she said, referring to the presidency of climate change denier Donald Trump. The conference, organized by the think tank founded by Vermont Sen. Bernie Sanders' wife, Jane, is aimed at forming bold progressive agendas for the future.

Progressives are looking to incoming Democratic New York Rep. Alexandria Ocasio-Cortez for leadership as she galvanizes a grassroots effort by the youth-led climate change group Sunrise Movement[22] to reduce fossil fuel dependence. Eighteen members of Congress support the idea of creating a House select committee to look at making a realistic plan by January 2020.

Uniting for a Green New Deal

Here are excerpts from an article entitled *Uniting for a Green New Deal*, by Margaret Flowers and Kevin Zeese. It was published on January 15, 2019.

Support is growing in the United States for a Green New Deal. Though there are competing visions for what that looks like, essentially, a Green New Deal includes a rapid transition to a clean energy economy, a jobs program and a stronger social safety net.

We need a Green New Deal for many reasons, most obviously the climate crisis and growing economic insecurity. Each new climate report describes the severe consequences of climate change with increasing alarm and the window of opportunity for action is closing. At the same time, wealth inequality is

[21] https://www.theguardian.com/environment/2018/oct/08/global-warming-must-not-exceed-15c-warns-landmark-un-report

[22] https://www.truthdig.com/articles/will-democrats-back-a-green-new-deal/

Figure 2.21: **Award-winning Canadian author Naomi Klein, speaking at the Sanders Institute in January, 2019. Her book *This Changes Everything: Capitalism vs. the Climate* (2014) was a New York Times Bestseller List nonfiction bestseller and the winner of the Hilary Weston Writers' Trust Prize for Nonfiction in its year. In 2016 Klein was awarded the Sydney Peace Prize for her activism on climate justice. Klein frequently appears on global and national lists of top influential thinkers. Writing in the wake of Hurricane Sandy she warned that the climate crisis constitutes a massive opportunity for disaster capitalists and corporations seeking to profit from crisis. But equally, the climate crisis "can be a historic moment to usher in the next great wave of progressive change". On November 9, 2016, following the election of Donald Trump as the 45th President of the United States, Klein called for an international campaign to impose economic sanctions on the United States if his administration refuses to abide by the terms of the Paris Agreement.**

also growing. Paul Bucheit writes that more than half of the population in the United States is suffering from poverty.

The Green New Deal provides an opportunity for transformational changes, not just reform, but changes that fundamentally solve the crises we face. This is the time to be pushing for a Green New Deal at all levels, in our towns and cities, states and nationally.

The idea of a Green New Deal seems to have arisen in early 2007 when the Green New Deal Group started meeting to discuss it, specifically as a plan for the United Kingdom. They published their report in July 2008. In April 2009, the United Nations Environmental Program also issued a plan for a global Green New Deal.

In the United States, Barack Obama included a Green New Deal in his 2008 presidential campaign and conservative Thomas Friedman started talking about it in 2007. Howie Hawkins, a Green Party gubernatorial candidate in New York, campaigned on a Green New Deal starting in 2010. Listen to our interview with Hawkins about how we win the Green New Deal on Clearing the FOG. Jill Stein campaigned on it during her presidential runs in 2012 and 2016, as have many Green Party candidates.

Alexandria Ocasio Cortez (AOC), who ran for Congress as a Democrat and won in 2018, has made the Green New Deal a major priority. With the backing of the Sunrise Movement, AOC pushed for a congressional committee tasked with developing a Green New Deal and convinced dozens of members of Congress to support it. Speaker of the House Nancy Pelosi sidelined that idea by creating a climate committee headed by Kathy Castor, which has no mandate to do anything and lacks the power to write legislation and issue subpoenas. Now the Sunrise Movement is planning a tour to build support for the Green New Deal. At each stop they will provide organizing tools to make the Green New Deal a major issue in the 2020 election season.

This week, more than 600 organizations, mostly environmental groups, sent a letter to Congress calling on it to take climate change seriously and design a plan to end dependence on fossil fuels, a transition to 100% clean energy by 2035, create jobs and more. Indigenous leaders are also organizing to urge Congress to pass a Green New Deal that is "Indigenized," meaning it prioritizes input from and the inclusion of Indigenous Peoples.

Roosevelt's original New Deal

In the United States, President Franklin D. Roosevelt was faced with the difficult problems of the depression during his first few years in office. Roosevelt introduced a number of special governmental programs, such as the WPA, the Civilian Construction Corps and the Tennessee Valley Authority, which were designed to create new jobs on projects directed towards socially useful goals - building highways, airfields, auditoriums, harbors, housing projects, schools and dams. The English economist John Maynard Keynes, (1883-1946),


The Atlanta Journal

ROOSEVELT PLEDGES QUICK ACTION IN EMERGENCY IN MOMENTOUS ADDRESS AT HIS INAUGURATION

Garner Takes Oath as Congress Ends Eventful Session

provided an analysis of the factors that had caused the 1929 depression, and a theoretical justification of Roosevelt's policies.

The transition to a sustainable global society will require a similar level of governmental responsibility, although the measures needed are not the same as those which Roosevelt used to end the great depression. Despite the burst of faith in the free market which has followed the end of the Cold War, it seems unlikely that market mechanisms alone will be sufficient to solve problems of unemployment in the long-range future, or to achieve conservation of land, natural resources and environment.

Honors and awards won by Naomi Klein

- 2014 Hilary Weston Writers' Trust Prize for Nonfiction for This Changes Everything
- The Observer 'Book of the Year', This Changes Everything
- Book Review '100 Notable Books of the Year', This Changes Everything
- Warwick Prize for Writing, for The Shock Doctrine
- The New York Times Critics' Pick of the Year, The Shock Doctrine
- No Logo - Top 100 Non Fiction books of all-time list (2016), The Guardian
- Time magazine's list of Top 100 Non-Fiction books published since 1923, No Logo.
- Sydney Peace Prize, 2016
- Honorary doctorate, Saint Thomas University (2011)
- Honorary doctorate, University of Amsterdam (2019)

2.14 The Sunrise Movement

The Sunrise Movement is a youth-lead climate activist organization founded in 2017. The movement's website states that "Sunrise is a movement to stop climate change and create

Figure 2.22: **Representative Alexandria Ocasio-Cortez addressing a meeting of the Sunrise Movement.**

millions of good jobs in the process. We're building an army of young people to make climate change an urgent priority across America, end the corrupting influence of fossil fuel executives on our politics, and elect leaders who stand up for the health and wellbeing of all people.

"We are ordinary young people who are scared about what the climate crisis means for the people and places we love. We are gathering in classrooms, living rooms, and worship halls across the country. Everyone has a role to play. Public opinion is already with us - if we unite by the millions we can turn this into political power and reclaim our democracy.

"We are not looking to the right or left. We look forward. Together, we will change this country and this world, sure as the sun rises each morning."

Principles of the Sunrise Movement

1. **We are a movement to stop climate change and create millions of good-paying jobs in the process.** We unite to make climate change an urgent priority across America, end the corrupting influence of fossil fuel executives on our politics, and elect leaders who stand up for the health and wellbeing of all people.

2. **We grow our power through talking to our communities.** We talk to our neighbors, families, religious leaders, classmates, and teachers, in order to spread our word. Our strength and work is rooted in our local communities, and we are always growing in number.

Figure 2.23: **Banner dropped by the Sunrise Movement on August 23, 2019, across from the Democratic National Committee meeting.**

3. **We are Americans from all walks of life.** We are of many colors and creeds, from the plains, mountains, and coasts. A wealthy few want to divide us, but we value each other in our differences and we are united in a shared fight to make real the promise of a society that works for all of us.

4. **We are nonviolent in word and deed.** Remaining nonviolent allows us to win the hearts of the public and welcomes the most people to participate. We need maximum participation in order to achieve our goals.

5. **We tell our stories and we honor each other's stories.** We all have something to lose to climate change, and something to gain in coming together. We tell our individual stories to connect with each other and understand the many different ways this crisis impacts us.

6. **We ask for help and we give what we can.** We all have something to offer to the movement. Some of us give time through volunteering anywhere from 1 to 50 hours per week. Some of us give money. Some of us donate housing or meeting space. We invite our community into the movement by asking for the help we need.

7. **We take initiative.** Any group of 3 people can take action in the name of Sunrise. We ask for advice - not permission - from each other to make this happen. To make decisions, we ask ourselves, "does this bring us closer to our goal?" If yes, we simply do the work that is exciting and makes sense.

8. **We embrace experimentation and we learn together.** We welcome imperfection, share innovations, and learn through honest mistakes followed by honest conversations that help us move forward together. If we see something we don't like, we contribute with something we do like, modeling an alternative.

9. **We take care of ourselves, each other, and our shared home.** We maintain our health of body, mind, spirit, and environment to the best of our ability so that we can maintain a strong movement together. We respect that for each of us this looks different.

10. **We stand with other movements for change.** Stopping climate change requires winning and holding power at every level of government. This is a huge job and we can't do it alone. When it makes sense, we work with other movements who share our values and are also working to win political power.

11. **We shine bright.** There are hard and sad days, to be sure. This isn't easy work. But we strive to bring a spirit of positivity and hope to everything we do. Changing the world is a fulfilling and joyful process, and we let that show

2.15 The Extinction Rebellion

Here is a quotation from the organization's website[23]:

"On 31st October 2018, we assembled on Parliament Square in London to announce a Declaration of Rebellion against the UK Government. We were expecting a couple of hundred people. Instead, 1500 came to participate in peaceful civil disobedience. The energy was contagious! The next few weeks were a whirlwind. Six thousand of us converged on London to peacefully block five major bridges across the Thames. We planted trees in the middle of Parliament Square, and dug a hole there to bury a coffin representing our future. We super-glued ourselves to the gates of Buckingham Palace as we read a letter to the Queen. Our actions generated huge national and international publicity and, as news spread, our ideas connected with tens of thousands of people around the world. The XR project was resonating with a deeply felt need for community and solidarity. "We are the ones we've been waiting for," we chanted! Dozens of countries now have groups springing up, from the Solomon Islands to Australia, from Spain to South Africa, the US to India.

"So what's next? We are working relentlessly, building our movement in preparation for phase two, an international rebellion that will begin on 15th April 2019. So come and join us. Rebel for life. For the planet. For our children's children's futures. There is so much work to be done."

Demands

1. Government must tell the truth by declaring a climate and ecological emergency, working with other institutions to communicate the urgency for change.
2. Government must act now to halt biodiversity loss and reduce greenhouse gas emissions to net-zero by 2025.
3. Government must create, and be led by the decisions of, a citizens' assembly on climate and ecological justice.

Stated principles

1. We have a shared vision of change - creating a world that is fit for generations to come. We set our mission on what is necessary - mobilizing 3.5% of the population to achieve system change by using ideas such as "momentum-driven organizing" to achieve this.
2. We need a regenerative culture - creating a culture that is healthy, resilient, and adaptable.
3. We openly challenge ourselves and this toxic system, leaving our comfort zones to take action for change.

[23]https://rebellion.earth/the-truth/about-us/

4. We value reflecting and learning, following a cycle of action, reflection, learning, and planning for more action (learning from other movements and contexts as well as our own experiences).
5. We welcome everyone and every part of everyone - working actively to create safer and more accessible spaces.
6. We actively mitigate for power - breaking down hierarchies of power for more equitable participation.
7. We avoid blaming and shaming - we live in a toxic system, but no one individual is to blame.
8. We are a non-violent network using non-violent strategy and tactics as the most effective way to bring about change.
9. We are based on autonomy and decentralization - we collectively create the structures we need to challenge power. Anyone who follows these core principles and values can take action in the name of RisingUp!"

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Chapter 3

EXTINCTION EVENTS AND FEEDBACK LOOPS

Introduction

Scientists warn that if the transition to renewable energy does not happen within very few decades, there is a danger that we will reach a tipping point beyond which feedback loops, such as the albedo effect and the methane hydrate feedback loop, will take over and produce an out-of-control and fatal increase in global temperature.

In 2012, the World Bank issued a report warning that without quick action to curb CO_2 emissions, global warming is likely to reach 4 °C during the 21st century. This is dangerously close to the temperature which initiated the Permian-Triassic extinction event: 6 °C above normal. During the Permian-Triassic extinction event, which occurred 252 million years ago, 96% of all marine species were wiped out, as well as 70% of all terrestrial vertebrates.[1]

[1] http://science.nationalgeographic.com/science/prehistoric-world/permian-extinction/ http://www.worldbank.org/en/news/feature/2012/11/18/Climate-change-report-warns-dramatically-warmer-world-this-century

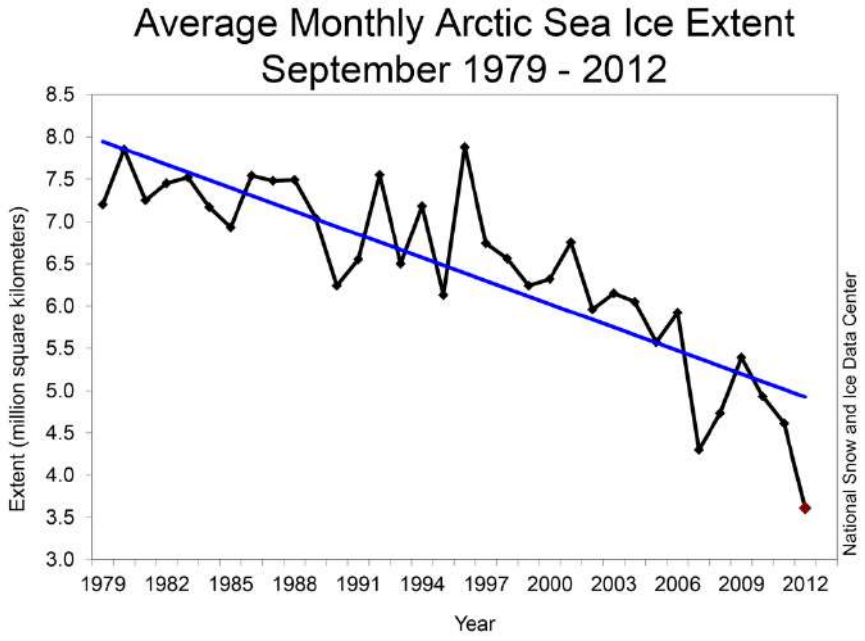

Figure 3.1: **Monthly September ice extent for 1979 to 2012 shows a decline of 13.0% per decade. One can also see that the straight line does not really fit the data, which more nearly resemble a downward curve will that reach zero in the period 2016-2019. Source: National Snow and Ice Data Center. Wikimedia Commons**

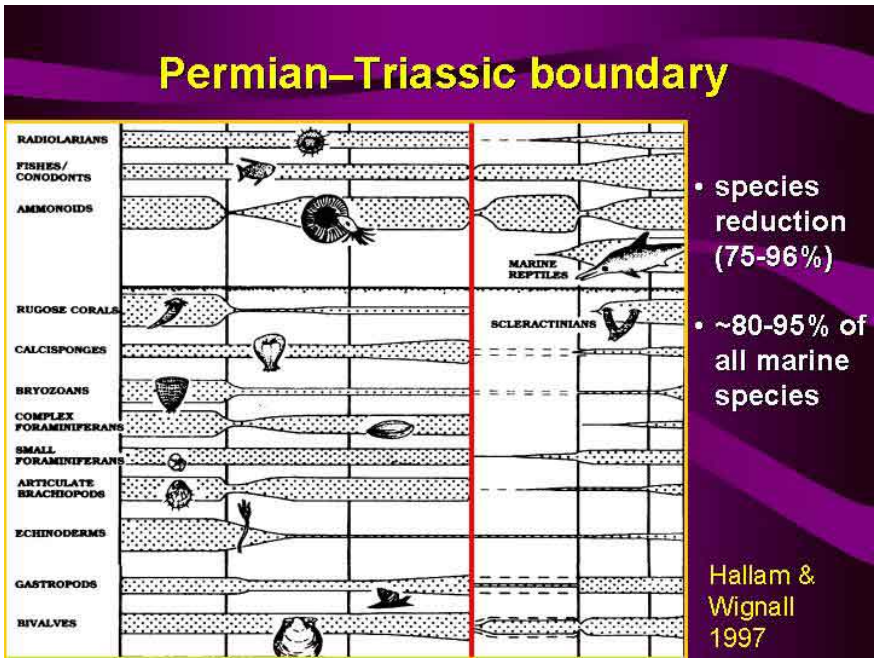

Figure 3.2: **Loss of species caused by the Permian-Triassic extinction event. Unless quick steps are taken to lower our greenhouse gas emissions, we may cause a similar extinction event, which will threaten the survival of our own species. Source: Australian Frontiers of Science, www.sciencearchive.org.au**

3.1 A warning from the World Bank

In 2012, the World Bank issued a report warning that without quick action to curb CO_2 emissions, global warming is likely to reach 4 °C during the 21st century. This is dangerously close to the temperature which initiated the Permian-Triassic extinction event: 6 °C above normal. During the Permian-Triassic extinction event, which occurred 252 million years ago, 96% of all marine species were wiped out, as well as 70% of all terrestrial vertebrates.[2]

The 4^oC scenarios are devastating: the inundation of coastal cities; increasing risks for food production potentially leading to higher malnutrition rates; many dry regions becoming dryer, wet regions wetter; unprecedented heat waves in many regions, especially in the tropics; substantially exacerbated water scarcity in many regions; increased frequency of high-intensity tropical cyclones; and irreversible loss of biodiversity, including coral reef systems.

And most importantly, a 4^oC world is so different from the current one that it comes with high uncertainty and new risks that threaten our ability to anticipate and plan for future adaptation needs. The lack of action on climate change not only risks putting prosperity out of reach of millions of people in the developing world, it threatens to roll back decades of sustainable development. It is clear that we already know a great deal about the threat before us. The science is unequivocal that humans are the cause of global warming, and major changes are already being observed: global mean warming is 0.8^oC above pre industrial levels; oceans have warmed by 0.09^oC since the 1950s and are acidifying; sea levels rose by about 20 cm since pre-industrial times and are now rising at 3.2 cm per decade; an exceptional number of extreme heat waves occurred in the last decade; major food crop growing areas are increasingly affected by drought.

Despite the global community's best intentions to keep global warming below a 2^oC increase above pre-industrial climate, higher levels of warming are increasingly likely. Scientists agree that countries' cur- rent United Nations Framework Convention on Climate Change emission pledges and commitments would most likely result in 3.5 to 4^oC warming. And the longer those pledges remain unmet, the more likely a 4^oC world becomes.

Data and evidence drive the work of the World Bank Group. Science reports, including those produced by the Intergovernmental Panel on Climate Change, informed our decision to ramp up work on these issues, leading to, a World Development Report on climate change designed to improve our understanding of the implications of a warming planet; a Strategic Framework on Development and Climate Change, and a report on Inclusive Green Growth. The World Bank is a leading advocate for ambitious action on climate change, not only because it is a moral imperative, but because it makes good economic sense.

But what if we fail to ramp up efforts on mitigation? What are the implications of a 4^oC world? We commissioned this report from the Potsdam Institute for Climate Impact

[2]http://science.nationalgeographic.com/science/prehistoric-world/permian-extinction/ http://www.worldbank.org/en/news/feature/2012/11/18/Climate-change-report-warns-dramatically-warmer-world-this-century

Research and Climate Analytics to help us understand the state of the science and the potential impact on development in such a world.

It would be so dramatically different from today's world that it is hard to describe accurately; much relies on complex projections and interpretations. We are well aware of the uncertainty that surrounds these scenarios and we know that different scholars and studies sometimes disagree on the degree of risk. But the fact that such scenarios cannot be discarded is sufficient to justify strengthening current climate change policies. Finding ways to avoid that scenario is vital for the health and welfare of communities around the world. While every region of the world will be affected, the poor and most vulnerable would be hit hardest. A 4^oC world can, and must, be avoided.

The World Bank Group will continue to be a strong advocate for international and regional agreements and increasing climate financing. We will redouble our efforts to support fast growing national initiatives to mitigate carbon emissions and build adaptive capacity as well as support inclusive green growth and climate smart development. Our work on inclusive green growth has shown that, through more efficiency and smarter use of energy and natural resources, many opportunities exist to drastically reduce the climate impact of development, without slowing down poverty alleviation and economic growth.

This report is a stark reminder that climate change affects everything. The solutions don't lie only in climate finance or climate projects. The solutions lie in effective risk management and ensuring all our work, all our thinking, is designed with the threat of a 4^oC degree world in mind. The World Bank Group will step up to the challenge.

3.2 Permian-Triassic extinction event

The geological record shows five major extinction events.

- Ordovician-Silurian Extinction. around 439 million years ago.
- Late Devonian Extinction. 375-360 million years ago.
- Permian-Triassic extinction. 352 million years ago.
- Triassic-Jurassic extinction, 201 million years ago.
- Cretaceous-Paleogene extinction, 66 million years ago.

The most devastating of these was the Permian-Triassic extinction, which occurred 252 million years ago.[3] In the Permian-Triassic extinction, 96% of all marine species and 76% of all terrestrial vertebrates disappeared forever. The cause of this extremely severe

[3] https://www.thomhartmann.com/bigpicture/last-hours-climate-change
The Last Hours of Humanity: Warming the World To Extinction (book), by Thom Hartmann
https://www.amazon.com/Last-Hours-Humanity-Warming-Extinction/dp/1629213640
http://www.mediaite.com/online/leonardo-dicaprio-boosts-thom-hartmann-apocalyptic-global-warming-film-last-hours/

event is disputed, but according to one of the most plausible theories it was triggered by a massive volcanic eruption in Siberia, which released enormous amounts of CO_2 into the earth's atmosphere.

The region where massive volcanic eruptions are known to have occurred 252 million years ago called the "Siberian Traps". (The "Traps" part of the name comes from the fact that many of the volcanic rock formations in the region resemble staircases. The Swedish word for staircase is "trappe".) The eruptions continued for about a million years.

Today the area covered is about 2 million square kilometers, roughly equal to western Europe in land area. Estimates of the original coverage are as high as 7 million square kilometers. The original volume of lava is estimated to range from 1 to 4 million cubic kilometers.

The CO_2 released by the Siberian Traps eruption is believed to have caused a global temperature increase of 6^oC, and this was enough to trigger the methane-hydrate feedback loop, which will be discussed below, The earth's temperature is thought to have continued to rise for 85,000 years, finally reaching 15^o above normal.

3.3 The Holocene (Anthropocene) extinction

We are now living in the midst of a sixth, human-caused, mass extinction. How severe it becomes is up to us.

Recently a group of scientists stated that the scope of human impact on planet Earth is so great that the *Anthropocene* warrants a formal place in the Geological Time Scale.

In a statement issued by University of Leicester Press Office on 2 October 2017, professor Jan Zalasiewicz from the University of Leicester's School of Geography, Geology, and the Environment said: "Our findings suggest that the Anthropocene should follow on from the Holocene Epoch that has seen 11.7 thousand years of relative environmental stability, since the retreat of the last Ice Age, as we enter a more unstable and rapidly evolving phase of our planet's history,"[4]

"We conclude that human impact has now grown to the point that it has changed the course of Earth history by at least many millennia, in terms of the anticipated long-term climate effects (e.g. postponement of the next glacial maximum: see Ganopolski et al., 2016; Clark et al., 2016), and in terms of the extensive and ongoing transformation of the biota, including a geologically unprecedented phase of human-mediated species invasions, and by species extinctions which are accelerating (Williams et al., 2015, 2016)."

The report stated that defining characteristics of the period include "marked acceleration of rates of erosion and sedimentation; large-scale chemical perturbations to the cycles of carbon, nitrogen, phosphorus and other elements; the inception of significant change in global climate and sea level; and biotic changes including unprecedented levels of species invasions across the Earth. Many of these changes are geologically long-lasting, and some are effectively irreversible."

[4]http://www2.le.ac.uk/offices/press/press-releases/2017/october/significant-scale-of-human-impact-on-planet-has-changed-course-of-earth2019s-history-scientists-suggest

Loss of biodiversity

Tropical rain forests are the most biologically diverse places in the world. This is because they have not been affected by the periods of glaciation that have periodically destroyed the forests of temperate and boreal regions. The destruction of species-rich tropical rain forests is one of the mechanisms driving the present high rate of species loss.

According to a recent article published in *The Guardian*[5] "Conservation experts have already signalled that the world is in the grip of the "sixth great extinction" of species, driven by the destruction of natural habitats, hunting, the spread of alien predators and disease, and climate change.

"The IUCN[6] created shock waves with its major assessment of the world's biodiversity in 2004, which calculated that the rate of extinction had reached 100-1,000 times that suggested by the fossil records before humans.

"No formal calculations have been published since, but conservationists agree the rate of loss has increased since then, and Stuart said it was possible that the dramatic predictions of experts like the renowned Harvard biologist E O Wilson, that the rate of loss could reach 10,000 times the background rate in two decades, could be correct."

A recent article by Profs. Gerardo Ceballos, Paul R. Ehrlich and Rodolfo Dirzo in the *Proceedings of the National Academy of Sciences* was entitles "Biological Annihilation via the Ongoing Sixth Mass Extinction Signaled by Vertebrate Population Losses and Declines".

The Abstract of the paper reads as follows: "The population extinction pulse we describe here shows, from a quantitative viewpoint, that Earth's sixth mass extinction is more severe than perceived when looking exclusively at species extinctions. Therefore, humanity needs to address anthropogenic population extirpation and decimation immediately. That conclusion is based on analyses of the numbers and degrees of range contraction (indicative of population shrinkage and/or population extinctions according to the International Union for Conservation of Nature) using a sample of 27,600 vertebrate species, and on a more detailed analysis documenting the population extinctions between 1900 and 2015 in 177 mammal species. We find that the rate of population loss in terrestrial vertebrates is extremely high, even in 'species of low concern.' In our sample, comprising nearly half of known vertebrate species, 32% (8,851/27,600) are decreasing; that is, they have decreased in population size and range. In the 177 mammals for which we have detailed data, all have lost 30% or more of their geographic ranges and more than 40% of the species have experienced severe population declines (¿80% range shrinkage). Our data indicate that beyond global species extinctions Earth is experiencing a huge episode of population declines and extirpations, which will have negative cascading consequences on ecosystem functioning and services vital to sustaining civilization. We describe this as a 'biological annihilation' to highlight the current magnitude of Earth's ongoing sixth major extinction event."

[5] https://www.theguardian.com/environment/2010/mar/07/extinction-species-evolve

[6] International Union for the Conservation of Nature

3.4 Global warming and atmospheric water vapor

A feedback loop is a self-re-enforcing trend. One of the main positive feedback loops in global warming is the tendency of warming to increase the atmospheric saturation pressure for water vapor, and hence amount of water vapor in the atmosphere, which in turn leads to further warming, since water vapor is a greenhouse gas.

Wikipedia's article on greenhouse gases states that, "Water vapor accounts for the largest percentage of the greenhouse effect, between 36% and 66% for clear sky conditions and between 66% and 85% when including clouds."

3.5 The albedo effect

Albedo is defined to be the fraction of solar energy (shortwave radiation) reflected from the Earth back into space. It is a measure of the reflectivity of the earth's surface. Ice, especially with snow on top of it, has a high albedo: most sunlight hitting the surface bounces back towards space.

Loss of sea ice

Especially in the Arctic and Antarctic regions, there exists a dangerous feedback loop involving the albedo of ice and snow. As is shown in Figure 4.1, Arctic sea ice is rapidly disappearing. It is predicted that during the summers, the ice covering arctic seas may disappear entirely during the summers. As a consequence, incoming sunlight will encounter dark light-absorbing water surfaces rather than light-reflecting ice and snow.

This effect is self-re-enforcing. In other words, it is a feedback loop. The rising temperatures caused by the absorption of more solar radiation cause the melting of more ice, and hence even more absorption of radiation rather than reflection, still higher temperatures, more melting, and so on.

The feedback loop is further strengthened by the fact that water vapor acts like a greenhouse gas. As polar oceans become exposed, more water vapor enters the atmosphere, where it contributes to the greenhouse effect and rising temperatures.

Darkened snow on Greenland's icecap

Greenland's icecap is melting, and as it melts, the surface becomes darker and less reflective because particles of soot previously trapped in the snow and ice become exposed. This darkened surface absorbs an increased amount of solar radiation, and the result is accelerated melting.

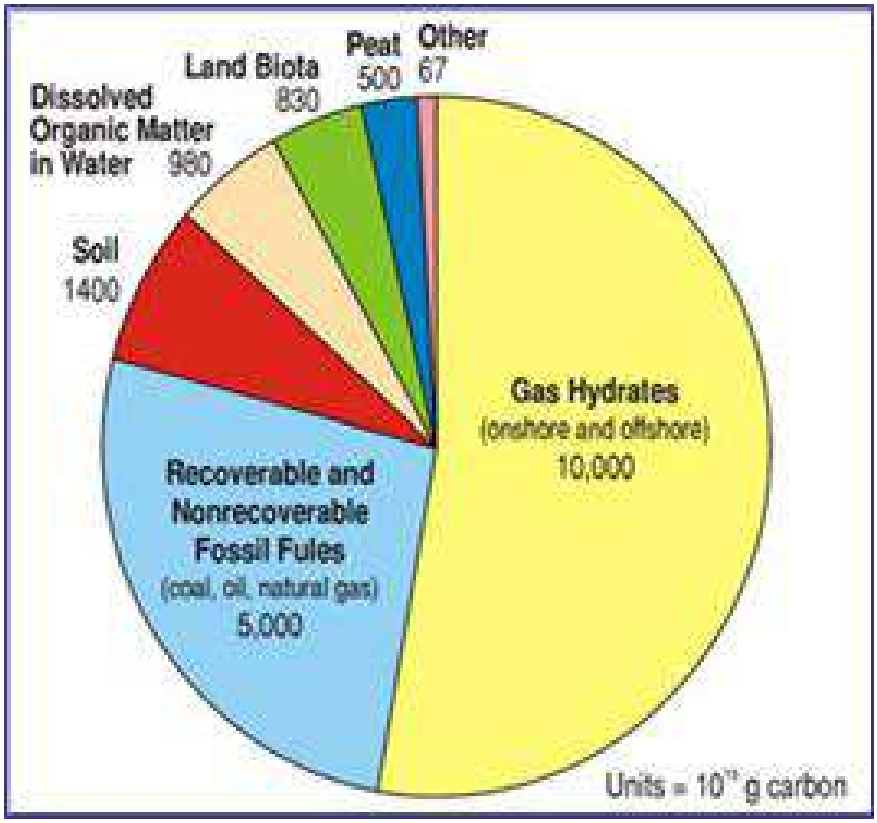

Figure 3.3: **The worrying thing about the methane/hydrate feedback loop is the enormous amount of carbon in the form of hydrate crystals, 10,000 gigatons most of it on the continental shelves of oceans. This greater than the amount of carbon in all other forms that might potentially enter the earth's atmosphere.**

Figure 3.4: **When ocean temperatures rise, methane hydrate crystals become unstable, and methane gas bubbles up to ocean surfaces.**

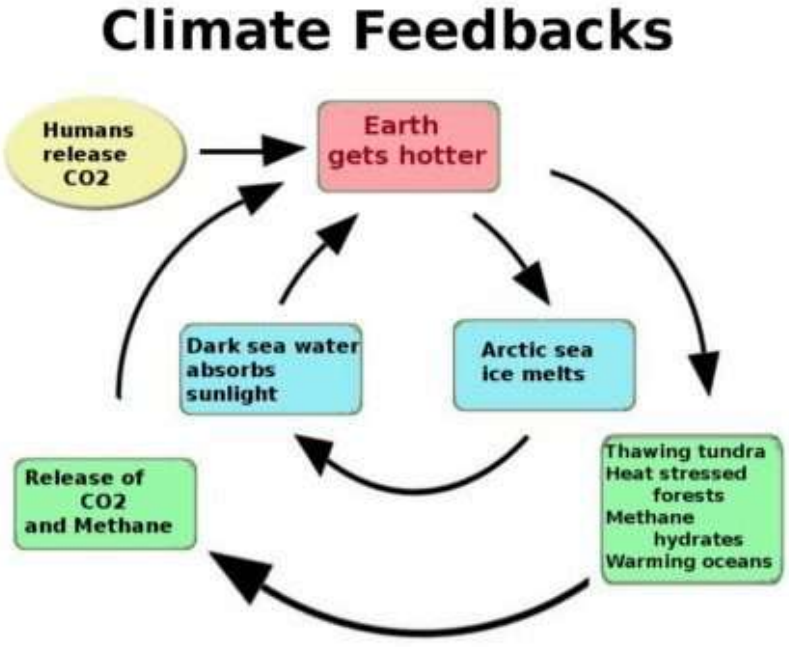

Figure 3.5: **This diagram shows two important feedback loops, one involving the albedo effect, and the other involving methane hydrates.**

3.6 The methane hydrate feedback loop

If we look at the distant future, by far the most dangerous feedback loop involves methane hydrates or methane clathrates. When organic matter is carried into the oceans by rivers, it decays to form methane. The methane then combines with water to form hydrate crystals, which are stable at the temperatures and pressures which currently exist on ocean floors. However, if the temperature rises, the crystals become unstable, and methane gas bubbles up to the surface. Methane is a greenhouse gas which is 70 times as potent as CO_2.

The worrying thing about the methane hydrate deposits on ocean floors is the enormous amount of carbon involved: roughly 10,000 gigatons. To put this huge amount into perspective, we can remember that the total amount of carbon in world CO2 emissions since 1751 has only been 337 gigatons.

A runaway, exponentially increasing, feedback loop involving methane hydrates could lead to one of the great geological extinction events that have periodically wiped out most of the animals and plants then living. This must be avoided at all costs.

3.7 A feedback loop from warming of soils

On October 6, 2017, the journal *Science* published an article entitled *Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world*[7]. The lead author, Jerry Melillo, is an ecologist working at the Marine Biological Laboratory, Woods Hole Massachusetts. In an interview with *Newsweek*, he said: "This self-reinforcing feedback is potentially a global phenomenon with soils, and once it starts it may be very difficult to turn off. It's that part of the problem that I think is sobering... We think that one of the things that may be happening is both a reorganization of the microbial community structure and its functional capacity,"

The study reported on three decades of observations of heated sections of a forest owned by Harvard University. The heated sections were 5^oC warmer than control sections.

3.8 Drying of forests and forest fires

According to a recent article in *Nature*[8],"Across the American west, the area burned each year has increased significantly over the past several decades, a trend that scientists attribute both to warming and drying and to a century of wildfire suppression and other human activities. Allen suggests that the intertwined forces of fire and climate change will take ecosystems into new territory, not only in the American west but also elsewhere around the world. In the Jemez, for example, it could transform much of the ponderosa pine (Pinus ponderosa) forest into shrub land. 'We're losing forests as we've known them

[7]J.M. Melillo et al., *Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world*, Science, Vol. 358, pp. 101-105, (2017).

[8]http://www.nature.com/news/forest-fires-burn-out-1.11424

for a very long time,' says Allen. 'We're on a different trajectory, and we're not yet sure where we're going.'

"All around the American west, scientists are seeing signs that fire and climate change are combining to create a 'new normal'. Ten years after Colorado's largest recorded fire burned 56,000 hectares southwest of Denver, the forest still has not rebounded in a 20,000-hectare patch in the middle, which was devastated by an intense crown fire. Only a few thousand hectares, which the US Forest Service replanted, look anything like the ponderosa-pine stands that previously dominated the landscape."

3.9 Tipping points and feedback loops

A tipping point is usually defined as the threshold for an abrupt and irreversible change[9]. To illustrate this idea, we can think of a book lying on a table. If we gradually push the book towards the edge of the table, we will finally reach a point after which more than half of the weight of the book will not be not supported by the table. When this "tipping point" is passed the situation will suddenly become unstable, and the book will fall to the floor. Analogously, as the earth's climate gradually changes, we may reach tipping points. If we pass these points, sudden instabilities and abrupt climatic changes will occur.

Greenland ice cores supply a record of temperatures in the past, and through geological evidence we have evidence of sea levels in past epochs. These historical records show that abrupt climatic changes have occurred in the past.

Timothy Michael Lenton, FRS, Professor of Climate Change and Earth System Science at he University of Exeter, lists the following examples of climatic tipping points:

- Boreal forest dieback
- Amazon rainforest dieback
- Loss of Arctic and Antarctic sea ice (Polar ice packs) and melting of Greenland and Antarctic ice sheets
- Disruption to Indian and West African monsoon
- Formation of Atlantic deep water near the Arctic ocean, which is a component process of the thermohaline circulation.
- Loss of permafrost, leading to potential Arctic methane release and clathrate gun effect

It can be seen from this list that climate tipping points are associated with feedback loops. For example, the boreal forest dieback and the Amazon rainforest dieback tipping points are associated with the feedback loop involving the drying of forests and forest fires,

[9]Other definitions of tipping points are possible. A few authors define these as points beyond which change is inevitable, emphasizing that while inevitable, the change may be slow.

while the tipping point involving loss of Arctic and Antarctic sea ice is associated with the Albedo effect feedback loop. The tipping point involving loss of permafrost is associated with the methane hydrate feedback loop.

Once a positive feedback loop starts to operate in earnest, change may be abrupt.

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Chapter 4

THE GLOBAL FOOD AND REFUGEE CRISIS

"Unless progress with agricultural yields remains very strong, the next century will experience human misery that, on a sheer numerical scale, will exceed everything that has come before"

Nobel Laureate Norman Borlaug speaking of a global food crisis in the 21st century

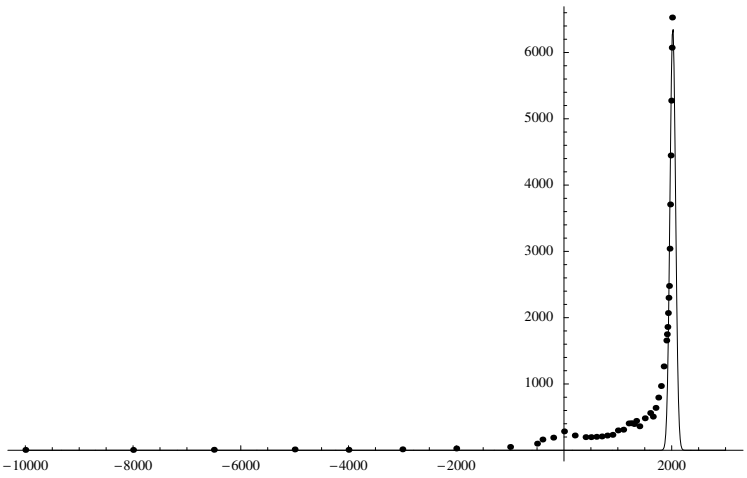

Figure 4.1: **Population growth and fossil fuel use, seen on a time-scale of several thousand years. The dots are population estimates in millions from the US Census Bureau. Fossil fuel use appears as a spike-like curve, rising from almost nothing to a high value, and then falling again to almost nothing in the space of a few centuries. When the two curves are plotted together, the explosive rise of global population is seen to be simultaneous with, and perhaps partially driven by, the rise of fossil fuel use. This raises the question of whether the world's population is headed for a crash when the fossil fuel era has ended.** (Author's own graph)

4.1 Introduction

As glaciers melt in the Himalayas, depriving India and China of summer water supplies; as sea levels rise, drowning the fertile rice fields of Viet Nam and Bangladesh; as drought threatens the productivity of grain-producing regions of North America; and as the end of the fossil fuel era impacts modern high-yield agriculture, there is a threat of wide-spread famine. There is a danger that the 1.5 billion people who are undernourished today will not survive an even more food-scarce future.

People threatened with famine will become refugees, desperately seeking entry into countries where food shortages are less acute. Wars, such as those currently waged in the Middle East, will add to the problem.

What can we do to avoid this crisis, or at least to reduce its severity? We must urgently address the problem of climate change; and we must shift money from military expenditure to the support of birth control programs and agricultural research. We must also replace the institution of war by a system of effective global governance and enforcible international laws.

4.2 Optimum population in the distant future

What is the optimum population of the world? It is certainly not the maximum number that can be squeezed onto the globe by eradicating every species of plant and animal that cannot be eaten. The optimum global population is one that can be supported in comfort, equality and dignity - and with respect for the environment.

In 1848 (when there were just over one billion people in the world), John Stuart Mill described the optimal global population in the following words:

"The density of population necessary to enable mankind to obtain, in the greatest degree, all the advantages of cooperation and social intercourse, has, in the most populous countries, been attained. A population may be too crowded, although all be amply supplied with food and raiment."

"... Nor is there much satisfaction in contemplating the world with nothing left to the spontaneous activity of nature; with every rood of land brought into cultivation, which is capable of growing food for human beings; every flowery waste or natural pasture plowed up, all quadrupeds or birds which are not domesticated for man's use exterminated as his rivals for food, every hedgerow or superfluous tree rooted out, and scarcely a place left where a wild shrub or flower could grow without being eradicated as a weed in the name of improved agriculture. If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not better or happier population, I sincerely hope, for the sake of posterity, that they will be content to be stationary, long before necessity compels them to it."[1]

Has the number of humans in the world already exceeded the earth's sustainable limits? Will the global population of humans crash catastrophically after having exceeded the carrying capacity of the environment? There is certainly a danger that this will happen - a danger that the 21st century will bring very large scale famines to vulnerable parts of the world, because modern energy-intensive agriculture will be dealt a severe blow by prohibitively high petroleum prices, and because climate change will reduce the world's agricultural output. When the major glaciers in the Himalayas have melted, they will no longer be able to give India and China summer water supplies; rising oceans will drown much agricultural land; and aridity will reduce the output of many regions that now produce much of the world's grain. Falling water tables in overdrawn aquifers, and loss of topsoil will add to the problem. We should be aware of the threat of a serious global food crisis in the 21st century if we are to have a chance of avoiding it.

The term *ecological footprint* was introduced by William Rees and Mathis Wackernagel in the early 1990's to compare demands on the environment with the earth's capacity to regenerate. In 2005, humanity used environmental resources at such a rate that it would take 1.3 earths to renew them. In other words, we have already exceeded the earth's carrying capacity. Since eliminating the poverty that characterizes much of the world

[1] John Stuart Mill, *Principles of Political Economy, With Some of Their Applications to Social Philosophy*, (1848).

today will require more resources per capita, rather than less. it seems likely that in the era beyond fossil fuels, the optimum global population will be considerably less than the present population of the world.

4.3 Population growth and the Green Revolution

Limitations on cropland

In 1944 the Norwegian-American plant geneticist Norman Borlaug was sent to Mexico by the Rockefeller Foundation to try to produce new wheat varieties that might increase Mexico's agricultural output. Borlaug's dedicated work on this project was spectacularly successful. He remained with the project for 16 years, and his group made 6,000 individual crossings of wheat varieties to produce high-yield disease-resistant strains.

In 1963, Borlaug visited India, bringing with him 100 kg. of seeds from each of his most promising wheat strains. After testing these strains in Asia, he imported 450 tons of the Lerma Rojo and Sonora 64 varieties - 250 tons for Pakistan and 200 for India. By 1968, the success of these varieties was so great that school buildings had to be commandeered to store the output. Borlaug's work began to be called a "Green Revolution". In India, the research on high-yield crops was continued and expanded by Prof. M.S. Swaminathan and his coworkers. The work of Green Revolution scientists, such Norman Borlaug and M.S. Swaminathan, has been credited with saving the lives of as many as a billion people.

Despite these successes, Borlaug believes that the problem of population growth is still a serious one. "Africa and the former Soviet republics", Borlaug states, "and the Cerrado[2], are the last frontiers. After they are in use, the world will have no additional sizable blocks of arable land left to put into production, unless you are willing to level whole forests, which you should not do. So, future food-production increases will have to come from higher yields. And though I have no doubt that yields will keep going up, whether they can go up enough to feed the population monster is another matter. Unless progress with agricultural yields remains very strong, the next century will experience human misery that, on a sheer numerical scale, will exceed the worst of everything that has come before."

With regard to the prospect of increasing the area of cropland, a report by the United Nations Food and Agricultural Organization (*Provisional Indicative World Plan for Agricultural Development*, FAO, Rome, 1970) states that "In Southern Asia,... in some countries of Eastern Asia, in the Near East and North Africa... there is almost no scope for expanding agricultural area... In the drier regions, it will even be necessary to return to permanent pasture the land that is marginal and submarginal for cultivation. In most of Latin America and Africa south of the Sahara, there are still considerable possibilities for expanding cultivated areas; but the costs of development are high, and it will often be more economical to intensify the utilization of areas already settled." Thus there is a possibility of increasing the area of cropland in Africa south of the Sahara and in Latin America, but

[2] The Cerrado is a large savanna region of Brazil.

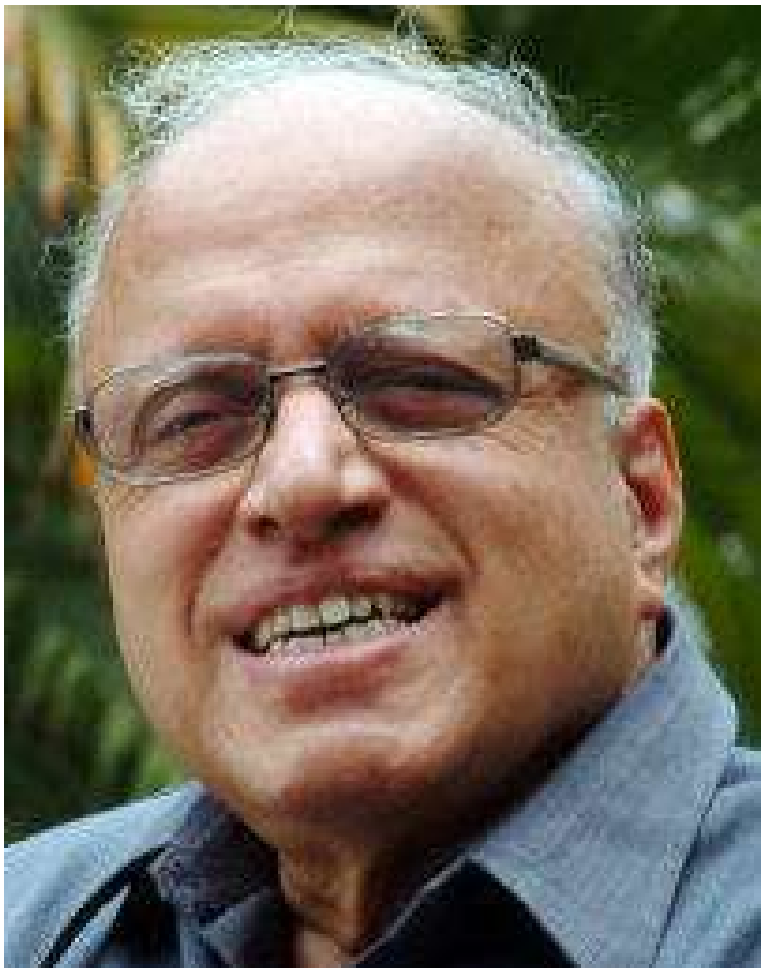

Figure 4.2: **Professor M.S. Swaminathan, father of the Green Revolution in India.** (Open and Shut7)

Figure 4.3: **Norman Borlaug and agronomist George Harrer in 1943.** (Human Wrongs Watch)

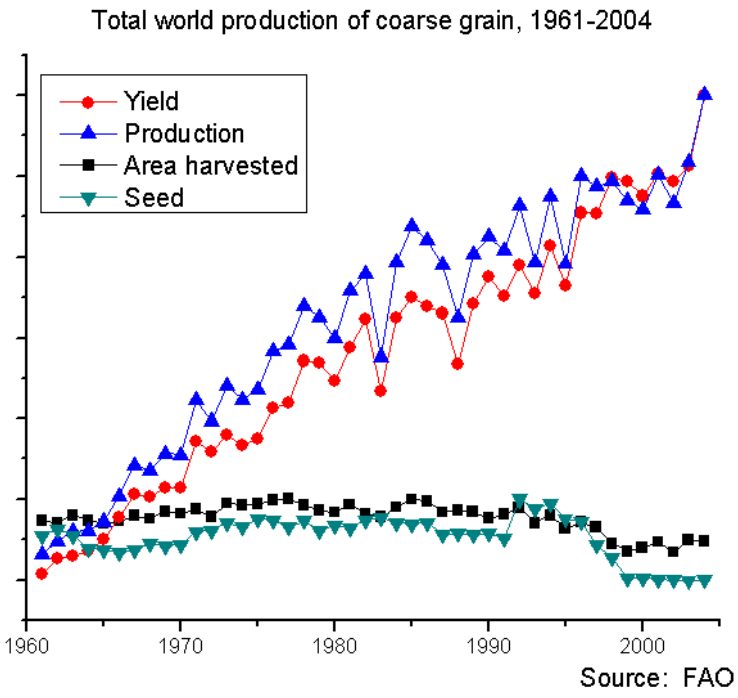

Figure 4.4: **This graph shows the total world production of coarse grain between 1960 and 2004. Because of high-yield varieties, the yield of grain increased greatly. Notice, however, that the land under cultivation remained almost constant. High-yield agriculture depends on large inputs of fossil fuel energy and irrigation, and may be difficult to maintain in the future.** (FAO)

only at the cost of heavy investment and at the additional cost of destruction of tropical rain forests.

Rather than an increase in the global area of cropland, we may encounter a future loss of cropland through soil erosion, salination, desertification, loss of topsoil, depletion of minerals in topsoil, urbanization and failure of water supplies. In China and in the southwestern part of the United States, water tables are falling at an alarming rate. The Ogallala aquifer (which supplies water to many of the plains states in the central and southern parts of the United States) has a yearly overdraft of 160%.

In the 1950's, both the U.S.S.R and Turkey attempted to convert arid grasslands into wheat farms. In both cases, the attempts were defeated by drought and wind erosion, just as the wheat farms of Oklahoma were overcome by drought and dust in the 1930's.

If irrigation of arid lands is not performed with care, salt may be deposited, so that the land is ruined for agriculture. This type of desertification can be seen, for example, in some parts of Pakistan. Another type of desertification can be seen in the Sahel region of Africa, south of the Sahara. Rapid population growth in the Sahel has led to overgrazing, destruction of trees, and wind erosion, so that the land has become unable to support even its original population.

Especially worrying is a prediction of the International Panel on Climate Change concerning the effect of global warming on the availability of water: According to Model A1 of the IPCC, global warming may, by the 2050's, have reduced by as much as 30% the water available in large areas of world that now a large producers of grain[3].

Added to the agricultural and environmental problems, are problems of finance and distribution. Famines can occur even when grain is available somewhere in the world, because those who are threatened with starvation may not be able to pay for the grain, or for its transportation. The economic laws of supply and demand are not able to solve this type of problem. One says that there is no "demand" for the food (meaning demand in the economic sense), even though people are in fact starving.

4.4 Energy-dependence of modern agriculture

Food prices and energy prices

A very serious problem with Green Revolution plant varieties is that they require heavy inputs of pesticides, fertilizers and irrigation. Because of this, the use of high-yield varieties contributes to social inequality, since only rich farmers can afford the necessary inputs. Monocultures, such as the Green Revolution varieties may also prove to be vulnerable to future epidemics of plant diseases, such as the epidemic that caused the Irish Potato Famine in 1845. Even more importantly, pesticides, fertilizers and irrigation all depend on the use of fossil fuels. One must therefore ask whether high agricultural yields can be maintained in the future, when fossil fuels are expected to become prohibitively scarce and expensive.

[3]See the discussion of the Stern Report in Chapter 7.

Modern agriculture has become highly dependent on fossil fuels, especially on petroleum and natural gas. This is especially true of production of the high-yield grain varieties introduced in the Green Revolution, since these require especially large inputs of fertilizers, pesticides and irrigation. Today, fertilizers are produced using oil and natural gas, while pesticides are synthesized from petroleum feedstocks, and irrigation is driven by fossil fuel energy. Thus agriculture in the developed countries has become a process where inputs of fossil fuel energy are converted into food calories. If one focuses only on the farming operations, the fossil fuel energy inputs are distributed as follows:

1. Manufacture of inorganic fertilizer, 31%
2. Operation of field machinery, 19%
3. Transportation, 16%
4. Irrigation, 13%
5. Raising livestock (not including livestock feed), 8%
6. Crop drying, 5%
7. Pesticide production, 5%
8. Miscellaneous, 8%

The ratio of the fossil fuel energy inputs to the food calorie outputs depends on how many energy-using elements of food production are included in the accounting. David Pimental and Mario Giampietro of Cornell University estimated in 1994 that U.S. agriculture required 0.7 kcal of fossil fuel energy inputs to produce 1.0 kcal of food energy. However, this figure was based on U.N. statistics that did not include fertilizer feedstocks, pesticide feedstocks, energy and machinery for drying crops, or electricity, construction and maintenance of farm buildings. A more accurate calculation, including these inputs, gives an input/output ratio of approximately 1.0. Finally, if the energy expended on transportation, packaging and retailing of food is included, Pimental and Giampietro found that the input/output ratio for the U.S. food system was approximately 10, and this figure did not include energy used for cooking.

The Brundtland Report's [4] estimate of the global potential for food production assumes "that the area under food production can be around 1.5 billion hectares (3.7 billion acres - close to the present level), and that the average yields could go up to 5 tons of grain equivalent per hectare (as against the present average of 2 tons of grain equivalent)." In other words, the Brundtland Report assumes an increase in yields by a factor of 2.5. This would perhaps be possible if traditional agriculture could everywhere be replaced by energy-intensive modern agriculture using Green Revolution plant varieties. However, Pimental

[4] World Commission on Environment and Development, *Our Common Future*, Oxford University Press, (1987). This book is often called "The Brundtland Report" after Gro Harlem Brundtland, the head of WCED, who was then Prime Minister of Norway.

and Giampietro's studies show that modern energy-intensive agricultural techniques cannot be maintained after fossil fuels have been exhausted.

At the time when the Brundtland Report was written (1987), the global average of 2 tons of grain equivalent per hectare included much higher yields from the sector using modern agricultural methods. Since energy-intensive petroleum-based agriculture cannot be continued in the post-fossil-fuel era, future average crop yields will probably be much less than 2 tons of grain equivalent per hectare.

The 1987 global population was approximately 5 billion. This population was supported by 3 billion tons of grain equivalent per year. After fossil fuels have been exhausted, the total world agricultural output is likely to be considerably less than that, and therefore the population that it will be possible to support will probably be considerably less than 5 billion, assuming that our average daily per capita use of food calories remains the same, and assuming that the amount of cropland and pasturage remains the same (1.5 billion hectares cropland, 3.0 billion hectares pasturage).

The Brundtland Report points out that "The present (1987) global average consumption of plant energy for food, seed and animal feed amounts to 6,000 calories daily, with a range among countries of 3,000-15,000 calories, depending on the level of meat consumption." Thus there is a certain flexibility in the global population that can survive on a given total agricultural output. If the rich countries were willing to eat less meat, more people could be supported.

4.5 Effects of climate change on agriculture

Effects of temperature increase on crops

There is a danger that when climate change causes both temperature increases and increased aridity in regions like the US grain belt, yields will be very much lowered. Of the three main grain types (corn, wheat and rice) corn is the most vulnerable to the direct effect of increases in temperature. One reason for this is the mechanism of pollination of corn: A pollen grain lands on one end of a corn-silk strand, and the germ cell must travel the length of the strand in order to fertilize the kernel. At high temperatures, the corn silk becomes dried out and withered, and is unable to fulfill its biological function. Furthermore, heat can cause the pores on the underside of the corn leaf to close, so that photosynthesis stops.

According to a study made by Mohan Wali and coworkers at Ohio State University, the photosynthetic activity of corn increases until the temperature reaches 20 degrees Celsius. It then remains constant until the temperature reaches 35 degrees, after which it declines. At 40 degrees and above, photosynthesis stops altogether.

Scientists in the Philippines report that the pollination of rice fails entirely at 40 degrees Celsius, leading to crop failures. Wheat yields are also markedly reduced by temperatures in this range.

Predicted effects on rainfall

According to the Stern Report, some of the major grain-producing areas of the world might loose up to 30% of their rainfall by 2050. These regions include much of the United States, Brazil, the Mediterranean region, Eastern Russia and Belarus, the Middle East, Southern Africa and Australia. Of course possibilities for agriculture may simultaneously increase in other regions, but the net effect of climate change on the world's food supply is predicted to be markedly negative.

Unsustainable use of groundwater

It may seem surprising that fresh water can be regarded as a non-renewable resource. However, groundwater in deep aquifers is often renewed very slowly. Sometimes renewal requires several thousand years. When the rate of withdrawal of groundwater exceeds the rate of renewal, the carrying capacity of the resource has been exceeded, and withdrawal of water becomes analogous to mining a mineral. However, it is more serious than ordinary mining because water is such a necessary support for life.

In many regions of the world today, groundwater is being withdrawn faster than it can be replenished, and important aquifers are being depleted. In China, for example, groundwater levels are falling at an alarming rate. Considerations of water supply in relation to population form the background for China's stringent population policy.

At a recent lecture, Lester Brown of the Worldwatch Institute was asked by a member of the audience to name the resource for which shortages would most quickly become acute. Most of the audience expected him to name oil, but instead he replied "water". Lester Brown then cited China's falling water table. He predicted that within decades, China would be unable to feed itself. He said that this would not cause hunger in China itself: Because of the strength of China's economy, the country would be able to purchase grain on the world market. However Chinese purchases of grain would raise the price, and put world grain out of reach of poor countries in Africa. Thus water shortages in China will produce famine in parts of Africa, Brown predicted.

Under many desert areas of the world are deeply buried water tables formed during glacial periods when the climate of these regions was wetter. These regions include the Middle East and large parts of Africa. Water can be withdrawn from such ancient reservoirs by deep wells and pumping, but only for a limited amount of time.

In oil-rich Saudi Arabia, petroenergy is used to drill wells for ancient water and to bring it to the surface. Much of this water is used to irrigate wheat fields, and this is done to such an extent that Saudi Arabia exports wheat. The country is, in effect, exporting its ancient heritage of water, a policy that it may, in time, regret. A similarly short-sighted project is Muammar Qaddafi's enormous pipeline, which will bring water from ancient sub-desert reservoirs to coastal cities of Libya.

In the United States, the great Ogallala aquifer is being overdrawn. This aquifer is an enormous stratum of water-saturated sand and gravel underlying parts of northern Texas, Oklahoma, New Mexico, Kansas, Colorado, Nebraska, Wyoming and South Dakota. The

Figure 4.5: **Whitechuck Glacier in the North Cascades National Park in 1973.** (Nicholas College)

Figure 4.6: **The same glacier in 2006** (Nicholas College)

average thickness of the aquifer is about 70 meters. The rate of water withdrawal from the aquifer exceeds the rate of recharge by a factor of eight.

Thus we can see that in many regions, the earth's present population is living on its inheritance of water, rather than its income. This fact, coupled with rapidly increasing populations and climate change, may contribute to a food crisis partway through the 21st century.

Glacial melting and summer water supplies

The summer water supplies of both China and India are threatened by the melting of glaciers. The Gangotri glacier, which is the principle glacier feeding India's great Ganges River, is reported to be melting at an accelerating rate, and it could disappear within a few decades. If this happens,the Ganges could become seasonal, flowing only during the

monsoon season.

Chinese agriculture is also threatened by disappearing Himalayan glaciers, in this case those on the Tibet-Quinghai Plateau. The respected Chinese glaciologist Yao Tandong estimates that the glaciers feeding the Yangtze and Yellow Rivers are disappearing at the rate of 7% per year.

The Indus and Mekong Rivers will be similarly affected by the melting of glaciers. Lack of water during the summer season could have a serious impact on the irrigation of rice and wheat fields.

Forest loss and climate change

Mature forests contain vast amounts of sequestered carbon, not only in their trees, but also in the carbon-rich soil of the forest floor. When a forest is logged or burned to make way for agriculture, this carbon is released into the atmosphere. One fifth of the global carbon emissions are at present due to destruction of forests. This amount is greater than the CO_2 emissions for the world's transportation systems.

An intact forest pumps water back into the atmosphere, increasing inland rainfall and benefiting agriculture. By contrast, deforestation, for example in the Amazonian rainforest, accelerates the flow of water back into the ocean, thus reducing inland rainfall. There is a danger that the Amazonian rainforest may be destroyed to such an extent that the region will become much more dry. If this happens, the forest may become vulnerable to fires produced by lightning strikes. This is one of the feedback loops against which the Stern Report warns - the drying and burning of the Amazonian rainforest may become irreversible, greatly accelerating climate change, if destruction of the forest proceeds beyond a certain point.

Erosion of topsoil

Besides depending on an adequate supply of water, food production also depends on the condition of the thin layer of topsoil that covers the world's croplands. This topsoil is being degraded and eroded at an alarming rate: According to the World Resources Institute and the United Nations Environment Programme, "It is estimated that since World War II, 1.2 billion hectares... has suffered at least moderate degradation as a result of human activity. This is a vast area, roughly the size of China and India combined." This area is 27% of the total area currently devoted to agriculture [5]. The report goes on to say that the degradation is greatest in Africa.

The risk of topsoil erosion is greatest when marginal land is brought into cultivation, since marginal land is usually on steep hillsides which are vulnerable to water erosion when wild vegetation is removed.

David Pimental and his associates at Cornell University pointed out in 1995 that "Because of erosion-associated loss of productivity and population growth, the per capita food

[5]The total area devoted to agriculture throughout the world is 1.5 billion hectares of cropland and 3.0 billion hectares of pasturage.

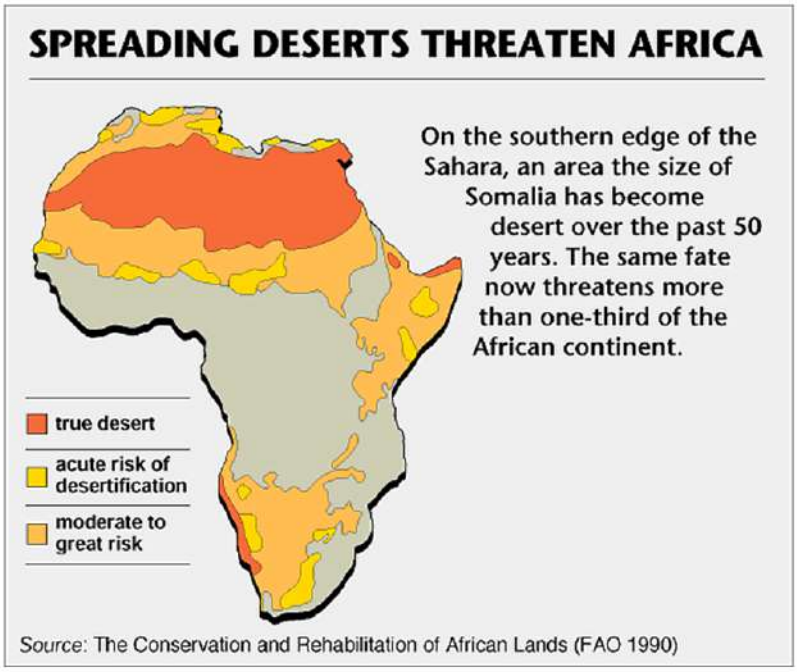

Figure 4.7: **Desert regions of the Africa that are in danger of spreading.** (FAO)

supply has been reduced over the past 10 years and continues to fall. The Food and Agricultural Organization reports that the per capita production of grains which make up 80% of the world's food supply, has been declining since 1984."

Pimental et al. add that "Not only is the availability of cropland per capita decreasing as the world population grows, but arable land is being lost due to excessive pressure on the environment. For instance, during the past 40 years nearly one-third of the world's cropland (1.5 billion hectares) has been abandoned because of soil erosion and degradation. Most of the replacement has come from marginal land made available by removing forests. Agriculture accounts for 80% of the annual deforestation."

Topsoil can also be degraded by the accumulation of salt when irrigation water evaporates. The worldwide area of irrigated land has increased from 8 million hectares in 1800 to more than 100 million hectares today. This land is especially important to the world food supply because it is carefully tended and yields are large in proportion to the area. To protect this land from salination, it should be irrigated in such a way that evaporation is minimized.

Finally cropland with valuable topsoil is being be lost to urban growth and highway development, a problem that is made more severe by growing populations and by economic growth.

Laterization

Every year, more than 100,000 square kilometers of rain forest are cleared and burned, an area which corresponds to that of Switzerland and the Netherlands combined. Almost half of the world's tropical forests have already been destroyed. Ironically, the land thus cleared often becomes unsuitable for agriculture within a few years.

Tropical soils may seem to be fertile when covered with luxuriant vegetation, but they are usually very poor in nutrients because of leeching by heavy rains. The nutrients which remain are contained in the vegetation itself; and when the forest cover is cut and burned, the nutrients are rapidly lost.

Often the remaining soil is rich in aluminum oxide and iron oxide. When such soils are exposed to oxygen and sun-baking, a rocklike substance called Laterite is formed. The temples of Angkor Wat in Cambodia are built of Laterite; and it is thought that laterization of the soil contributed to the disappearance of the Khmer civilization, which built these temples.

4.6 Harmful effects of industrialized farming

A major global public health crisis may soon be produced by the wholesale use of antibiotics in the food of healthy farm animals. The resistance factors produced by shovelling antibiotics into animal food produces resistance factors (plasmids) which can easily be transferred to human pathogens. A related problem is the excessive use of pesticides and artificial fossil-fuel-derived fertilizers in agriculture. Pharming is not a joke. It is a serious threat.[6]

Plasmids

Bacteria belong to a class of organisms (prokaryotes) whose cells do not have a nucleus. Instead, the DNA of the bacterial chromosome is arranged in a large loop. In the early 1950's, Joshua Lederberg discovered that bacteria can exchange genetic information. He found that a frequently-exchanged gene, the F-factor (which conferred fertility), was not linked to other bacterial genes; and he deduced that the DNA of the F-factor was not physically a part of the main bacterial chromosome. In 1952, Lederberg coined the word "plasmid" to denote any extrachromosomal genetic system.

[6] http://ecowatch.com/2014/03/06/misuse-antibiotics-fatal-superbug-crisis/
http://ecowatch.com/2013/12/06/8-scary-facts-about-antibiotic-resistance/
http://ecowatch.com/2015/03/27/obama-fight-superbug-crisis/
http://ecowatch.com/2014/03/12/fda-regulation-antibiotics-factory-farms/
http://www.bbc.com/news/health-35153795
http://www.bbc.com/news/health-21702647
http://www.bbc.com/news/health-34857015
http://sustainableagriculture.net/about-us/
https://pwccc.wordpress.com/programa/

In 1959, it was discovered in Japan that genes for resistance to antibiotics can be exchanged between bacteria; and the name "R-factors" was given to these genes. Like the F-factors, the R-factors did not seem to be part of the main loop of bacterial DNA.

Because of the medical implications of this discovery, much attention was focused on the R-factors. It was found that they were plasmids, small loops of DNA existing inside the bacterial cell, but not attached to the bacterial chromosome. Further study showed that, in general, between one percent and three percent of bacterial genetic information is carried by plasmids, which can be exchanged freely even between different species of bacteria.

In the words of the microbiologist, Richard Novick, "Appreciation of the role of plasmids has produced a rather dramatic shift in biologists' thinking about genetics. The traditional view was that the genetic makeup of a species was about the same from one cell to another, and was constant over long periods of time. Now a significant proportion of genetic traits are known to be variable (present in some individual cells or strains, absent in others), labile (subject to frequent loss or gain) and mobile, all because those traits are associated with plasmids or other atypical genetic systems."

Because of the ease with which plasmids conferring resistance to antibiotics can be transferred from animal bacteria to the bacteria carrying human disease, the practice of feeding antibiotics to healthy farm animals is becoming a major human health hazard. The World Health Organization has warned that if we lose effective antibiotics through this mechanism, "Many common infections will no longer have a cure, and could kill unabated". The US Center for Disease Control has pointed to the emergence of "nightmare bacteria", and the chief medical officer for England Prof Dame Sally Davies has evoked parallels with the "apocalypse".

Pesticides, artificial fertilizers and topsoil

A closely analogous danger results from the overuse of pesticides and petroleum-derived fertilizers in agriculture. A very serious problem with Green Revolution plant varieties is that they require heavy inputs of pesticides, fertilizers and irrigation. Because of this, the use of high-yield varieties contributes to social inequality, since only rich farmers can afford the necessary inputs. Monocultures, such as the Green Revolution varieties may also prove to be vulnerable to future plant diseases, such as the epidemic that caused the Irish Potato Famine in 1845. Even more importantly, pesticides, fertilizers and irrigation all depend on the use of fossil fuels. One must ask, therefore, whether high-yield agriculture can be maintained in the post-fossil-fuel era.

Topsoil is degraded by excessive use of pesticides and artificial fertilizers. Natural topsoil is rich in organic material, which contains sequestered carbon that would otherwise be present in our atmosphere in the form of greenhouse gases. In addition, natural topsoil contains an extraordinarily rich diversity of bacteria and worms that act to convert agricultural wastes from one year's harvest into nutrients for the growth of next year's crop. Pesticides kill these vital organisms, and make the use of artificial fertilizers necessary.

Finally, many small individual farmers, whose methods are sustainable, are being eliminated by secret land-grabs or put out of business because they cannot compete with unsustainable high-yield agriculture. Traditional agriculture contains a wealth of knowledge and biodiversity, which it would be wise for the world to preserve.

4.7 The demographic transition

The phrase "developing countries" is more than a euphemism; it expresses the hope that with the help of a transfer of technology from the industrialized nations, all parts of the world can achieve prosperity. Some of the forces that block this hope have just been mentioned. Another factor that prevents the achievement of worldwide prosperity is population growth.

In the words of Dr. Halfdan Mahler, former Director General of the World Health Organization, "Country after country has seen painfully achieved increases in total output, food production, health and educational facilities and employment opportunities reduced or nullified by excessive population growth."

The growth of population is linked to excessive urbanization, infrastructure failures and unemployment. In rural districts in the developing countries, family farms are often divided among a growing number of heirs until they can no longer be subdivided. Those family members who are no longer needed on the land have no alternative except migration to overcrowded cities, where the infrastructure is unable to cope so many new arrivals. Often the new migrants are forced to live in excrement-filled makeshift slums, where dysentery, hepatitis and typhoid are endemic, and where the conditions for human life sink to the lowest imaginable level. In Brazil, such shanty towns are called "favelas".

If modern farming methods are introduced in rural areas while population growth continues, the exodus to cities is aggravated, since modern techniques are less labor-intensive and favor large farms. In cities, the development of adequate infrastructure requires time, and it becomes a hopeless task if populations are growing rapidly. Thus, population stabilization is a necessary first step for development.

It can be observed that birth rates fall as countries develop. However, development is sometimes blocked by the same high birth rates that economic progress might have prevented. In this situation (known as the "demographic trap"), economic gains disappear immediately because of the demands of an exploding population.

For countries caught in the demographic trap, government birth control programs are especially important, because one cannot rely on improved social conditions to slow birth rates. Since health and lowered birth rates should be linked, it is appropriate that family-planning should be an important part of programs for public health and economic development.

A recent study conducted by Robert F. Lapham of Demographic Health Surveys and W. Parker Maudlin of the Rockefeller Foundation has shown that the use of birth control is correlated both with socio-economic setting and with the existence of strong family-planning programs. The implication of this study is that even in the absence of increased

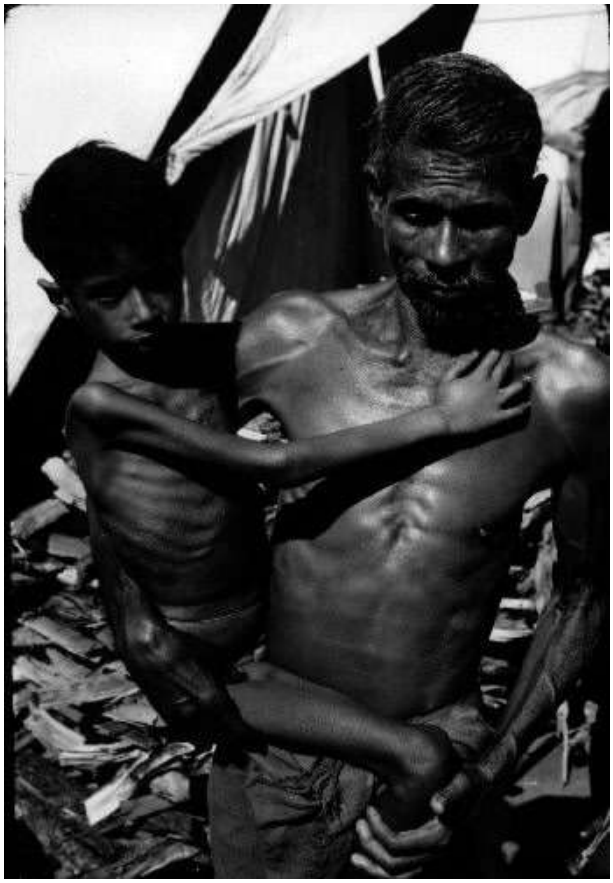

Figure 4.8: **Child suffering with the deficiency disease Marasmus in India.** (Public domain)

Figure 4.9: **Education of women and higher status for women are vitally important measures, not only for their own sake, but also because these social reforms have proved to be the key to lower birth rates.** (Kundan Srivastava)

living standards, family-planning programs can be successful, provided they have strong government support.

China, the world's most populous nation, has adopted the somewhat draconian policy of allowing only one child for families in living in towns and cities (35.9% of the population). Chinese leaders obtained popular support for their one-child policy by means of an educational program which emphasized future projections of diminishing water resources and diminishing cropland per person if population increased unchecked. Like other developing countries, China has a very young population, which will continue to grow even when fertility has fallen below the replacement level because so many of its members are contributing to the birth rate rather than to the death rate. China's present population is 1.3 billion. Its projected population for the year 2025 is 1.5 billion. China's one-child policy is supported by 75% of the country's people, but the methods of enforcement are sometimes criticized, and it has led to a M/F sex ratio of 1.17/1.00. The natural baseline for the sex ratio ranges between 1.03/1.00 and 1.07/1.00.

Education of women and higher status for women are vitally important measures, not only for their own sake, but also because in many countries these social reforms have proved to be the key to lower birth rates. Religious leaders who oppose programs for the education of women and for family planning on "ethical" grounds should think carefully about the scope and consequences of the catastrophic global famine which will undoubtedly occur within the next 50 years if population is allowed to increase unchecked. Do these leaders really wish to be responsible for the suffering and death from starvation of hundreds of millions of people?

At the United Nations Conference on Population and Development, held in Cairo in September, 1994, a theme which emerged very clearly was that one of the most important

keys to controlling the global population explosion is giving women better education and equal rights. These goals are desirable for the sake of increased human happiness, and for the sake of the uniquely life-oriented point of view which women can give us; but in addition, education and improved status for women have shown themselves to be closely connected with lowered birth rates. When women lack education and independent careers outside the home, they can be forced into the role of baby-producing machines by men who do not share in the drudgery of cooking, washing and cleaning; but when women have educational, legal, economic, social and political equality with men, experience has shown that they choose to limit their families to a moderate size.

Sir Partha Dasgupta of Cambridge University has pointed out that the changes needed to break the cycle of overpopulation and poverty are all desirable in themselves. Besides education and higher status for women, they include state-provided social security for old people, provision of water supplies near to dwellings, provision of health services to all, abolition of child labor and general economic development.

The UN Summit on Addressing Large Movements of Refugees and Migrants

On September 19, 2016, the United Nations General Assembly held a 1-day summit meeting to address the pressing problem of refugees. It is a problem that has been made acute by armed conflicts in the Middle East and Africa, and by climate change.

One of the outcomes of the summit was the a Declaration for Refugees and Migrants. Here is a statement of the severity of the problem from paragraph 3 of the Declaration:

"We are witnessing in today's world an unprecedented level of human mobility. More people than ever before live in a country other than the one in which they were born. Migrants are present in all countries of the world. Most of them move without incident. In 2015, their number surpassed 244 million, growing at a rate faster than the world's population. However, there are 65 million forcibly displaced persons, including over 21 million refugees, 3 million asylum seekers and over 40 million internally displaced persons."

Sadly, the world's response to the tragic plight of refugees fleeing from zones of armed conflict has been less than generous. Men, women and many children, trying to escape from almost certain death in the war-torn Middle East, have been met, not with sympathy and kindness, but with barbed wire and tear gas.

Germany's Chancellor, Angela Merkel, courageously made arrangements for her country to accept a large number of refugees, but as a consequence her party has suffered political setbacks. On the whole, European governments have moved to the right, as anti-refugee parties gained strength. The United States, Canada Australia and Russia, countries that could potentially save the lives of many refugees, have accepted almost none. In contrast, tiny Lebanon, despite all its problems, has become the home of so many refugees that they are a very large fraction of the country's total population.

As the effects of climate change become more pronounced, we can expect the suffering and hopelessness of refugees to become even more severe. This is a challenge which the

world must meet with humanity and solidarity.

The World Cities Report, 2016

According to the World Cities Report[7], by 2030, two thirds of the world's population will be living in cities. As the urban population increases, the land area occupied by cities is increasing at a higher rate. It is projected that by 2030, the urban population of developing countries will double, while the area covered by cites could triple.

Commenting on this, the UN-Habitat Executive Director, Joan Clos, said: "In the twenty years since the Habitat II conference, the world has seen a gathering of its population in urban areas. This has been accompanied by socioeconomic growth in many instances. But the urban landscape is changing and with it, the pressing need for a cohesive and realistic approach to urbanization".

"Such urban expansion is wasteful in terms of land and energy consumption and increases greenhouse gas emissions. The urban centre of gravity, at least for megacities, has shifted to the developing regions."

One can foresee that in the future, as fossil fuels become increasingly scarce, the problem of feeding urban populations will become acute.

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[7]http://wcr.unhabitat.org/

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Chapter 5

SIR DAVID ATTENBOROUGH

5.1 The message of Sir David Attenborough

Sir David Attenborough's films which have been broadcast by the BBC

- **Life on Earth (1979)**
- **The Living Planet (1984)**
- **The Trials of Life (1990)**
- **Life in the Freezer (1993)**
- **The Private Life of Plants (1995)**
- **The Life of Birds (1998)**
- **The Life of Mammals (2002)**
- **Life in the Undergrowth (2005)**
- **Life in Cold Blood (2008)**
- **Zoo Quest (1954-63)**
- **The People of Paradise (1960)**
- **The World About Us (1967)**
- **The Miracle of Bali (1969)**
- **The Tribal Eye (1975)**
- **Wildlife on One (1977)**
- **The First Eden (1987)**
- **Lost Worlds, Vanished Lives (1989)**
- **BBC Wildlife Specials (1995-2008)**
- **The Lost Gods of Easter Island (2000)**
- **State of the Planet (2000)**
- **The Blue Planet (2001)**
- **Planet Earth (2006)**
- **Are We Changing Planet Earth? (2006)**
- **Charles Darwin and the Tree of Life (2009)**
- **Nature's Great Events (2009)**

- **Life (2009)**
- **First Life (2010)**
- **Flying Monsters 3D (2010)**
- **The Penguin King (2011)**
- **Kingdom of Plants 3D (2012)**
- **Galapagos 3D (2013)**
- **David Attenborough's Natural History Museum Alive (2014)**
- **Madagascar (2011)**
- **Frozen Planet (2011)**
- **Attenborough: 60 Years in the Wild (2012)**
- **Africa (2013)**
- **David Attenborough's Natural Curiosities (episodes) (2013-)**
- **David Attenborough's Rise of Animals: Triumph of the Vertebrates (2013)**
- **When Björk Met Attenborough (2013)**
- **Life Story (2014) The Hunt (2015)**
- **Great Barrier Reef (2015)**
- **Planet Earth II (2016)**
- **Blue Planet II (2017)**
- **Dynasties (2018)**
- **Our Planet (2019)**
- **Climate Change - The Facts (2019)**

5.2 Books by Sir David Attenborough

- **Zoo Quest to Guyana (1956)**
- **Zoo Quest for a Dragon (1957) - republished in 1959 to include an additional 85 pages titled Quest for the Paradise Birds**
- **Zoo Quest in Paraguay (1959)**
- **Quest in Paradise (1960)**
- **People of Paradise (1960)**
- **Zoo Quest to Madagascar (1961)**
- **Quest Under Capricorn (1963)**
- **Fabulous Animals (1975)**
- **The Tribal Eye (1976)**
- **Life on Earth (1979)**
- **Discovering Life on Earth (1981)**
- **The Living Planet (1984)**
- **The First Eden: The Mediterranean World and Man (1987)**
- **The Atlas of the Living World (1989)**
- **The Trials of Life (1990)**
- **The Private Life of Plants (1994)**
- **The Life of Birds (1998)**

- **The Life of Mammals (2002)**
- **Life on Air: Memoirs of a Broadcaster (2002) - autobiography, revised in 2009**
- **Life in the Undergrowth (2005)**
- **Amazing Rare Things: The Art of Natural History in the Age of Discovery (2007) - with Susan Owens, Martin Clayton and Rea Alexandratos**
- **Life in Cold Blood (2007)**
- **David Attenborough's Life Stories (2009)**
- **David Attenborough's New Life Stories (2011)**
- **Drawn From Paradise: The Discovery, Art and Natural History of the Birds of Paradise (2012) - with Errol Fuller**
- **Adventures of a Young Naturalist: The Zoo Quest Expeditions (2017)**
- **Journeys to the Other Side of the World: Further Adventures of a Young Naturalist (2018)**
- **Dynasties: The Rise and Fall of Animal Families with Stephen Moss (BBC Books, 2018)**

Sir David Attenborough's almost unbelievably enormous and impressive opus of television programs about the natural world have helped to raise public awareness of the importance of the natural environment. He also has made a number of television programs specifically related to questions such as saving threatened species, the dangers of exploding global human populations, and the destruction of forests for the sake of palm oil plantations.

5.3 The Blue Planet

The BBC has recently produced Sir David Attenborough's new series, *Blue Planet II*, which focuses on environmental issues in connection with our oceans.[1]

"My hope is that the world is coming to its senses ... I'm so old I remember a time when ... we didn't talk about climate change, we talked about animals and species extermination," Sir David told Greenpeace in an interview, "For the first time I'm beginning to think there is actually a groundswell, there is a change in the public view. I feel many more people are concerned and more aware of what the problems are. Young people - people who've got 50 years of their life ahead of them - they are thinking they ought to be doing something about this. That's a huge change."

[1] http://www.bbcearth.com/blueplanet2/

Figure 5.1: **Speaking at the opening ceremony of COP24, the universally loved and respected naturalist Sir David Attenborough said: "If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon."**

5.4 Sir David testifies in Parliament

Referencing the rise of climate science denial in some countries while giving evidence to a committee of MPs in the UK, Attenborough said he was "sorry that there are people in power and internationally, notably the United States, but also in Australia".

Attenborough also said it would be "a very sad day" if President Donald Trump succeeded in withdrawing the US from the Paris Agreement, praising the UN process as an example of international cooperation.

He accused climate science deniers of cherry-picking their data, arguing it isn't proof to find a particular example of where glaciers had grown, rather than shrunk. "The proof is in the graphs, the proof is in the scientific records, the proof is in when you analyze bubbles from the sea ice and glacier ice to show you what has happened to the climate over the years," he added.

Asked if flights would have to become more expensive, to the point that normal families could no longer afford an annual holiday in France or Spain, he replied: "I don't know how you would restrict air travel other than economically, so I am afraid that is the case, yes."

He told the Business, Energy and Industrial Strategy Committee: "There's a huge change in public perception. I suspect we are right now in the beginning of a big change."

Sir David credited young people for bringing about the change, saying the electorate of tomorrow already understand the changes that need to be made.

Figure 5.2: **Sir David Attenborough testifying at the British Parliament in July, 2019**

5.5 Some things that Sir David Attenborough has said

The future of life on earth depends on our ability to take action. Many individuals are doing what they can, but real success can only come if there's a change in our societies and our economics and in our politics. I've been lucky in my lifetime to see some of the greatest spectacles that the natural world has to offer. Surely we have a responsibility to leave for future generations a planet that is healthy, inhabitable by all species.

Three and a half million years separate the individual who left these footprints in the sands of Africa from the one who left them on the moon. A mere blink in the eye of evolution. Using his burgeoning intelligence, this most successful of all mammals has exploited the environment to produce food for an ever-increasing population. In spite of disasters when civilizations have over-reached themselves, that process has continued, indeed accelerated, even today. Now mankind is looking for food, not just on this planet but on others. Perhaps the time has now come to put that process into reverse. Instead of controlling the environment for the benefit of the population, perhaps it's time we control the population to allow the survival of the environment.

The growth in human numbers is frightening. I've seen wildlife under mounting human pressure all over the world, and it's not just from human economy or technology. Behind every threat is the frightening explosion in human numbers. I've never seen a problem that wouldn't be easier to solve with fewer people - or harder, and ultimately impossible, with more.

We cannot continue to deny the problem. People have pushed aside the question of population sustainability and not considered it because it is too awkward, embarrassing and difficult. But we have to talk about it.

We are a plague on the Earth. It's coming home to roost over the next 50 years or so. It's not just climate change; it's sheer space, places to grow food for this enormous horde. Either we limit our population growth or the natural world will do it for us, and the natural world is doing it for us right now.

5.6 Extinction: The Facts

In his newest documentary, Sir David presents the stark facts about the current rate of extinction of species.

Here is a quotation from an article by Andrea D. Steffen entitled *Sir David Attenborough's Heartbreaking New Film On Extinction Is A Must See* and published on September 18, 2020[2]:

The now 94-year-old David Attenborough presents us all with a new film called *Extinction: The Facts*. And while Britain's favorite naturalist spent the last seven decades delivering programs about the world's national treasures, this time, it's a hard-hitting documentary warning about species extinction.

The new BBC film begins with heartbreaking footage of devastation with animals battling for survival because of the impact humans inflict on the natural world. It then goes on to explain how serious the state of nature is, why it matters, and what needs to change.

It links the rise of crises like the coronavirus pandemic, food shortage, poverty, and catastrophic weather events to mankind's encroachment on natural habitats and the destruction of biodiversity. It highlights how species extinction undermines human progress but also points out that this desperate situation can be turned around.

[2]https://www.intelligentliving.co/david-attenboroughs-film-extinction/

Figure 5.3: **94-year-old Sir David Attenborough issues a stark warning in *Extinction: The Facts*.**

Another article reviewing *Extinction: The Facts*

And here is a quotation from an article by Sally Ho entitled *Sir David Attenborough Warns Of Extinction Crisis In Latest BBC Documentary*, published on September 18, 2020[3]:

"In his most recent return to television screens, Sir David Attenborough warns the world about the crisis our planet is in. Premiered on the BBC last weekend, the documentary saw the legendary naturalist deliver a stark message about mass biodiversity loss and the consequences that the world will face as a result.

"Unlike his usual productions that tracks the wonders and beauty of the natural world, Attenborough's latest documentary titled Extinction: The Facts has a radically different tone. 'We are facing a crisis,' he says at the very start of the film. 'One that has consequences for us all.'

"Over the course of the one-hour programme, Attenborough takes viewers on a journey through scenes of destruction due to humankind's activities on Earth. In one scene, monkeys jump from trees into a river in order to make a hasty escape from a wildfire, while another sequence shows a koala struggling to find

[3]https://www.greenqueen.com.hk/david-attenborough-warning-extinction-crisis-latest-bbc-documentary/

shelter as its natural habitat is ablaze.

"There are an estimated 8 million species inhabiting our planet, the film tells us, and almost one million are now already threatened with extinction. Since the 1970s, vertebrate animals have declined by at least 60%. That's within the past few decades.

"While species do naturally go extinct, Attenborough says that the current rate of extinction is speeding up at such a dramatic rate that it now exceeds the natural course by 100 times - and this figure is still on the rise. In a study published in June this year, scientists said that 500 land animal species are now on the verge of disappearing forever in just 20 years.

"'Over the course of my life I've encountered some of the world's most remarkable species of animals. Only now do I realise just how lucky I've been - many of these wonders seem set to disappear forever,' he remarks in the film.

"Biodiversity loss will not only mean that we will no longer be able to appreciate the different creatures, flora and fauna in nature, but will also impact our own survival too. The loss of nature's pollinators, such as wild bees, could threaten the crops that we depend on for food, or other plants that help regulate water flow and produce the oxygen we need.

"The coronavirus pandemic is another clear instance of the dangers that come with the rampant destruction of nature and wildlife, a warning many scientists and experts have raised alarm bells about in recent months.

"However, as with all Attenborough's films, Extinction: The Facts ended with a clear message that there is still hope as long as immediate action takes place. 'I may not be here to see it. But if we make the right decisions at this critical moment, we can safeguard our planet's ecosystems, its extraordinary biodiversity and all its inhabitants.'

"Ending with a powerful line, Attenborough said: 'What happens next is up to every one of us'."

A Life On Our Planet

Here is a quotation from an article by Sally Ho entitled *David Attenborough Urges People To Ditch Meat In New Film*, published on 2 September, 2020[4]:

[4]https://www.greenqueen.com.hk/sir-david-attenborough-urges-people-to-ditch-meat-in-new-film/

In his upcoming documentary, the legendary Sir David Attenborough calls for a mass dietary shift to plant-based foods in order to re-wild the Earth and save the planet. Called *A Life On Our Planet*, 94-year-old stresses in the film that humans can no longer wait to take drastic action if we are to avoid complete climate and ecological breakdown, and that it has become increasingly clear that the planet simply 'can't support billions of meat-eaters.'

***A Life On Our Planet* is described as Attenborough's most personal exploration into his decades-long career documenting the destruction of wildlife and the environment and his 'witness statement' for the natural world. Set to premiere on Netflix later this year, the WWF and Silverback Films co-produced documentary comes with a bold message from Attenborough that humans must make dramatic changes to our diets in order to save the planet.**

'I had the most extraordinary life. It's only now I appreciate how extraordinary. The living world is a unique and spectacular marvel,' he says in the movie trailer. 'Yet, the way we humans live on earth is sending it into a decline. Human needs have overrun the world.'

But Attenborough makes clear that this film is not meant to guilt viewers into changing their habits. It's a documentary aimed at showing how each and every one of us can act right now.

'If we act now we can yet put it right. Our planet is headed for disaster. We need to learn how to work with nature rather than against it and I'm going to tell you how,' the wildlife broadcaster, filmmaker and environmentalist said.

His advice to the world, which is revealed in the movie trailer, is to reduce meat consumption or make a full switch to a vegetarian or vegan diet. 'We must radically reduce the way we farm. We must change our diet. The planet can't support billions of meat-eaters.'

While Attenborough himself does not consider himself a 'doctrinaire' vegetarian or vegan, he revealed in a recent interview that he does not have the same appetite for animal meat anymore due to the state of the planet and the realisation of the enormous damage the meat industry has caused.

5.7 Climate Change - The Facts

Here are some quotations from an article describing Sir David's 2019 documentary film[5]

This Earth Day, Sir David Attenborough hosts a compelling documentary on PBS, "Climate Change - The Facts." The new film dives into one of the globe's most pressing issues, our changing climate. Leading climate scientists come together to discuss what may happen if global warming increases by 1.5

[5]https://www.pbs.org/wnet/nature/blog/david-attenborough-on-how-our-changing-climate-affects-wildlife/

degrees. While that figure might not seem drastic, the impacts of this rise in temperature are significant both in terms of scale and scope, especially with regards to animals and their ecosystems. Experts examine the consequences of rising temperatures on ice sheets, fragile ecosystems, developing communities and extreme weather events.

Extreme weather events have an impact on ecosystems. For example, an extreme heatwave engulfed Cairns, Australia, in November 2019, with temperatures hitting 42 degrees Celsius (about 108 degrees Fahrenheit). Even animals that are specifically adapted to extreme heat were unable to survive, including flying foxes. Like all species, flying foxes have ways of dealing with the conditions of their environment. But their cooling methods proved to not be enough for the extreme heat. While conservationists work to save about 350 animals, over 11,000 flying foxes died as a result.

"I've seen for myself that in addition to the many other threats they face, animals of all kinds are now struggling to adapt to rapidly changing conditions, Attenborough said in the film.

Certain locations, including those around the equator, are becoming increasingly uninhabitable as temperatures rise, University of Exeter Professor Catherin Mitchell explains in the film. With global temperatures rising at an increasing rate, animals are not able to keep up with the changing climate. Scientists believe that 8% of animals are at risk of extinction solely due to climate change. The loss of even the smallest organism destabilizes and increases the risk of a potential collapse of the world's ecosystem, which holds together life on Earth.

In recent years, record-breaking hurricanes, extreme coastal flooding and devastating wildfires, such as in California and Australia, have left irreversible damage on the affected areas. As extreme weather events like these continue to increase across the globe, many wonder if these events are caused by climate change. Scientists are unable to definitively answer whether the increase in these extreme weather events is caused by climate change, but evidence suggests a connection. In the film, scientists discuss the relationship between climate change and the increase in extreme weather, hinting it may at least exacerbate the tumultuous situation with rising temperatures and sea levels.

"In the 20 years since I first started talking about the impact of climate change on our world, conditions have changed far faster than I ever imagined," said Sir David Attenborough in the new documentary. "It may sound frightening, but the scientific evidence is that if we have not taken dramatic action within the next decade, we could face irreversible damage to the natural world and the collapse of our societies. We're running out of time, but there is still hope."

Suggestions for further reading

1. *David Attenborough's First Life: A Journey Back in Time with Matt Kaplan* Kindle Edition by Matt Kaplan
2. *Life on Earth: A Natural History* (Book Club Associates Edition) Hardcover - 1979 by Sir David Attenborough
3. *Discovering Life on Earth* Hardcover - 23 Nov 1981 by Sir David Attenborough
4. *Life Stories* (2009) Hardcover by Sir David Attenborough.
5. *The Trials of Life: A Natural History of Animal Behaviour* by David Attenborough (4-Oct-1990) Hardcover
6. By Sir David Attenborough - *The Living Planet (New edition)* Paperback - 25 Mar 1992

Chapter 6

GRETA THUNBERG

6.1 Greta Thunberg's TED talk

Greta Thunberg was born in Sweden in 2003. Her father, Svante Thunberg, is related to Svante Arrhenius, one of the important pioneers of climate science, and is named after him. Greta's mother was a successful opera singer. Greta Thunberg's strong belief in the urgency of action to prevent catastrophic climate change converted her parents, so that they made changes in their lives. For example, Greta's mother gave up her career as an opera singer because it involved air travel.

In November, 2018, Greta Thunberg gave an impressively clear TEDx talk in Stockholm, the video of which was recently released.[1]. Here is a transcript of the talk.

When I was about 8 years old, I first heard about something called 'climate change' or 'global warming'. Apparently, that was something humans had created by our way of living. I was told to turn off the lights to save energy and to recycle paper to save resources. I remember thinking that it was very strange that humans, who are an animal species among others, could be capable of changing the Earth's climate. Because, if we were, and if it was really happening, we wouldn't be talking about anything else. As soon as you turn on the TV, everything would be about that. Headlines, radio, newspapers: You would never read or hear about anything else. As if there was a world war going on, but no one ever talked about it. If burning fossil fuels was so bad that it threatened our very existence, how could we just continue like before? Why were there no restrictions? Why wasn't it made illegal?

To me, that did not add up. It was too unreal.

So, when I was 11, I became ill, I fell into depression, I stopped talking, and I stopped eating. In two months, I lost about 10 kilos of weight. Later on, I was diagnosed with Asperger's syndrome, OCD and selective mutism. This

[1] https://www.dailykos.com/stories/2018/12/16/1819508/-A-Call-to-Action-on-Climate-Change-by-15-year-Old-Greta-Thunberg

basically means, I only speak, when I think it is necessary.

Now is one of those moments.

For those of us, who are on the spectrum, almost everything is black or white. We aren't very good at lying and we usually don't enjoy participating in the social games that the rest of you seem so fond of. I think, in many ways, that we autistic are the normal ones and the rest of the people are pretty strange. Especially when it comes to the sustainability crisis: Where everyone keeps saying that climate change is an existential threat and the most important issue of all. And yet, they just carry on like before.

I don't understand that. Because if the emissions have to stop, then we must stop the emissions. To me, that is black or white. There are no gray areas when it comes to survival. Either we go on as a civilization or we don't.

We have to change.

Rich countries like Sweden need to start reducing emissions by at least 15% every year. And that is so that we can stay below a 2 degrees warming target. Yet, as the IPCC has recently demonstrated, aiming instead for 1.5 degrees Celsius would significantly reduce the climate impacts. But we can only imagine what that means for reducing emissions.

You would think the media and every one of our leaders would be talking about nothing else. But they never even mention it.

Nor does anyone ever mentioned the greenhouse gases already locked in the system. Nor that air pollution is hiding some warming; so that, when we stop burning fossil fuels, we already have an extra level of warming - perhaps as high as 0.5 to 1.1 degrees Celsius.

Furthermore, does hardly anyone speak about the fact that we are in the midst of the sixth mass extinction: With up to 200 species going extinct every single day. That the extinction rate is today between 1000 and 10,000 times higher than what is seen as normal.

Nor does hardly anyone ever speak about the aspect of equity or climate justice, clearly stated everywhere in the Paris agreement, which is absolutely necessary to make it work on a global scale. That means that rich countries need to get down to zero emissions within 6 to 12 years with today's emission speed. And that is so that people in poorer countries can have a chance to heighten their standard of living by building some of the infrastructures that we have already built, such as roads, schools, hospitals, clean drinking water, electricity, and so on. Because, how can we expect countries like India or Nigeria to care about the climate crisis if we, who already have everything, don't care even a second about it or our actual commitments to the Paris agreement?

So why are we not reducing our emissions? Why are they in fact still increasing? Are we knowingly causing a mass extinction? Are we evil?

No, of course, not. People keep doing what they do because the vast majority doesn't have a clue about the actual consequences for their everyday life.

And they don't know that rapid change is required.

We all think we know and we all think everybody knows. But we don't.

Because, how could we? If there really was a crisis, and if this crisis was caused by our emissions, you would at least see some signs. Not just flooded cities. Tens of thousands of dead people and whole nations leveled to piles of torn down buildings. You would see some restrictions.

But no. And no one talks about it. There are no emergency meetings, no headlines, no breaking news. No one is acting as if we were in a crisis.

Even most climate scientists or green politicians keep on flying around the world, eating meat and dairy.

If I live to be 100, I will be alive in the year 2103. When you think about the future today, you don't think beyond the year 2050. By then I will, in the best case, not even have lived half of my life. What happens next? In the year 2078, I will celebrate my 75th birthday. If I have children or grandchildren, maybe they will spend that day with me. Maybe they will ask me about you, the people who were around back in 2018. Maybe they will ask why you didn't do anything while there still was time to act. What we do or don't do right now, will affect my entire life and the lives of my children and grandchildren. What we do or don't do right now, me and my generation can't undo in the future.

So, when school started in August of this year, I decided that this was enough. I set myself down on the ground outside the Swedish parliament. I school-striked for the climate.

Some people say that I should be in school instead. Some people say that I should study, to become a climate scientist so that I can solve the climate crisis.

But the climate crisis has already been solved. We already have all the facts and solutions. All we have to do is to wake up and change.

And why should I be studying for a future that soon will be no more, when no one is doing anything whatsoever to save that future? And what is the point of learning facts in the school system, when the most important facts given by the finest science of that same school system clearly means nothing to our politicians and our society?

Some people say that Sweden is just a small country and that it doesn't matter what we do. But I think that if a few children can get headlines all over the world just by not coming to school for a few weeks, imagine what we could all do together if we wanted to?

Now we're almost at the end of my talk and this is where people usually start talking about hope. Solar panels, wind power, circular economy, and so on. But I'm not going to do that. We've had 30 years of pep talking and selling positive ideas. And I'm sorry but it doesn't work because if it would have, the emissions would have gone down by now. They haven't.

And yes, we do need hope. Of course, we do. But the one thing we need

more than hope is action. Once we start to act, hope is everywhere. So instead of looking for hope, look for action. Then and only then, hope will come today.

Today we use 100 million barrels of oil every single day. There are no politics to change that. There are no rules to keep that oil in the ground. So, we can't save the world by playing by the rules, because the rules have to be changed.

Everything needs to change and it has to start today.

Thank you.

6.2 Only immediate climate action can save the future

Immediate action to halt the extraction of fossil fuels and greatly reduce the emission of CO_2 and other greenhouse gasses is needed to save the long-term future of human civilization and the biosphere.

At the opening ceremony of United Nations-sponsored climate talks in Katowice, Poland, Sir David Attenborough said "Right now, we are facing a man-made disaster of global scale. Our greatest threat in thousands of years. Climate change. If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon. The world's people have spoken. Their message is clear. Time is running out. They want you, the decision-makers, to act now."

Antonio Guterres, UN Secretary-General, said climate change was already "a matter of life and death" for many countries. He added that the world is "nowhere near where it needs to be" on the transition to a low-carbon economy.

Swedish student Greta Thunberg, is a 16-year-old who has launched a climate protest movement in her country. She said, in a short but very clear speech after that of UN leader Antonio Guterres: "Some people say that I should be in school instead. Some people say that I should study to become a climate scientist so that I can 'solve the climate crisis'. But the climate crisis has already been solved. We already have all the facts and solutions."

She added: "Why should I be studying for a future that soon may be no more, when no one is doing anything to save that future? And what is the point of learning facts when the most important facts clearly mean nothing to our society?"

Thunberg continued: "Today we use 100 million barrels of oil every single day. There are no politics to change that. There are no rules to keep that oil in the ground. So we can't save the world by playing by the rules. Because the rules have to be changed."

She concluded by saying that "since our leaders are behaving like children, we will have to take the responsibility they should have taken long ago."

Appearing among billionaires, corporate CEO's and heads of state at the Davos Economic Forum in Switzerland, like a new Joan of Arc, 16-year-old Swedish climate activist Greta Thunberg called on decision-makers to fulfil their responsibilities towards future generations. Here are some excerpts from her speech:


SKOLSTREJK
FÖR
KLIMATET

Greta's speech at Davos

Our house is on fire. I am here to say, our house is on fire. According to the IPCC, we are less than 12 years away from not being able to undo our mistakes. In that time, unprecedented changes in all aspects of society need to have taken place, including a reduction of our CO_2 emissions by at least 50%...

Here in Davos - just like everywhere else - everyone is talking about money. It seems money and growth are our only main concerns.

And since the climate crisis has never once been treated as a crisis, people are simply not aware of the full consequences on our everyday life. People are not aware that there is such a thing as a carbon budget, and just how incredibly small that remaining carbon budget is. That needs to change today.

No other current challenge can match the importance of establishing a wide, public awareness and understanding of our rapidly disappearing carbon budget, that should and must become our new global currency and the very heart of our future and present economics.

We are at a time in history where everyone with any insight of the climate crisis that threatens our civilization - and the entire biosphere - must speak out in clear language, no matter how uncomfortable and unprofitable that may be.

We must change almost everything in our current societies. The bigger your carbon footprint, the bigger your moral duty. The bigger your platform, the bigger your responsibility.

Figure 6.1: **Greta Thunberg on the cover of Time Magazine, The Intergovernmental Panel on Climate Change, in their October 2018 report, used strong enough language to wake up at least part of the public: the children whose future is at stake. Here is an excerpt from a speech which 16-year-old Swedish climate activist Greta Thunberg made at the Davos Economic Forum in January, 2019: "Our house is on fire. I am here to say, our house is on fire. According to the IPCC, we are less than 12 years away from not being able to undo our mistakes. In that time, unprecedented changes in all aspects of society need to have taken place, including a reduction of our CO2 emissions by at least 50%..."**

6.3 Worldwide school strike, 15 March, 2019

Over 1.4 million young students across all continents took to the streets on Friday March 15th for the first ever global climate strike. Messages in more than 40 languages were loud and clear: world leaders must act now to address the climate crisis and save our future. The school strike was the largest climate action in history. Nevertheless it went almost unmentioned in the media,

Here are some of the statements by the students explaining why they took part in the strikes:

In India, no one talks about climate change. You don't see it on the news or in the papers or hear about it from government. We want global leaders to declare a climate emergency. If we don't act today, then we will have no tomorrow. - Vidit Baya, 17, Udaipur, India.

We face heartbreaking loss due to increasingly extreme weather events. We urge the Taiwanese government to implement mitigation measures and face up to the vulnerability of indigenous people, halt construction projects in the indigenous traditional realm, and recognize the legal status of Plains Indigenous People, in order to implement environmental protection as a bottom-up approach - Kaisanan Ahuan, Puli City, Taiwan.

We have reached a point in history when we have the technical capacities to solve poverty, malnutrition, inequality and of course global warming. The deciding factors for whether we take advantage of our potential will be our activism, our international unity and our ability to develop the art of making the impossible possible. Whether we succeed or not depends on our political will - Eyal Weintraub, 18, and Bruno Rodriguez, 18, Argentina.

The damage done by multinationals is enormous: the lack of transparency, dubious contracts, the weakening of the soil, the destruction of flora and fauna, the lack of respect for mining codes, the contamination of groundwater. In Mali, the state exercises insufficient control over the practices of the multinationals, and it is us, the citizens, who suffer the consequences. The climate alarm has sounded, and the time has come for us all to realize that there is still time to act locally, in our homes, our villages, our cities - Mone Fousseny, 22, Mali.

[2]

[2]https://www.theguardian.com/environment/2019/apr/03/parents-around-the-world-mobilise-behind-youth-climate-strikes


STOP
BURNING
MY
ANCESTORS
CLIMATE


IT'S
OUR
FUTURE
DECLARATION OF CLIMATE EMERGENCY
#lambethschoolstrike Friday 15TH March 3.00-4.30pm WINDRUSH SQ. BRIXTON


THERESA
THE ONLY
THING
FULL
OF
HOT AIR
THERE'S
NO
PLANET
WE'RE
MISSING
YOU'RE MISSING
THE
POINT
CLIMATE
ACTION
NOW
12
YEARS
NO

Figure 6.2: **Eve White and her children join climate protesters in Tasmania. According to an article in The Guardian, parents and grandparents around the world are mobilizing in support of the youth climate movement that has swept the globe.**

Concerns of young protesters are justified

In an article in the journal *Science* dated 12 April, 2019, [3] 20 prominent climate scientists stated that the concerns of student protesters around the world are fully justified. Here are some quotations from the article:

The world's youth have begun to persistently demonstrate for the protection of the climate and other foundations of human well-being. As scientists and scholars who have recently initiated similar letters of support in our countries, we call for our colleagues across all disciplines and from the entire world to support these young climate protesters. We declare: Their concerns are justified and supported by the best available science. The current measures for protecting the climate and biosphere are deeply inadequate.

Nearly every country has signed and ratified the Paris Agreement of 2015, committing under international law to hold global warming well below 2^{o}C above preindustrial levels and to pursue efforts to limit the temperature increase to 1.5^{o}C. The scientific community has clearly concluded that a global warming of 2^{o}C instead of 1.5^{o}C would substantially increase climate-related impacts and the risk of some becoming irreversible. Moreover, given the uneven distribution of most impacts, 2^{o}C of warming would further exacerbate existing global inequalities.

It is critical to immediately begin a rapid reduction in CO_2 and other greenhouse gas emissions. The degree of climate crisis that humanity will experience in the future will be determined by our cumulative emissions; rapid reduction now will limit the damage. For example, the Intergovernmental Panel on Climate Change (IPCC) has recently assessed that halving CO_2 emissions by 2030 (relative to 2010 levels) and globally achieving net-zero $CO_2$2 emissions by 2050 (as well as strong reductions in other greenhouse gases) would allow a 50% chance of staying below 1.5^{o}C of warming. Considering that industrialized countries produced more of and benefited more from previous emissions, they have an ethical responsibility to achieve this transition more quickly than the world as a whole.

Many social, technological, and nature-based solutions already exist. The young protesters rightfully demand that these solutions be used to achieve a sustainable society. Without bold and focused action, their future is in critical danger. There is no time to wait until they are in power...

The enormous grassroots mobilization of the youth climate movement - including Fridays for Future, School (or Youth) Strike 4 Climate, Youth for (or 4) Climate, and Youth Climate Strike - shows that young people understand the situation. We approve and support their demand for rapid and forceful action. We see it as our social, ethical, and scholarly responsibility to state in no uncertain terms: Only if humanity acts quickly and resolutely can we limit

[3] https://science.sciencemag.org/content/364/6436/139.2

global warming, halt the ongoing mass extinction of animal and plant species, and preserve the natural basis for the food supply and well-being of present and future generations. This is what the young people want to achieve. They deserve our respect and full support.

Figure 6.3: **Greta Thunberg addressing a meeting of the European Parliament in April, 2019. She complained that Brexit was treated as an emergency by the European Union, but climate change, which is a far greater emergency has been almost neglected. The 16-year-old, who is due to meet the Pope on Wednesday, said, "We face an end to civilization as we know it unless permanent changes take place in our society...European elections are coming soon and many like me who are affected most by this crisis, are not allowed to vote. That is why millions of children are taking to the street to draw attention to the climate crisis... It is not too late to act but it will take far-reaching vision and fierce determination... My plea is: Please wake up and do the seemingly impossible."**

6.4 The World Meteorological Organization's report

According to a recent United Nations report, extreme weather events displaced 2 million people during 2018. While no single event can be unambiguously attributed to anthropogenic climate change, scientists believe the the increasing frequency of extreme weather events is definitely linked to global warming. The same is true of their increasing severity.

The report states that during 2018, extreme weather events impacted roughly 62 million people, of whom 2 million were displaced from their homes. In the words of the WMO report, "The physical signs and socio-economic impacts of climate change are accelerating, as record greenhouse gas concentrations drive global temperatures towards increasingly dangerous levels."

UN Secretary General Antonio Guterres, speaking at the launching of the WMO report, used the occasion to remind global leaders of the urgency of the climate emergency. Guterres has convened a climate summit meeting scheduled for September 23, 2019, and referring to the meeting, he said: "Don't come with a speech, come with a plan. This is what science says is needed. It is what young people around the globe are rightfully demanding." Two weeks previously, on March 15, one and a half million students from more that 130 countries had skipped school to participate in the largest climate demonstration in history, demanding action to save the future from the threat of catastrophic climate change.

6.5 Only 12 years left to limit climate change catastrophe

The world's leading scientists met at the Forty-Eighth Session of the IPCC and First Joint Session of Working Groups I, II, and III, 1-5 October 2018 in Inchon, Republic of Korea and openly declared that civilization is on track for collapse because of reckless use of fossil fuels, unless immediate action is taken to drastically cut the extraction and use of fossil fuels.

The report finds that limiting global warming to 1.5^{o}C would require "rapid and far-reaching" transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050.

"It's a line in the sand and what it says to our species is that this is the moment and we must act now," said Debra Roberts, a co-chair of the working group on impacts. "This is the largest clarion bell from the science community and I hope it mobilizes people and dents the mood of complacency."

"We have presented governments with pretty hard choices. We have pointed out the enormous benefits of keeping to 1.5C, and also the unprecedented shift in energy systems and transport that would be needed to achieve that," said Jim Skea, a co-chair of the working group on mitigation. "We show it can be done within laws of physics and chemistry.

Figure 6.4: **A firefighter battles fire in California. The world is currently 1 degree Centigrade warmer than preindustrial levels.**

Then the final tick box is political will. We cannot answer that. Only our audience can - and that is the governments that receive it."

Bob Ward, of the Grantham Research Institute on Climate Change, said the final document was "incredibly conservative" because it did not mention the likely rise in climate-driven refugees or the danger of tipping points that could push the world on to an irreversible path of extreme warming.

Policymakers commissioned the report at the Paris climate talks in 2016, but since then the gap between science and politics has widened. Donald Trump has promised to withdraw the US - the world's biggest source of historical emissions - from the accord. Brazil's president. Jair Bolsonaro, threatens to do the same and also open the Amazon rainforest to agribusiness.

6.6 COP24, the climate summit in Poland

The UN Secretary General's address to the opening session

Welcome to COP 24.

I thank President Duda, Minister Kowalczyk and COP President Designate Mijal Kurtyka for their warm welcome.

We are in trouble. We are in deep trouble with climate change.

Climate change is running faster than we are and we must catch up sooner rather than later before it is too late.

For many, people, regions even countries this is already a matter of life and death.

This meeting is the most important gathering on climate change since the Paris Agreement was signed.

Figure 6.5: **UN Secretary-General Antonio Guterres: "It is hard to overstate the urgency of our situation. Even as we witness devastating climate impacts causing havoc across the world, we are still not doing enough, nor moving fast enough, to prevent irreversible and catastrophic climate disruption. Nor are we doing enough to capitalize on the enormous social, economic and environmental opportunities of climate action."**

It is hard to overstate the urgency of our situation.

Even as we witness devastating climate impacts causing havoc across the world, we are still not doing enough, nor moving fast enough, to prevent irreversible and catastrophic climate disruption.

Nor are we doing enough to capitalize on the enormous social, economic and environmental opportunities of climate action.

And so, I want to deliver four simple messages.

First: science demands a significantly more ambitious response.

Second: the Paris Agreement provides the framework for action, so we must operationalize it.

Third: we have a collective responsibility to invest in averting global climate chaos, to consolidate the financial commitments made in Paris and to assist the most vulnerable communities and nations.

Fourth: climate action offers a compelling path to transform our world for the better.

Let me turn first to science.

According to the World Meteorological Organization, the 20 warmest years on record have been in the past 22 years, with the top four in the past four years.

The concentration of carbon dioxide is the highest it has been in 3 million years.

Emissions are now growing again.

The recent special report from the Intergovernmental Panel on Climate Change finds that warming could reach 1.5 degrees as soon as 2030, with devastating impacts.

The latest UN Environment Programme Emissions Gap Report tells us that the current Nationally Determined Contributions under the Paris Agreement will lead to global warming of about 3 degrees by the end of the century.

Furthermore, the majority of countries most responsible for greenhouse gas emissions are behind in their efforts to meet their Paris pledges.

So, it is plain we are way off course.

We need more action and more ambition.

We absolutely have to close this emissions gap.

If we fail, the Arctic and Antarctic will continue to melt, corals will bleach and then die, the oceans will rise, more people will die from air pollution, water scarcity will plague a significant proportion of humanity, and the cost of disasters will skyrocket.

Last year I visited Barbuda and Dominica, which were devastated by hurricanes. The destruction and suffering I saw was heart-breaking. That story is repeated almost daily somewhere in the world.

These emergencies are preventable.

Emissions must decline by 45 per cent from 2010 levels by 2030 and be net zero by 2050.

Renewable energy will need to supply half to two-thirds of the world's primary energy by 2050 with a corresponding reduction in fossil fuels.

In short, we need a complete transformation of our global energy economy, as well as how we manage land and forest resources.

We need to embrace low-carbon, climate-resilient sustainable development.

I am hopeful that the Talanoa Dialogue will provide a very strong impulse for increased ambition in the commitments for climate action.

Excellencies,

This brings me to my second point.

The Paris Agreement provides a framework for the transformation we need.

It is our job here in Katowice is to finalize the Paris Agreement Work Programme – the rule book for implementation.

I remind all Parties that this is a deadline you set for yourselves and it is vital you meet it.

We need a unifying implementation vision that sets out clear rules, inspires action and promotes raised ambition, based on the principle of equity and common but differentiated responsibilities and respective capabilities, in light of different national circumstances.

We have no time for limitless negotiations.

A completed Work Programme will unleash the potential of the Paris Agreement.

It will build trust and make clear that countries are serious about addressing climate change.

Dear Friends,

This brings me to my third point: the central importance of finance.

We need concerted resource mobilization and investment to successfully combat climate change.

We need transformative climate action in five key economic areas - energy, cities, land use, water and industry.

Some 75 per cent of the infrastructure needed by 2050 still remains to be built.

How this is done will either lock us in to a high-emissions future or steer us towards truly sustainable low-emissions development.

Governments and investors need to bet on the green economy, not the grey.

That means embracing carbon pricing, eliminating harmful fossil fuel subsidies and investing in clean technologies.

It also means providing a fair transition for those workers in traditional sectors that face disruption, including through retraining and social safety nets.

We also have a collective responsibility to assist the most vulnerable communities and countries - such as small island nations and the least developed countries - by supporting adaptation and resilience.

Making clear progress to mobilize the pledged $100 billion dollars a year will provide a much-needed positive political signal.

I have appointed the President of France and Prime Minister of Jamaica to lead the mobilization of the international community, both public and private, to reach that target in the context of preparation of the Climate Summit I have convened in September of next year.

I also urge Member States to swiftly implement the replenishment of the Green Climate Fund.

It is an investment in a safer, less costly future.

Dear Friends,

All too often, climate action is seen as a burden. My fourth point is this: decisive climate action today is our chance to right our ship and set a course for a better future for all.

We have the knowledge.

Many technological solutions are already viable and affordable.

Cities, regions, civil society and the business community around the world are moving ahead.

What we need is political more will and more far-sighted leadership.

This is the challenge on which this generation's leaders will be judged.

Climate action is not just the right thing to do - it makes social and economic sense.

Meeting the goals of the Paris Agreement would reduce air pollution - saving more than a million lives each year by 2030, according to the World Health

Organization.

According to the recent New Climate Economy report, ambitious climate action could yield 65 million jobs and a direct economic gain of $26 trillion US dollars compared to business as usual over the next 12 years.

We are seeing early signs of this economic transformation, but we are nowhere near where we need to be.

The transition to a low-carbon economy needs political impetus from the highest levels.

And it requires inclusivity, because everyone is affected by climate change.

That is the message of the Talanoa Dialogue.

We need a full-scale mobilization of young people.

And we need a global commitment to gender equality, because women's leadership is central to durable climate solutions.

A successful conference here in Katowice can provide the catalyst.

There is now significant global momentum for climate action.

It has galvanized private business and investors around the world, while cities and regional governments are also showing that ambitious climate action is possible and desirable.

Let us build on this momentum.

I am convening a Climate Summit in September next year to raise ambition and mobilize the necessary resources.

But that ambition needs to begin here, right now, in Katowice, driven by governments and leaders who understand that their legacies and the well-being of future generations are at stake.

We cannot afford to fail in Katowice.

Some might say that it will be a difficult negotiation. I know it is not easy. It requires a firm political will for compromise. But, for me, what is really difficult is to be a fisherman in Kiribati seeing his country in risk of disappearing or a farmer or herder in the Sahel losing livelihoods and losing peace. Or being a woman in Dominica or any other Caribbean nation enduring hurricane after hurricane destroying everything in its path.

Ladies and gentlemen,

Climate change is the single most important issue we face.

It affects all our plans for sustainable development and a safe, secure and prosperous world.

So, it is hard to comprehend why we are collectively still moving too slowly - and even in the wrong direction.

The IPCC's Special Report tells us that we still have time to limit temperature rise.

But that time is running out.

We achieved success in Paris because negotiators were working towards a common goal.

Figure 6.6: **Greta: "Many people say that Sweden is just a small country, and it doesn't matter what we do. But I've learned that you are never too small to make a difference. And if a few children can get headlines all over the world just by not going to school, then imagine what we could all do together if we really wanted to."**

I implore you to maintain the same spirit of urgent collaboration here in Katowice with a dynamic Polish leadership in the negotiations.

Katowice must ensure that the bonds of trust established in Paris will endure.

Incredible opportunity exists if we embrace a low-carbon future and unleash the power of the Paris Agreement.

But we must start today building the tomorrow we want.

Let us rise to the challenge and finish the work the world demands of us.

Thank you.

Greta Thunberg's address to the opening session

Greta Thunberg (born 3 January 2003) is a Swedish climate activist. She is known for protesting outside the Swedish parliament building to raise climate change activism.

On 20 August 2018, Thunberg, then in 9th grade, decided to not attend school until the 2018 Sweden general election on 9 September after heat waves and wildfires in Sweden. Her demands were that the Sweden government reduce carbon emissions as per the Paris Agreement, and she protested via sitting outside the Riksdag every day during school hours with the sign "Skolstrejk för klimatet" (school strike for the climate). After the general elections, she continued to strike only on Fridays. The strike is now in its 17th week. The

Figure 6.7: **Greta: "You only talk about moving forward with the same bad ideas that got us into this mess, even when the only sensible thing to do is pull the emergency brake. You are not mature enough to tell it like it is. Even that burden you leave to us children."**

Figure 6.8: **Greta: "Until you start focusing on what needs to be done, rather than what is politically possible, there is no hope. We cannot solve a crisis without treating it as a crisis. We need to keep the fossil fuels in the ground, and we need to focus on equity. And if solutions within the system are so impossible to find, then maybe we should change the system itself."**

transcript of her address to the opening session of COP24[4][5] [6] [7] is given below,

My name is Greta Thunberg. I am 15 years old, and I'm from Sweden. I speak on behalf of Climate Justice Now!

Many people say that Sweden is just a small country, and it doesn't matter what we do. But I've learned that you are never too small to make a difference. And if a few children can get headlines all over the world just by not going to school, then imagine what we could all do together if we really wanted to.

But to do that, we have to speak clearly, no matter how uncomfortable that may be. You only speak of green eternal economic growth because you are too scared of being unpopular. You only talk about moving forward with the same bad ideas that got us into this mess, even when the only sensible thing to do is pull the emergency brake. You are not mature enough to tell it like it is. Even that burden you leave to us children.

But I don't care about being popular. I care about climate justice and the living planet. Our civilization is being sacrificed for the opportunity of a very small number of people to continue making enormous amounts of money. Our biosphere is being sacrificed so that rich people in countries like mine can live in luxury. It is the sufferings of the many which pay for the luxuries of the few.

The year 2078, I will celebrate my 75th birthday. If I have children, maybe they will spend that day with me. Maybe they will ask me about you. Maybe they will ask why you didn't do anything while there still was time to act. You say you love your children above all else, and yet you are stealing their future in front of their very eyes.

Until you start focusing on what needs to be done, rather than what is politically possible, there is no hope. We cannot solve a crisis without treating it as a crisis. We need to keep the fossil fuels in the ground, and we need to focus on equity. And if solutions within the system are so impossible to find, then maybe we should change the system itself.

We have not come here to beg world leaders to care. You have ignored us in the past, and you will ignore us again. We have run out of excuses, and we are running out of time. We have come here to let you know that change is coming, whether you like it or not. The real power belongs to the people. Thank you.

[4] https://www.youtube.com/watch?v=VFkQSGyeCWg
[5] https://www.youtube.com/watch?v=0TYyBtb1PH4
[6] https://www.youtube.com/watch?v=DdAOgNTxxt0
[7] https://www.youtube.com/watch?v=pJ1HRGA8g10

Figure 6.9: **Greta Thunberg addresses the National Assembly In Paris on July 23, 2019 in Paris, France.**

Figure 6.10: **Greta Thunberg crossing the Atlantic on a small emission-free boat.**

6.7 The UK declares a climate emergency

Introducing the motion in the House of Commons, Labour leader Jeremy Corbyn said: **"We have no time to waste. We are living in a climate crisis that will spiral dangerously out of control unless we take rapid and dramatic action now. This is no longer about a distant future. We're talking about nothing less than the irreversible destruction of the environment within our lifetimes of members of this house."**

Here are some excerpts from an article by Amy Goodman and Nermeen Shaikh of Democracy now published in Truthout on May 2, 2019.[8]:

On Wednesday, the House of Commons became the first parliament in the world to declare a climate emergency. The resolution came on the heels of the recent Extinction Rebellion mass uprising that shut down Central London last month in a series of direct actions. Activists closed bridges, occupied public landmarks and even superglued themselves to buildings, sidewalks and trains to demand urgent action to combat climate change. Police arrested more than 1,000 protesters. Labour Party Leader Jeremy Corbyn told Parliament, "We are witnessing an unprecedented upsurge of climate activism, with groups like Extinction Rebellion forcing the politicians in this building to listen. For all the dismissive and defensive column inches the processes have provoked, they are a massive and, I believe, very necessary wake-up call. Today we have the opportunity to say, 'We hear you.'" We speak with George Monbiot, British journalist, author and columnist with The Guardian. His recent piece for The Guardian is headlined "Only rebellion will prevent an ecological apocalypse." Monbiot says capitalism "is like a gun pointed at the heart of the planet. It will essentially, necessarily destroy our life-support systems. Among those characteristics is the drive for perpetual economic growth on a finite planet."

[8]https://truthout.org/video/george-monbiot-on-the-uk-climate-emergency/

6.8 Understatement of existential climate risk

Here are some excerpts from a 44-page report entitled *What Lies Beneath: The Understanding of Existential Climate Risk*, by David Spratt and Ian Dunlop[9]:

Three decades ago, when serious debate on human-induced climate change began at the global level, a great deal of statesmanship was on display. There was a preparedness to recognize that this was an issue transcending nation states, ideologies and political parties which had to be addressed pro-actively in the long-term interests of humanity as a whole. This was the case even though the existential nature of the risk it posed was far less clear cut than it is today.

As global institutions, such as the United Nations Framework Convention on Climate Change (UNFCCC) which was established at the Rio Earth Summit in 1992, were developed to take up this challenge, and the extent of change this would demand of the fossil-fuel-dominated world order became clearer, the forces of resistance began to mobilize. Today, as a consequence, and despite the diplomatic triumph of the 2015 Paris Agreement, the debate around climate change policy has never been more dysfunctional, indeed Orwellian.

In his book 1984, George Orwell describes a double-think totalitarian state where most of the population accepts "the most flagrant violations of reality, because they never fully grasped the enormity of what was demanded of them, and were not sufficiently interested in public events to notice what was

[9]https://www.breakthroughonline.org.au/

happening. By lack of understanding they remained sane."

Orwell could have been writing about climate change and policymaking. International agreements talk of limiting global warming to 1.5-2 degrees Celsius (^{o}C), but in reality they set the world on a path of 3-5^{o}C of warming. Goals are reaffirmed, only to be abandoned. Coal is "clean". Just 1^{o}C of warming is already dangerous, but this cannot be admitted. The planetary future is hostage to myopic national self-interest. Action is delayed on the assumption that as yet unproven technologies will save the day, decades hence. The risks are existential, but it is "alarmist" to say so.

A one-in-two or one-in-three chance of missing a goal is normalized as reasonable. Moral hazard permeates official thinking, in that there is an incentive to ignore the risks in the interests of political expediency.

Climate policymaking for years has been cognitively dissonant, "a flagrant violation of reality". So it is unsurprising that there is a lack of understanding amongst the public and elites of the full measure of the climate challenge. Yet most Australians sense where we are heading: three-quarters of Australians see climate change as catastrophic risk, and half see our way of life ending within the next 100 years.

Politics and policymaking have norms: rules and practices, assumptions and boundaries, that constrain and shape them. In recent years, the previous norms of statesmanship and long-term thinking have disappeared, replaced by an obsession with short-term political and commercial advantage. Climate policymaking is no exception. Since 1992, short-term economic interest has trumped environmental and future human needs.

The world today emits 50% more carbon dioxide (CO_2) from the consumption of energy than it did 25 years ago, and the global economy has more than doubled in size. The UNFCCC strives "to enable economic development to proceed in a sustainable manner", but every year humanity's ecological footprint becomes larger and less sustainable. Humanity now requires the biophysical capacity of 1.7 Earths annually as it rapidly chews up natural capital.

A fast, emergency-scale transition to a post-fossil fuel world is absolutely necessary to address climate change. But this is excluded from consideration by policymakers because it is considered to be too disruptive. The orthodoxy is that there is time for an orderly economic transition within the current short-termist political paradigm. Discussion of what would be safe - less warming than we presently experience - is non-existent. And so we have a policy failure of epic proportions.

Policymakers, in their magical thinking, imagine a mitigation path of gradual change to be constructed over many decades in a growing, prosperous world. The world not imagined is the one that now exists: of looming financial instability; of a global crisis of political legitimacy and "fake news"; of a sustainability crisis that extends far beyond climate change to include all the fundamentals of human existence and most significant planetary boundaries

(soils, potable water, oceans, the atmosphere, biodiversity, and so on); and of severe global energy-sector dislocation.

In anticipation of the upheaval that climate change would impose upon the global order, the IPCC was established by the United Nations (UN) in 1988, charged with regularly assessing the global consensus on climate science as a basis for policymaking. The IPCC Assessment Reports (AR), produced every five-to-eight years, play a large part in the public framing of the climate narrative: new reports are a global media event.

AR5 was produced in 2013-14, with AR6 due in 2022. The IPCC has done critical, indispensable work of the highest standard in pulling together a periodic consensus of what must be the most exhaustive scientific investigation in world history.

It does not carry out its own research, but reviews and collates peer-reviewed material from across the spectrum of this incredibly complex area, identifying key issues and trends for policymaker consideration. However, the IPCC process suffers from all the dangers of consensus-building in such a wide-ranging and complex arena. For example, IPCC reports, of necessity, do not always contain the latest available information. Consensus-building can lead to "least drama", lowest-common-denominator outcomes, which overlook critical issues. This is particularly the case with the "fat-tails" of probability distributions, that is, the high-impact but lower-probability events where scientific knowledge is more limited.

Vested-interest pressure is acute in all directions; climate denialists accuse the IPCC of alarmism, whereas many climate action proponents consider the IPCC to be far too conservative. To cap it all, the IPCC conclusions are subject to intense political oversight before being released, which historically has had the effect of substantially watering-down sound scientific findings.

These limitations are understandable, and arguably were not of overriding importance in the early period of the IPCC. However, as time has progressed, it is now clear that the risks posed by climate change are far greater than previously anticipated. We have moved out of the twilight period of much talk, but relatively limited climate impacts, into the harsh light of physically-evident existential threats. Climate change is now turning nasty, as we have witnessed recently in the North America, East and South Asia, the Middle East and Europe, with record-breaking heatwaves and wildfires, more intense flooding and more damaging hurricanes.

The distinction between climate science and risk is the critical issue, for the two are not the same. Scientific reticence - a reluctance to spell out the full risk implications of climate science in the absence of perfect information - has become a major problem. Whilst this is understandable, particularly when scientists are continually criticized by denialists and political apparatchiks for speaking out, it is extremely dangerous given the fat-tail risks of climate change. Waiting for perfect information, as we are continually urged to do

by political and economic elites, means it will be too late to act. Time is not on our side. Sensible risk management addresses risk in time to prevent it happening, and that time is now.

Irreversible, adverse climate change on the global scale now occurring is an existential risk to human civilization. Many of the world's top climate scientists - Kevin Anderson, James Hansen, Michael E. Mann, Michael Oppenheimer, Naomi Oreskes, Stefan Rahmstorf, Eric Rignot, Hans Joachim Schellnhuber, Kevin Trenberth and others - who are quoted in this report well understand these implications and are forthright about their findings, where we are heading, and the limitations of IPCC reports.

This report seeks to alert the wider community and business and political leaders to these limitations and urges changes to the IPCC approach, to the wider UNFCCC negotiations, and to national policymaking. It is clear that existing processes will not deliver the transformation to a carbon-negative world in the limited time now available. We urgently require a re-framing of scientific research within an existential risk-management framework. This requires special precautions that go well beyond conventional risk management. Like an iceberg, there is great danger in "what lies beneath".

Existential Risk to Human Civilization

In 2016, the World Economic Forum survey of the most impactful risks for the years ahead elevated the failure of climate change mitigation and adaptation to the top of the list, ahead of weapons of mass destruction, ranking second, and water crises, ranking third. By 2018, following a year characterized by high-impact hurricanes and extreme temperatures, extreme-weather events were seen as the single most prominent risk. As the survey noted: "We have been pushing our planet to the brink and the damage is becoming increasingly clear."

Climate change is an existential risk to human civilization: that is, an adverse outcome that would either annihilate intelligent life or permanently and drastically curtail its potential.

Temperature rises that are now in prospect, after the Paris Agreement, are in the range of 3-5 ^{o}C. At present, the Paris Agreement voluntary emission reduction commitments, if implemented, would result in planetary warming of 3.4 ^{o}C by 2100, without taking into account "long-term" carbon- cycle feedbacks. With a higher climate sensitivity figure of 4.5 ^{o}C, for example, which would account for such feedbacks, the Paris path would result in around 5 ^{o}C of warming, according to a MIT study.

A study by Schroeder Investment Management published in June 2017 found - after taking into account indicators across a wide range of the political, financial, energy and regulatory sectors - the average temperature increase implied for the Paris Agreement across all sectors was 4.1 ^{o}C.

Yet 3 ^{o}C of warming already constitutes an existential risk. A 2007 study

by two US national security think-tanks concluded that 3 ^{o}C of warming and a 0.5 meter sea-level rise would likely lead to "outright chaos" and "nuclear war is possible", emphasizing how "massive non-linear events in the global environment give rise to massive nonlinear societal event".

The Global Challenges Foundation (GCF) explains what could happen: "If climate change was to reach 3 ^{o}C, most of Bangladesh and Florida would drown, while major coastal cities - Shanghai, Lagos, Mumbai - would be swamped, likely creating large flows of climate refugees. Most regions in the world would see a significant drop in food production and increasing numbers of extreme weather events, whether heat waves, floods or storms. This likely scenario for a 3 ^{o}C rise does not take into account the considerable risk that self-reinforcing feedback loops set in when a certain threshold is reached, leading to an ever increasing rise in temperature. Potential thresholds include the melting of the Arctic permafrost releasing methane into the atmosphere, forest die-back releasing the carbon currently stored in the Amazon and boreal forests, or the melting of polar ice caps that would no longer reflect away light and heat from the sun."

Warming of 4 ^{o}C or more could reduce the global human population by 80% or 90%, and the World Bank reports "there is no certainty that adaptation to a 4 ^{o}C world is possible."

Prof. Kevin Anderson says a 4 ^{o}C future "is incompatible with an organized global community, is likely to be beyond 'adaptation', is devastating to the majority of ecosystems, and has a high probability of not being stable".

This is a commonly-held sentiment amongst climate scientists. A recent study by the European Commission's Joint Research Centre found that if the global temperature rose 4 ^{o}C, then extreme heatwaves with "apparent temperatures" peaking at over 55 ^{o}C will begin to regularly affect many densely populated parts of the world, forcing much activity in the modern industrial world to stop. ("Apparent temperatures" refers to the Heat Index, which quantifies the combined effect of heat and humidity to provide people with a means of avoiding dangerous conditions.)

In 2017, one of the first research papers to focus explicitly on existential climate risks proposed that "mitigation goals be set in terms of climate risk category instead of a temperature threshold", and established a "dangerous" risk category of warming greater than 1.5 ^{o}C, and a "catastrophic" category for warming of 3 ^{o}C or more. The authors focussed on the impacts on the world's poorest three billion people, on health and heat stress, and the impacts of climate extremes on such people with limited adaptation resources. They found that a 2 ^{o}C warming "would double the land area subject to deadly heat and expose 48% of the population (to deadly heat). A 4 ^{o}C warming by 2100 would subject 47% of the land area and almost 74% of the world population to deadly heat, which could pose existential risks to humans and mammals alike unless massive adaptation measures are implemented."

A 2017 survey of global catastrophic risks by the Global Challenges Foundation found that: "In high-end [climate] scenarios, the scale of destruction is beyond our capacity to model, with a high likelihood of human civilization coming to an end."

84% of 8000 people in eight countries surveyed for the Foundation considered climate change a "global catastrophic risk".

Existential risk may arise from a fast rate of system change, since the capacity to adapt, in both the natural and human worlds, is inversely proportional to the pace of change, amongst other factors. In 2004, researchers reported on the rate of warming as a driver of extinction...

At 4 ^{o}C of warming "the limits for adaptation for natural systems would largely be exceeded throughout the world".

Ecological breakdown of this scale would ensure an existential human crisis. By slow degrees, these existential risks are being recognized. In May 2018, an inquiry by the Australian Senate into national security and global warming recognized "climate change as a current and existential national security risk... defined as 'one that threatens the premature extinction of Earth-originating intelligent life or the permanent and drastic destruction of its potential for desirable future development'".

In April 2018, the Intelligence on European Pensions and Institutional Investment think-tank warned business leaders that "climate change is an existential risk whose elimination must become a corporate objective".

However the most recent IPCC Assessment Report did not consider the issue. Whilst the term "risk management" appears in the 2014 IPCC Synthesis Report fourteen times, the terms "existential" and "catastrophic" do not appear...

6.9 The 2018 IPCC report

Excerpts from an article summarizing the report

Here are excerpts from an article entitled **UN Experts Warn of 'Climate Catastrophe' by 2040** by Jesica Corbett. The article was published in Common Dreams on Monday, October 8, 2018.[10]:

"The climate crisis is here and already impacting the most vulnerable," notes 350.org's program director. "Staying under 1.5^{o}C is now a matter of political will."

Underscoring the need for "rapid, far-reaching, and unprecedented" changes to life as we know it to combat the global climate crisis, a new report from

[10]https://www.commondreams.org/news/2018/10/08/un-experts-warn-climate-catastrophe-2040-without-rapid-and-unprecedented-global

the Intergovernmental Panel on Climate Change (IPCC) - the United Nations' leading body for climate science - details what the world could look like if the global temperature rises to 1.5^{o}C versus 2^{o}C (2.7^{o}F versus 3.6^{o}F) above pre-industrial levels, and outlines pathways to reducing greenhouse gas emissions in the context of sustainable development and efforts to eradicate poverty.

"Climate change represents an urgent and potentially irreversible threat to human societies and the planet," the report reads. "Human-induced warming has already reached about 1^{o}C (1.8^{o}F) above pre-industrial levels at the time of writing of this Special Report... If the current warming rate continues, the world would reach human-induced global warming of 1.5^{o}C around 2040."

Approved by the IPCC in South Korea on Saturday ahead of COP24 in Poland in December, Global Warming of 1.5^{o}C was produced by 91 authors and reviewers from 40 countries. Its release has elicited calls to action from climate campaigners and policymakers the world over.

"This is a climate emergency. The IPCC 1.5 report starkly illustrates the difference between temperature rises of 1.5^{o}C and 2^{o}C - for many around the world this is a matter of life and death," declared Karin Nansen, chair of Friends of the Earth International (FOEI). "It is crucial to keep temperature rise well below 1.5 degrees ... but the evidence presented by the IPCC shows that there is a narrow and shrinking window in which to do so."

The report was requested when the international community came together in December of 2015 for the Paris agreement, which aims to keep global warming within this century "well below" 2^{o}C, with an ultimate target of 1.5^{o}C. President Donald Trump's predecessor supported the accord, but Trump has vowed to withdraw the United States, even as every other nation on the planet has pledged their support for it. In many cases, however, sworn support hasn't led to effective policy.

"It's a fresh reminder, if one was needed, that current emissions reduction pledges are not enough to meet the long-term goals of the Paris agreement. Indeed, they are not enough for any appropriately ambitious temperature target, given what we know about dangerous climate impacts already unfolding even at lower temperature thresholds," Rachel Cleetus, lead economist and climate policy manager for the Union of Concerned Scientists (UCS), wrote ahead of its release.

"The policy implications of the report are obvious: We need to implement a suite of policies to sharply limit carbon emissions and build climate resilience, and we must do all this is in a way that prioritizes equitable outcomes particularly for the world's poor and marginalized communities," Cleetus added.

"We want a just transition to a clean energy system that benefits people not corporations," Nansen emphasized. "Only with a radical transformation of our energy, food and economic systems, embracing environmental, social, gender and economic justice, can we prevent climate catastrophe and temperature rises exceeding 1.5^{o}C."

Only immediate climate action can save the future

Immediate action to halt the extraction of fossil fuels and greatly reduce the emission of CO_2 and other greenhouse gasses is needed to save the long-term future of human civilization and the biosphere.

At the opening ceremony of United Nations-sponsored climate talks in Katowice, Poland, Sir David Attenborough said "Right now, we are facing a man-made disaster of global scale. Our greatest threat in thousands of years. Climate change. If we don't take action, the collapse of our civilizations and the extinction of much of the natural world is on the horizon. The world's people have spoken. Their message is clear. Time is running out. They want you, the decision-makers, to act now."

Antonio Guterres, UN Secretary-General, said climate change was already "a matter of life and death" for many countries. He added that the world is "nowhere near where it needs to be" on the transition to a low-carbon economy.

Swedish student Greta Thunberg, is a 16-year-old who has launched a climate protest movement in her country. She said, in a short but very clear speech after that of UN leader Antonio Guterres: "Some people say that I should be in school instead. Some people say that I should study to become a climate scientist so that I can 'solve the climate crisis'. But the climate crisis has already been solved. We already have all the facts and solutions."

She added: "Why should I be studying for a future that soon may be no more, when no one is doing anything to save that future? And what is the point of learning facts when the most important facts clearly mean nothing to our society?"

Thunberg continued: "Today we use 100 million barrels of oil every single day. There are no politics to change that. There are no rules to keep that oil in the ground. So we can't save the world by playing by the rules. Because the rules have to be changed."

She concluded by saying that "since our leaders are behaving like children, we will have to take the responsibility they should have taken long ago."

Institutional inertia

Our collective failure to respond adequately to the current crisis is very largely due to institutional inertia. Our financial system is deeply embedded and resistant to change. Our entire industrial infrastructure is based on fossil fuels; but if the future is to be saved, the use of fossil fuels must stop. International relations are still based based on the concept of absolutely sovereign nation states, even though this concept has become a dangerous anachronism in an era of instantaneous global communication and economic interdependence. Within nations, systems of law and education change very slowly, although present dangers demand rapid revolutions in outlook and lifestyle.

The failure of the recent climate conferences to produce strong final documents can be attributed to the fact that the nations attending the conferences felt themselves to be in competition with each other, when in fact they ought to have cooperated in response to a common danger. The heavy hand of the fossil fuel industry also made itself felt at the conferences.

Until the development of coal-driven steam engines in the 19th century humans lived more or less in harmony with their environment. Then, fossil fuels, representing many millions of years of stored sunlight, were extracted and burned in two centuries, driving a frenzy of growth of population and industry that has lasted until the present. But today, the party is over. Coal, oil and gas are nearly exhausted, and what remains of them must be left in the ground to avoid existential threats to humans and the biosphere. Big coal and oil corporations base the value of their stocks on ownership of the remaining resources that are still buried, and they can be counted on to use every trick, fair or unfair, to turn those resources into money.

In general corporations represent a strong force resisting change. By law, the directors of corporations are obliged to put the profits of stockholders above every other consideration. No room whatever is left for an ecological or social conscience. Increasingly, corporations have taken control of our mass media and our political system. They intervene in such a way as to make themselves richer, and thus to increase their control of the system.

Polite conversation and cultural inertia

Each day, the conventions of polite conversation contribute to our sense that everything is as it always was. Politeness requires that we do not talk about issues that might be contrary to another person's beliefs. Thus polite conversation is dominated by trivia, entertainment, sports, the weather, gossip, food, and so on, Worries about the the distant future , the danger of nuclear war, the danger of uncontrollable climate change, or the danger of widespread famine seldom appear in conversations at the dinner table, over coffee or at the pub. In conversations between polite people, we obtain the false impression that all is well with the world. But in fact, all is not well. We have to act promptly and adequately to save the future.

The situation is exactly the same in the mass media. The programs and articles are dominated by trivia and entertainment. Serious discussions of the sudden crisis which civilization now faces are almost entirely absent, because the focus is on popularity and ratings. As Neil Postman remarked, we are entertaining ourselves to death.

Further growth implies future collapse

We have to face the fact that endless economic growth on a finite planet is a logical impossibility, and that we have reached or passed the the sustainable limits to growth.

In today's world, we are pressing against the absolute limits of the earth's carrying capacity, and further growth carries with it the danger of future collapse. In the long run, neither the growth of industry not that of population is sustainable; and we have now reached or exceeded the sustainable limits.

The size of the human economy is, of course, the product of two factors: the total number of humans, and the consumption per capita. Let us first consider the problem of reducing the per-capita consumption in the industrialized countries. The whole structure of western society seems designed to push its citizens in the opposite direction, towards

ever-increasing levels of consumption. The mass media hold before us continually the ideal of a personal utopia, filled with material goods.

Every young man in a modern industrial society feels that he is a failure unless he fights his way to the "top"; and in recent years, women too have been drawn into the competition. Of course, not everyone can reach the top; there would not be room for everyone; but society urges us all to try, and we feel a sense of failure if we do not reach the goal. Thus, modern life has become a competition of all against all for power and possessions.

When possessions are used for the purpose of social competition, demand has no natural upper limit; it is then limited only by the size of the human ego, which, as we know, is boundless. This would be all to the good if unlimited industrial growth were desirable; but today, when further industrial growth implies future collapse, western society urgently needs to find new values to replace our worship of power, our restless chase after excitement, and our admiration of excessive consumption.

If you turn on your television set, the vast majority of the programs that you will be offered give no hint at all of the true state of the world or of the dangers which we will face in the future. Part of the reason for this willful blindness is that no one wants to damage consumer confidence. No one wants to bring on a recession. No one wants to shoot Santa Claus.

But sooner or later a severe recession will come, despite our unwillingness to recognize this fact. Perhaps we should prepare for it by reordering the world's economy and infrastructure to achieve long-term sustainability, i.e. steady-state economics, population stabilization, and renewable energy.

Our responsibility to future generations and to the biosphere

All of the technology needed for the replacement of fossil fuels by renewable energy is already in place. Although renewable sources currently supply only 19 percent of the world's energy requirements, they are growing rapidly. For example, wind energy is growing at the rate of 30 percent per year. Because of the remarkable properties of exponential growth, this will mean that wind will soon become a major supplier of the world's energy requirements, despite bitter opposition from the fossil fuel industry.

Both wind and solar energy can now compete economically with fossil fuels, and this situation will become even more pronounced if more countries put a tax on carbon emissions, as Finland, the Netherlands, Norway, Costa Rica, the United Kingdom and Ireland already have done. [11]

Much research and thought have also been devoted to the concept of a steady-state economy. The only thing that is lacking is political will. It is up to the people of the world to make their collective will felt. [12]

[11] http://eruditio.worldacademy.org/issue-5/article/urgent-need-renewable-energy
[12] http://steadystate.org/category/herman-daly/

History has given to our generation an enormous responsibility towards future generations. We must achieve a new kind of economy, a steady-state economy. We must stabilize global population. We must replace fossil fuels by renewable energy. We must abolish nuclear weapons. We must end the institution of war. We must reclaim democracy in our own countries when it has been lost. We must replace nationalism by a just system of international law. We must prevent degradation of the earth's environment. We must act with dedication and fearlessness to save the future of the earth for human civilization and for the plants and animals with which we share the gift of life.

"And yes, we do need hope. Of course, we do. But the one thing we need more than hope is action. Once we start to act, hope is everywhere. So instead of looking for hope, look for action. Then and only then, hope will come today."
Greta Thunberg

Why do we not respond to the crisis?

Today we are faced with multiple interrelated crises, for example the threat of catastrophic climate change or equally catastrophic thermonuclear war, and the threat of widespread famine. These threats to human existence and to the biosphere demand a prompt and rational response; but because of institutional and cultural inertia, we are failing to take the steps that are necessary to avoid disaster.

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Chapter 7

CONTINUED EXTRACTION OF FOSSIL FUELS MUST STOP!

Figure 7.1: **Protesters at the 2017 G20 meeting in Hamburg Germany.**

7.1 The Middle East

According to current estimates, 81.5% of the world's proven crude oil reserves are located in OPEC Member Countries, with the bulk of OPEC oil reserves in the Middle East, amounting to 65.5% of the OPEC total.

7.2 China

China's large reserves of coal lie near to the surface, and are thus very easily accessible. Mining of coal has driven the country's rapid industrial growth, but it has also produced a severe public health problem because of air pollution.

In April, 2017, China's rate of economic growth was 6.9%[1]. This rate of growth, if continued, would mean that China's economy would double every ten years. and increase by a factor of 1024 every century. Obviously this is impossible. Never-ending economic growth on a finite planet is a logical absurdity. China's high economic growth rate, is driven by its use of coal, and this must quickly stop if ecological disaster is to be avoided.

7.3 India

The MIT Technology Review recently published an important article entitled *India's Energy Crisis*[2].

The article makes alarming reading in view of the world's urgent need to make a very rapid transition from fossil fuels to 100% renewable energy. We must make this change

[1]https://tradingeconomics.com/china/gdp-growth-annual
[2]http://www.technologyreview.com/featuredstory/542091/indias-energy-crisis/

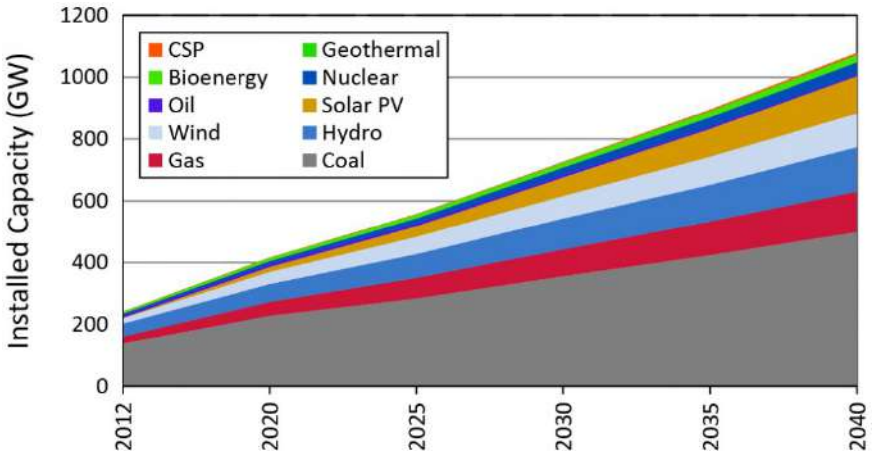

Figure 7.2: **India's installed and future energy mix, as visualized by the World Coal Association**

quickly in order to avoid a tipping point beyond which catastrophic climate change will be unavoidable.

The MIT article states that "Since he took power in May, 2014, Prime Minister Narendra Modi has made universal access to electricity a key part of his administration's ambitions. At the same time, he has pledged to help lead international efforts to limit climate change. Among other plans, he has promised to increase India's total power generating capacity to 175 gigawatts, including 100 gigawatts of solar, by 2022. (That's about the total power generation of Germany.)"

However India plans to expand its industrial economy, and to do this, it is planning to very much increase its domestic production and use of coal. The MIT article continues, pointing out that

However India plans to expand its industrial economy, and to do this, it is planning to very much increase its domestic production and use of coal. The MIT article continues, pointing out that "Such growth would easily swamp efforts elsewhere in the world to curtail carbon emissions, dooming any chance to head off the dire effects of global climate change. (Overall, the world will need to reduce its current annual emissions of 40 billion tons by 40 to 70 percent between now and 2050.) By 2050, India will have roughly 20 percent of the world's population. If those people rely heavily on fossil fuels such as coal to expand the economy and raise their living standards to the level people in the rich world have enjoyed for the last 50 years, the result will be a climate catastrophe regardless of anything the United States or even China does to decrease its emissions. Reversing these trends will require radical transformations in two main areas: how India produces electricity, and how it distributes it."

The Indian Minister of Power, Piyush Goyal, is an enthusiastic supporter of renewable energy expansion, but he also supports, with equal enthusiasm, the large-scale expansion of domestic coal production in India.

Meanwhile, the consequences of global warming are being felt by the people of India.

For example, last May, a heat wave killed over 1,400 people and melted asphalt streets.[3]

Have India's economic planners really thought about the long-term future? Have they considered the fact that drastic climate change could make India completely uninhabitable?

7.4 Russia

According to Wikipedia, "The petroleum industry in Russia is one of the largest in the world. Russia has the largest reserves, and is the largest exporter, of natural gas. It has the second largest coal reserves, the eighth largest oil reserves, and is one of the largest producer of oil. It is the third largest energy user."

One of the difficulties of reducing Russia's fossil fuel production is that the Russian economy depends so heavily on its oil and gas industries. Many European countries also depend on natural gas from Russia for winter heating of homes and workplaces.

[3]https://www.rt.com/news/262641-india-heat-wave-killed/

Figure 7.3: **Oil production on the shelf in the Russian Arctic.**

7.5 North America

Canadian oil sands

Canada's oil-sands deposits contain an amount of carbon comparable to the world's total reserves of conventional oil. Oil is currently being extracted by methods that release four times as much carbon into the atmosphere as is contained in the refined oil from the deposits. Nevertheless, the government of Canada wholeheartedly supports extraction of oil from the tar sands.

The position of the Canadian government has been strongly criticized by leading climate scientist Professor James Hansen. A recent article in *The Guardian*[4], reported him as saying; "To leave our children with a manageable situation, we need to leave the unconventional fuel in the ground. Canada's ministers are acting as salesmen for those people who will gain from the profits of that industry. But I don't think they are looking after the rights and wellbeing of the population as a whole.

"The thing we are facing overall is that the fossil fuel industry has so much money that they are buying off governments. Our democracies are seriously handicapped by the money that is driving decisions in Washington and other capitals."

Fracking in the United States

According to the US Department of Energy (DOE), in 2013 at least two million oil and gas wells in the US have been hydraulically fractured, and that of new wells being drilled,

[4]https://www.theguardian.com/environment/2013/may/19/tar-sands-exploitation-climate-scientist

Figure 7.4: **Get rich quick at the oil sands.**

up to 95% are hydraulically fractured. The output from these wells makes up 43% of the oil production and 67% of the natural gas production in the United States.

Because of earthquakes and poisoning of water supplies caused by fracking, this practice has been banned by several states in the US, and nine countries or regions in Europe: France, Bulgaria, Roumania, Germany, The Czech Republic, Luxembourg, Northern Ireland, Spain and Switzerland,

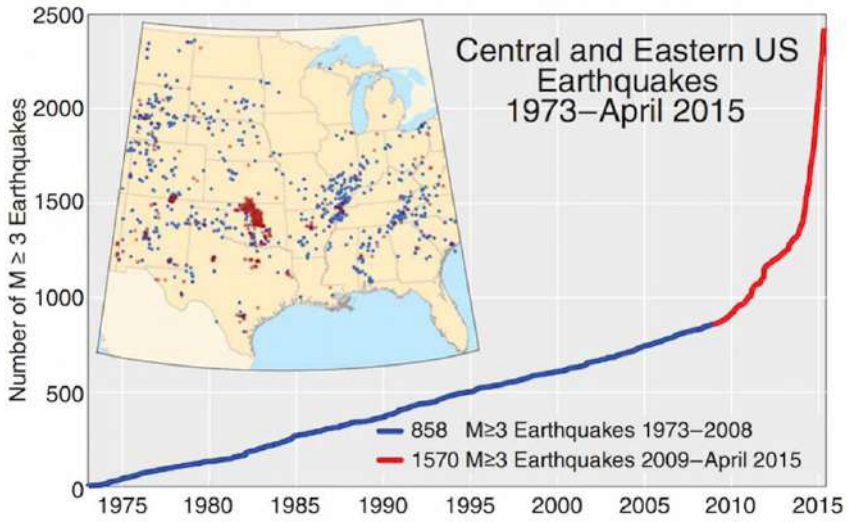

Figure 7.5: **The sharply increased number of earthquakes in the United States has been linked to fracking. The use of fracking has also caused poisoning of water supplies.**

7.6 Latin America

Venezuela's Belt of Tar

The Orinoco River Basin in Venezuela contains the world's largest deposit of extra-heavy oil and tar. The amount of carbon contained in this deposit is comparable to the carbon content of all the world's known reserves of conventional oil, and also larger than the carbon contained in Canada's oil sands.

The Belt of Tar follows the line of the Orinoco river. It is approximately 600 kilometers (370 mi) from east to west, and 70 kilometers (43 mi) from north to south, with an area about 55,314 square kilometers (21,357 sq mi). The Orinoco deposit is estimated to contain 1.2 trillion barrels of extra-heavy oil.

The government of Venezuela has no plans for halting extraction from the Belt of Tar. On the contrary, detailed plans have been made for expanded exploitation of the deposit[5].

Extraction of oil in Brazil

According to a recent article in *The Guardian*[6] "The discovery of tens of billions of barrels of oil in fields far off the coast of Rio de Janeiro was billed as one of the biggest finds of this century when it was announced in 2006.

[5]https://en.wikipedia.org/wiki/PDVSA

[6]https://www.theguardian.com/environment/ng-interactive/2015/jun/25/brazils-gamble-on-deep-water-oil-guanabara-bay

Figure 7.6: **Venezuela's Belt of Tar under the Orinoco River Basin is the world's largest deposit of extra-heavy oil and tar.**

"Many hoped it would deliver a bonanza for education and health and make Brazil one of world's major economies.

"But with the country's biggest energy company, Petrobras, mired in debt and scandal, the low price of oil and the dangers of a second Deepwater Horizon, the viability of this massive undertaking has never been under more scrutiny."

The Brazilian offshore deposits are called "presalt oil", since they lie under a thick layer of salt deposits.

According to the article in *The Guardian*, "Suggestions by climate campaigners that this reservoir of fossil fuel is a 'carbon bomb' that should be left in the ground, are dismissed as hypocrisy."

The article quotes the geologist who discovered the off-shore fields as saying "The big countries of the world today developed without any concern for the environment. The base of US development was the oil in the Gulf of Mexico. The base of the UK's industrial revolution was coal. How can they now say we can't use our own pre-salt?"

7.7 The European Union

Coal in Germany and Poland

In 2016, Germany produced 176,100,000 tonnes of coal while Poland produced 131,100,000 tonnes. In the past, Poland experienced severe ecological effects from acid rain due to the burning of coal. Polish forests were destroyed by the effects of acid rain, and the facades of statues and buildings in Krakow and elsewhere were dissolved by the acid. Today the situation is improving, but the two countries are still heavily dependant on coal.

North Sea oil

According to Wikipedia, "The British and Norwegian sections hold most of the remainder of the large oil reserves. It is estimated that the Norwegian section alone contains 54% of the sea's oil reserves and 45% of its gas reserves- More than half of the North Sea oil reserves have been extracted, according to official sources in both Norway and the UK. For Norway, the Norwegian Petroleum Directorate [28] gives a figure of 4,601 million cubic meters of oil (corresponding to 29 billion barrels) for the Norwegian North Sea alone (excluding smaller reserves in Norwegian Sea and Barents Sea) of which 2,778 million cubic meters (60%) has already been produced prior to January 2007. UK sources give a range of estimates of reserves, but even using the most optimistic 'maximum' estimate of ultimate recovery, 76% had been recovered at end 2010.[citation needed] Note the UK figure includes fields which are not in the North Sea (onshore, West of Shetland).

7.8 Major producers of fossil fuels

The top 20 oil-producing nations in 2016

Wikipedia's article entitles *List of countries by oil production* gives information shown in the table below. In the table. which is based on data from the International Energy Agency, production is measured in barrels of oil per day

1	Russia	10,551,497
2	Saudi Arabia	10,460,710
3	United States	8,875,817
4	Iraq	4,451,516
5	Iran	3,990,956
6	China	3,980,650
7	Canada	3,662,694
8	United Arab Emirates	3,106,077
9	Kuwait	2,923,825
10	Brazil	2,515,459
11	Venezuela	2,276,967
12	Mexico	2,186,877
13	Nigeria	1,999,885
14	Angola	1,769,615
15	Norway	1,647,975
16	Kazakhstan	1,595,199
17	Qatar	1,522,902
18	Algeria	1,348,361
19	Oman	1,006,841
20	United Kingdom	939,760

The top 10 coal producing nations in 2016

Wikipedia gives a similar list of coal producing nations. Only the top 10 are shown here, since these countries completely dominate global coal production. In the table, production is measured in millions of tonnes per year.

1	China	3411.0
2	India	692.4
3	United States	660.6
4	Australia	492.8
5	Indonesia	434.0
6	Russia	385.4
7	South Africa	251.3
8	Germany	176.1
9	Poland	131.1
10	Kazakhstan	102.4
	World	7,460.4

The world production of coal is falling. In 2014 it was 8,164.9 tonnes, in 2015, 7,861.1 tonnes, and in 2016 7,460.4 tonnes. Nevertheless, global production of coal remains worryingly high. If catastrophic climate change is to be avoided, it must stop altogether within one or two decades. At the moment the world is still producing roughly 1 tonne of coal per capita each year.

List of countries by natural gas production

Here is a similar table for natural gas. Production is measured in m^3 per year. The final column indicates the date of the data.

1	United States	728,200,000,000	2014
2	Russia	578,700,000,000	2014
3	Iran	438,000,000,000	2017
4	Canada	143,100,000,000	2012
5	Qatar	133,200,000,000	2011
6	Norway	114,700,000,000	2012
7	China	107,200,000,000	2012
8	Saudi Arabia	103,200,000,000	2012
9	Algeria	82,760,000,000	2011
10	Netherlands	80,780,000,000	2012
	World	4,359,000,000,000	2010

7.9 Blood for oil

There is a close relationship between petroleum and war. James A. Paul, Executive Director of the Global Policy Forum, has described this relationship very clearly in the following words:

"Modern warfare particularly depends on oil, because virtually all weapons systems rely on oil-based fuel - tanks, trucks, armored vehicles, self-propelled artillery pieces, airplanes, and naval ships. For this reason, the governments and general staffs of powerful nations

Figure 7.7: **A view of oil refineries from the Galveston Channel in Texas (Photo: Roy Luck/flick/CC)**

seek to ensure a steady supply of oil during wartime, to fuel oil-hungry military forces in far-flung operational theaters."

"Just as governments like the US and UK need oil companies to secure fuel for their global war-making capacity, so the oil companies need their governments to secure control over global oilfields and transportation routes. It is no accident, then, that the world 's largest oil companies are located in the world 's most powerful countries."

"Almost all of the world 's oil-producing countries have suffered abusive, corrupt and undemocratic governments and an absence of durable development. Indonesia, Saudi Arabia, Libya, Iraq, Iran, Angola, Colombia, Venezuela, Kuwait, Mexico, Algeria - these and many other oil producers have a sad record, which includes dictatorships installed from abroad, bloody coups engineered by foreign intelligence services, militarization of government and intolerant right-wing nationalism."

The resource curse

The way in which the industrialized countries maintain their control over less developed nations can be illustrated by the "resource curse", i.e. the fact that resource-rich developing countries are no better off economically than those that lack resources, but are cursed with corrupt and undemocratic governments. This is because foreign corporations extracting local resources under unfair agreements exist in a symbiotic relationship with corrupt local officials.

One might think that taxation of foreign resource-extracting firms would provide developing countries with large incomes. However, there is at present no international law governing multinational tax arrangements. These are usually agreed to on a bilateral basis, and the industrialized countries have stronger bargaining powers in arranging the bilateral agreements.

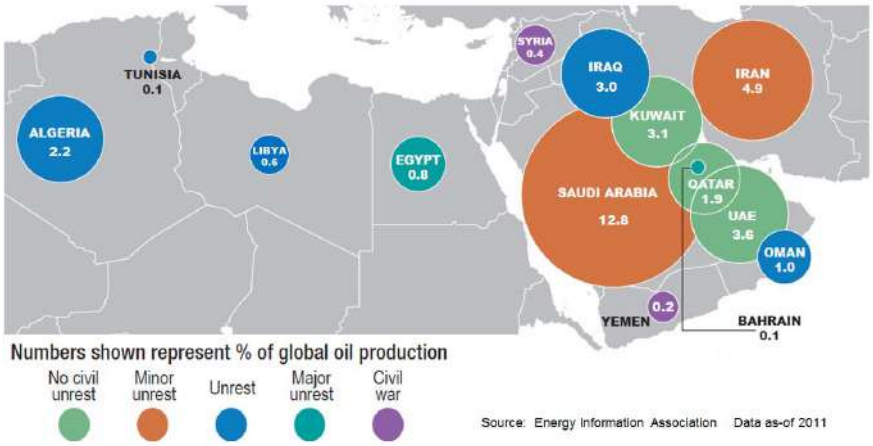

Figure 7.8: **A map showing the major oil-producing countries of the Middle East and North Africa. The percent of global oil production is indicated. Many of the countries shown have some degree of civil unrest or civil war.**

Figure 7.9: **Burning of coal in China has contributed to rapid industrial growth, but besides being a major factor in the threat of catastrophic climate change, it has produced hundreds of thousands of deaths each year through air pollution (an estimated 366,000 in 2013).**

Figure 7.10: **Protests against the Keystone XL and Dakota Access piplines which, if completed, would carry oil from the Canadian oil sands to refineries in Texas.**

7.10 Fossil fuel extraction must stop!

"Leave the oil in the soil! Leave the coal in the hole! Leave the gas under the grass!" That was message of protesters at the 2017 G20 meeting. But from the facts shown in this chapter, we can see that on the whole, fossil fuels are not being left in the ground, where they have to remain if an ecological disaster is to be avoided. On the contrary, the extraction of coal, oil and gas continues almost as though the climate emergency did not exist. Most politicians, with their eyes focused on the present, seem blind to future dangers. They think primarily about the jobs and living standards of their constituents, and about the next election. Meanwhile, the future of human civilization is neglected and remains in peril.[7]

The fact that historically, the highly industrialized nations were primarily responsible for atmospheric CO_2 increases does not excuse the developing countries from their responsibility for saving the future. Today China's coal, India's coal, Venezuela's tar sands and Brazil's pre-salt oil are among the greatest threats, and in these countries as elsewhere, extraction must stop.

We have to wake up! Business as usual cannot continue!

[7]See https://www.theguardian.com/commentisfree/2017/sep/18/enough-tiptoeing-around-lets-make-this-clear-coal-kills-people

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Chapter 8

THE HEALTH OF OUR OCEANS

8.1 Thermal inertia of the oceans

Calories required to warm a gram of water

We all know that saucepan full of water on the kitchen stove does not start to boil immediately when the heat under it is turned on. In fact, for every gram of water in the saucepan, one calorie is needed for every degree C in temperature rise. If the pan contains a kilogram of water, a kilocalorie is needed to make it warm by 1^oC.

The same principle, vastly scaled up in size, holds for the earth's oceans. When humans "turn on the heat"by releasing greenhouse gases into the atmosphere, the oceans respond very slowly because of the vast amount of energy needed to warm them. The total volume of the oceans is estimated to be 1.35×10^9 km^3 or 1.35×10^{24} cm^3. Thus to warm the earth's oceans by 1^oC requires 1.35×10^{24} calories, and the current imbalance between incoming and outgoing radiation supplies only a small fraction of this amount each year.

This means that even if the CO_2 and other greenhouse gases in our atmosphere were stabilized at their current levels, the oceans would continue to warm for many decades. This does not mean that our efforts to reduce greenhouse gas emissions are futile. We must certainly experience some very unpleasant effects of sea level rise, ocean life destruction and global warming during the next few decades, but how bad these become is up to us.

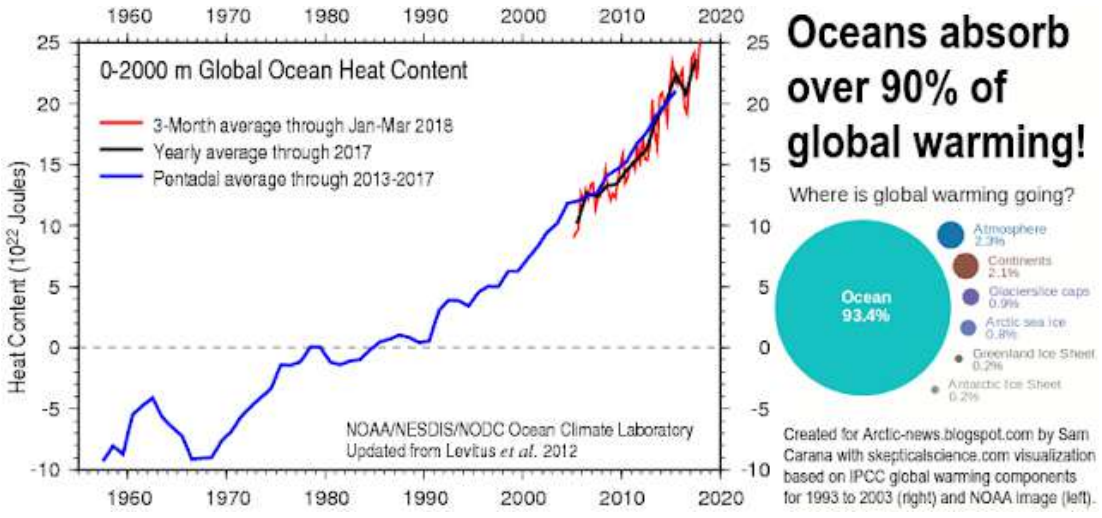

Figure 8.1: **The heat content of the oceans is rapidly increasing.**

8.2 Carbon dioxide content and acidity

Roughly 30-40% of the CO_2 released into the atmosphere by human activities is absorbed by oceans and lakes. Much of the dissolved CO_2 undergoes a reaction with water which converts it into carbonic acid:

$$CO_2 + H_2O \rightarrow HCO_3^- + H^+$$

Between 1751 and 1995 the amount of H^+ ion in ocean surface water is estimated to have increased by 35%. Living organisms are very sensitive to acidity, and today we can observe the alarming death of many forms of marine life, for example the death of coral in the Great Barrier Reef and other coral reef systems. Over a billion people depend on fish from coral reef habitats for protein in their diets.

8.3 Pollution with plastic waste

Our oceans are now massively polluted with carelessly discarded plastic waste. Plastic waste is found in huge quantities on the beaches of the remotest islands and in the blocked digestive systems of dead whales. A recent study [1] found that in 2010, 8 million tonnes of plastic went into our oceans,

The problem of plastic waste in our oceans is connected with the climate emergency, but in an indirect way. Today, most plastics are synthesized from starting chemicals extracted from fossil fuels. But the use of fossil fuels must stop if catastrophic climate change is to be avoided. However, there are new methods for synthesizing biodegradable plastics starting with chemicals extracted from plants.

[1] http://www.abc.net.au/science/articles/2015/02/13/4178113.htm

According to the polymer chemist Professor Andrew Holmes,[2] the world may have to move to fully biodegradable plastics, made out of plants. But these have drawbacks. "The challenge is, is there enough arable land to produce the building blocks of plastic when we also need to produce food?"

In the meantime, he said, we must recycle anything we can.

"Ideally all plastics should be recyclable, but at present that is not the case."

Professor Holmes said plastics that cannot be recycled - such as those used in plastic bags, or expanded polystyrene foam used in coffee cups and packaging around electronic goods - must be responsibly disposed into landfill or by burning.

"The plastic waste in the oceans is disastrous for marine and bird life, and the human race has to avoid disposal of this waste in a way that enables it to enter drains, rivers, and eventually the ocean," he said."

8.4 Overfishing

Like the massive pollution of our oceans with plastic waste, overfishing is only indirectly related to climate change. However, all three phenomena are part of the ecological mega-catastrophe that may result if humans continue to over-exploit and degrade the earth's ecological systems.

Wikipedia's article on overfishing states that "As much as 85% of the world's fisheries may be over-exploited, depleted, fully exploited or in recovery from exploitation....

"With present and forecast world population levels it is not possible to solve the over fishing issue; however, there are mitigation measures that can save selected fisheries and forestall the collapse of others...

"The United Nations Convention on the Law of the Sea treaty deals with aspects of over fishing in articles 61, 62, and 65:

- Article 61 requires all coastal states to ensure that the maintenance of living resources in their exclusive economic zones is not endangered by over-exploitation. The same article addresses the maintenance or restoration of populations of species above levels at which their reproduction may become seriously threatened.
- Article 62 provides that coastal states: "shall promote the objective of optimum utilization of the living resources in the exclusive economic zone without prejudice to Article 61"
- Article 65 provides generally for the rights of, inter alia, coastal states to prohibit, limit, or regulate the exploitation of marine mammals.

"Several scientists have called for an end to subsidies paid to deep sea fisheries. In international waters beyond the 200 nautical mile exclusive economic zones of coastal

[2]University of Melbourne
http://www.abc.net.au/news/science/2017-02-27/plastic-and-plastic-waste-explained/8301316

countries, many fisheries are unregulated, and fishing fleets plunder the depths with state-of-the-art technology. In a few hours, massive nets weighing up to 15 tons, dragged along the bottom by deep-water trawlers, can destroy deep-sea corals and sponge beds that have taken centuries or millennia to grow. The trawlers can target orange roughly, grenadiers, or sharks. These fish are usually long-lived and late maturing, and their populations take decades, even centuries to recover."

8.5 Warming oceans

In its article on "Ocean heat content", Wikipedia stated the following:

"In oceanography and climatology, ocean heat content (OHC) is a term for the energy absorbed by the ocean, which is stored as internal energy or enthalpy. Changes in the ocean heat content play an important role in the sea level rise, because of thermal expansion.

Ocean warming accounts for 90% of the energy accumulation from global warming between 1971 and 2010. About one third of that extra heat has been estimated to propagate to depth below 700 meters.Beyond the direct impact of thermal expansion, ocean warming contributes to an increased rate of ice melting in the fjords of Greenland and Antarctic ice sheets. Warmer oceans are also responsible for coral bleaching."

8.6 Biodiversity and the loss of coral reefs

Coral reefs occupy less than 0.1% 0f the ocean area, but they are the home of 25% of marine species. Because of their great biodiversity, they have been called "the rainforests of the sea".

During the voyage of the Beagle, Charles Darwin developed a theory of how coral reefs are formed, and that theory is considered to be valid today. According to Darwin's ideas, the floor of the Pacific ocean is, in general, sinking. Corals can live only at a limited range of depths. They must be covered by water, even at low tide, but not too deep under water, because sunlight is required for the photosynthesis that the polyp-algae symbionts rely on for energy. Thus as a volcano sinks below the surface with the general sinking of the Pacific ocean floor, the coral reefs grow upward around the perifera to be near to the surface, and thus, according to Darwin, circular coral atolls are formed.

Coral reefs, such as Australia's famous Great Barrier Reef, are under threat from warming oceans and from the acidification that follows from absorption of CO_2. Bleaching and death of corals, underway today, give us yet another reason to urgently address the threat of climate change.

Figure 8.2: **The crown-of-thorns starfish eats coral.**

Figure 8.3: **The overfished giant triton eats the crown-of-thorns starfish.**

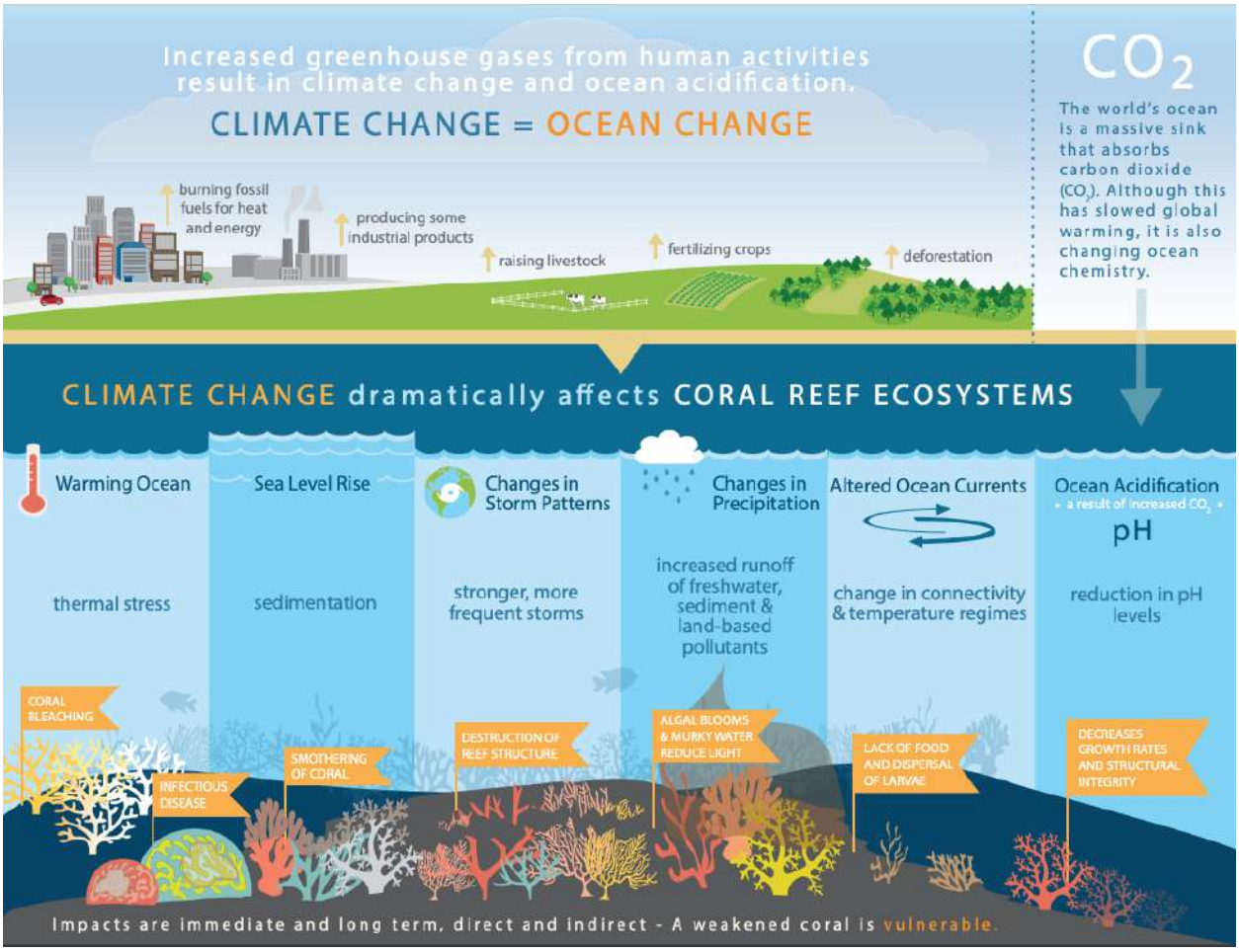

Figure 8.4: **Climate change threats to coral reefs.**

Figure 8.5: **Higher levels of carbon dioxide in the water harms the ability of young clown and damsel fishes to smell and hear.**

8.7 Kelp forests; *My Octopus Teacher*

Like coral reefs, kelp forests around the world form an environment of very high biodiversity. Activists hope that attention will be focused on the need to protect kelp forests by the highly successful Netflix documentary film, *My Octopus Teacher* (2020). The film documents Craig Foster's year-long relationship with an octopus in a South African kelp forest. The film has already won numerous awards, including the British Academy Film Award for Best Documentary, 11 April, 2021, the Critic's Choice Documentary Awards for both Best Cinematography and Best Science/Nature Documentary. The film also won the Pare Lorentz Award, the Grand Teton Award, Best People & Nature Film - Long Form, Best Science in Nature Film - Long Form, and Best Editing at the International Documentary Association Awards, January 16, 2021, as well as numerous other awards.

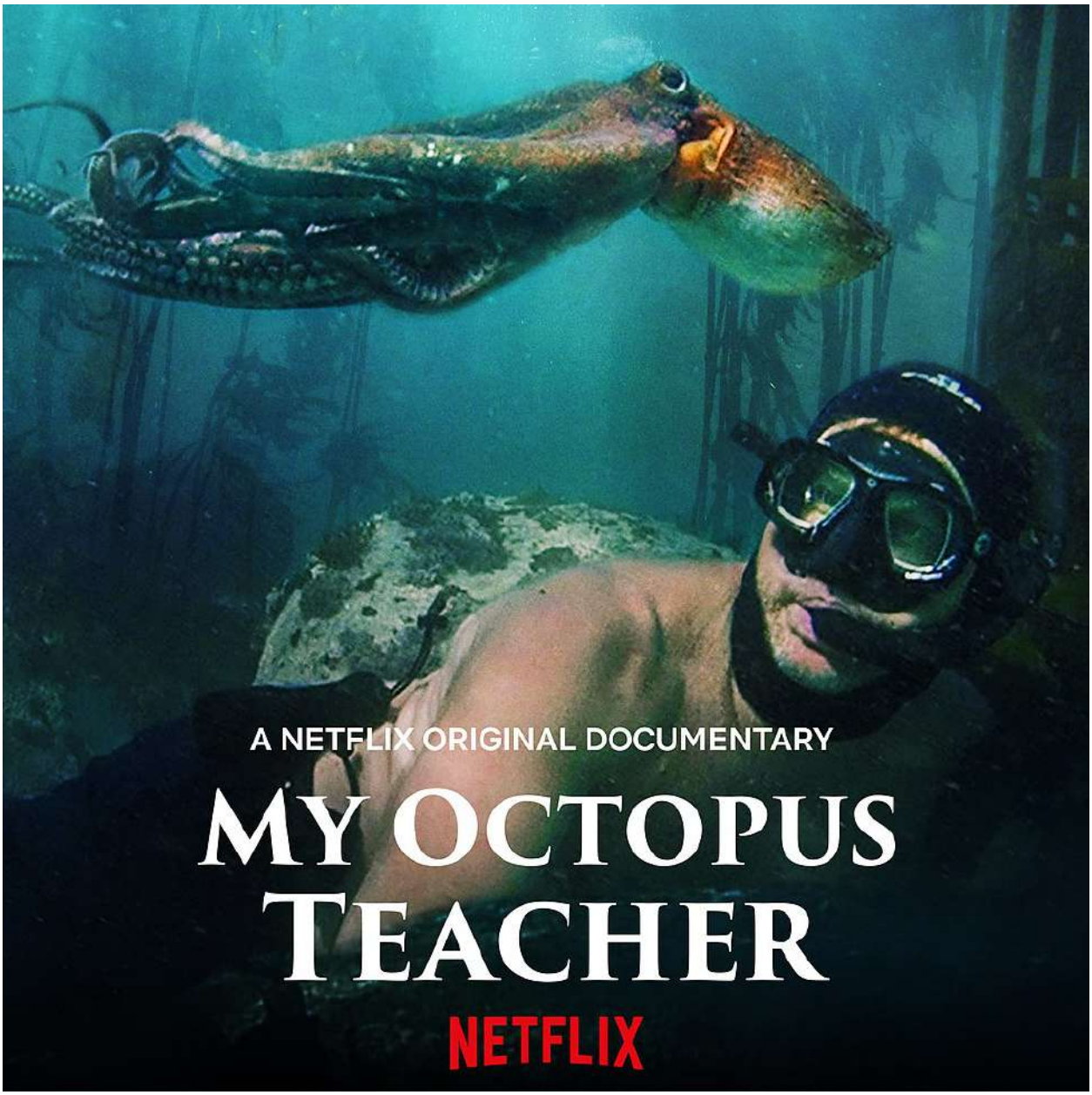

Figure 8.6: **Craig Foster dives with an octopus in the kelp forests off South Africa.**

8.8 Pollution of the Baltic with mercury

The Baltic Sea is among the most polluted ecosystems in the world. It is especially contaminated with organic chemicals and with mercury from the Swedish paper industry. Toxicologists recommend that people in the region surrounding the Baltic should strictly limit their consumption of fish caught in that sea, because of the risk of mercury poisoning. Like other heavy metals, such as lead, mercury accumulates in the body.

8.9 Ocean currents and monsoons

Climate change is increasingly causing ocean currents to change. For example, the current bringing the West African Monsoon has failed in recent years, bringing distress to farmers in the region, who rely on monsoon rains for agriculture. Global warming may also bring ocean current changes that will threaten India's monsoon, on which India's farmers are dependent.

8.10 Algae as a source of food

The amount of fresh water needed to produce food by conventional methods is very large, and limitations on the world's supply of fresh water may also limit our efforts to expand global food production unless new methods are found. One such method is the use of algae as a food source.[3]

Algae can be grown in desert areas in closed waterfilled containers, supplied with carbon dioxide. No water evaporates because the containers are closed, and the conversion of CO_2 into organic matter is an additional benefit. Protein-rich algae are already in baking mixes, cookies, milk, nondairy creamers, vegan eggs, salad dressing, ice-cream, smoothies, and protein powders, to name a few.

[3]See *Algae as a Potential Source of Food and Energy in the Developing Countries*, edited by Alvise Perosa, Guido Bordignon, Giampietro Ravagnan, and Sergey Zinoviev. The pdf file of this book is available for free downloading.

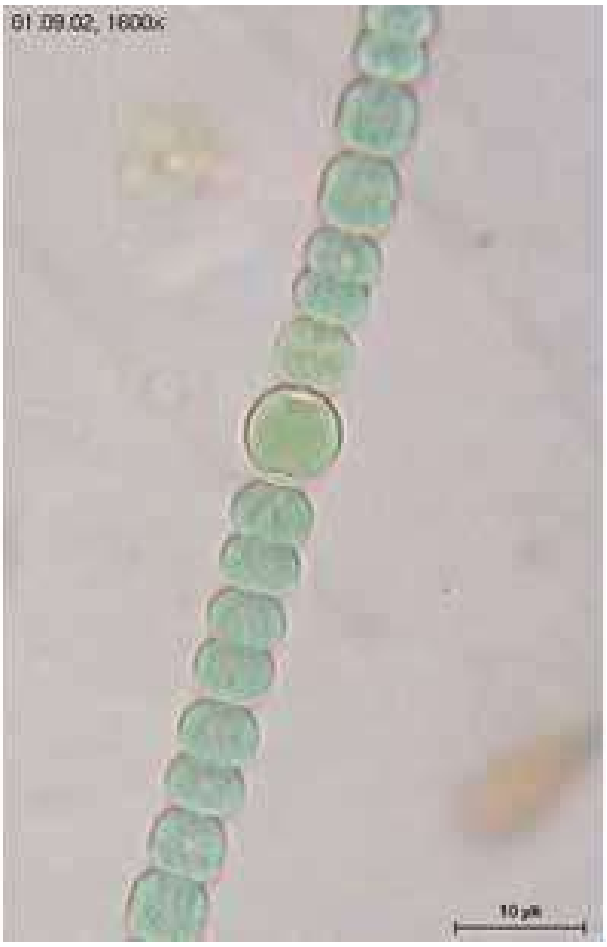

Figure 8.7: **Cyanobacteria (blue-green alga) Anabaena spherica.**

Figure 8.8: **Red alga Polysiphonia spp.**

8.11 Farming the seas

A second way in which the shortage of fresh water for global agriculture can be circumvented is to farm the seas and oceans with crops and other edible species that thrive in salt water. A study by Frank Asche of the University of Stvanger[4] points out that:

- In 1970 aquaculture contributed 5% of the total supply of seafood. In 2005 aquaculture's share was 40% with a production of 62.9 million tonnes.
- Although aquaculture is old, a revolution occurred in the 1970s.
- New technologies and better feeding has led to an enormous increase in production.
- Increasing control with the production process, and semiintensive and intensive farming allow productivity growth and market development.
- Aquaculture is increasingly becoming more like any other crop, and one is Farming the Sea.
- The farming practice varies from highly extensive and very close to hunting and gathering (fisheries) to highly intensive and industrialized.
- It is intensive industrialized farming that allows us to produce much more, and that makes aquaculture a significant source of food.
- This development is still in the early beginning, and there is still a substantial scope for innovation.
- Compared to agriculture, there is still a long way to go.
- Aquaculture is in many ways still in its infancy. There are still only a few species with closed production cycles and selective breeding. There are even fewer species that primarily are sold as fresh packed beside the chicken fillet. There are no farmers that specialize in producing feed for the food crops.
- One can still only observe the first crude attempts to farm the sea.
- We will therefore see a tremendous development during the next decades.
- Aquaculture is likely to be like any other crop or livestock in the future, because one has the same type of control with the production process. There will be a large range of practices but the large volume producers will be the most intensive.
- Local environmental issues are a management problem and can be solved.

8.12 Rate of melting of Arctic ice

Loss of Arctic sea ice

The melting of Arctic sea ice is taking place far more rapidly than was predicted by IPCC reports. David Wasdell, Director of the Apollo-Gaia Project, points out that the observed melting has been so rapid that within less than five years, the Arctic may be free of sea ice at the end of each summer. It will, of course continue to re-freeze during the winters, but the thickness and extent of the winter ice will diminish.

[4]http://www.umb.no/statisk/ior/refsnes/asche.pdf

For January 2016, the satellite based data showed the lowest overall Arctic sea ice extent of any January since records begun in 1979. Bob Henson from *Wundergrund* commented: "Hand in hand with the skimpy ice cover, temperatures across the Arctic have been extraordinarily warm for midwinter. Just before New Year's, a slug of mild air pushed temperatures above freezing to within 200 miles of the North Pole. That warm pulse quickly dissipated, but it was followed by a series of intense North Atlantic cyclones that sent very mild air poleward, in tandem with a strongly negative Arctic Oscillation during the first three weeks of the month."

During some periods, Arctic temperatures have been 50^oC above normal for the time of year. Equally alarming is the fact that plumes of methane several km^2 in area have been observed bubbling up from the sea floor in the shallow ice-free seas north of Russia.[5]

8.13 Temperature and CO_2 in ice cores

Ice cores from the Greenland and Antarctic ice sheets and from glaciers have yielded valuable data on climate changes as far back as 800,000 years in the past. The ice cores show that there is a close correlation between global temperatures and the CO_2 content of the atmosphere. The cores also show that climatic changes can take place with great rapidity.

An article by Richard B. Alley in the Proceedings of the National Academy of Science (US) [6] Here is an excerpt from the article:

"Ice-core records show that climate changes in the past have been large, rapid, and synchronous over broad areas extending into low latitudes, with less variability over historical times. These ice-core records come from high mountain glaciers and the polar regions, including small ice caps and the large ice sheets of Greenland and Antarctica.

"As the world slid into and out of the last ice age, the general cooling and warming trends were punctuated by abrupt changes. Climate shifts up to half as large as the entire difference between ice age and modern conditions occurred over hemispheric or broader regions in mere years to decades. Such abrupt changes have been absent during the few key millennia when agriculture and industry have arisen. The speed, size, and extent of these abrupt changes required a reappraisal of climate stability. Records of these changes are especially clear in high-resolution ice cores. Ice cores can preserve histories of local climate (snowfall, temperature), regional (wind-blown dust, sea salt, etc.), and broader (trace gases in the air) conditions, on a common time scale, demonstrating synchrony of climate changes over broad regions."

[5] N. Shakhova et al., *Methane release on the Arctic East Siberian shelf* , Geophysical Research Abstracts, Vol.**9**, 01071, 2007

[6] Proc Natl Acad Sci U S A. 2000 Feb 15; 97(4): 1331-1334. PMCID: PMC34297

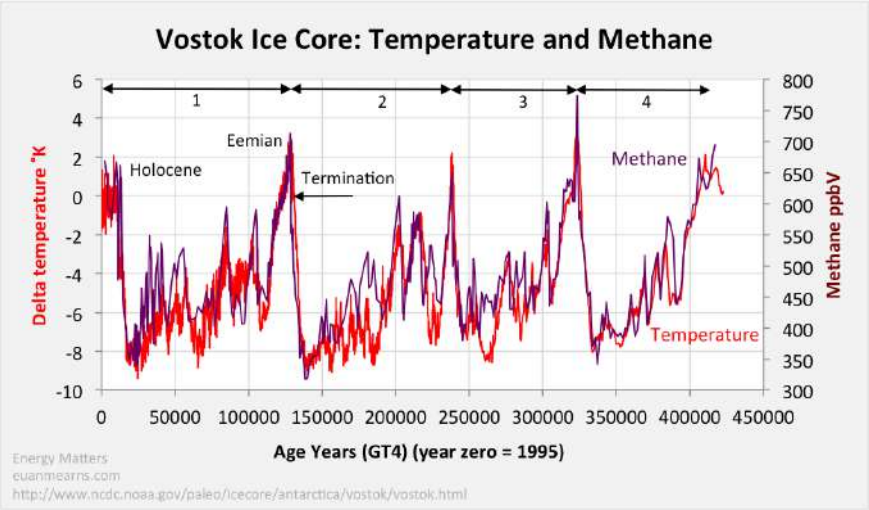

Figure 8.9: **In ice core data, we see a close correlation between temperature and atmospheric CO_2. There is also a close correlation between temperature and atmospheric methane.**

8.14 Short-term sea level rise

Flooding of coastal cities in the United States

The *National Geographic* recently published an article by Laura Parker entitled "Sea Level Rise Will Flood Hundreds of Cities in the Near Future+."[7] Here are a few excerpts from the article:

"Sea level rise caused by global warming is usually cast as a doomsday scenario that will play out so far into the future, it's easy to ignore. Just ask anyone in South Florida, where new construction proceeds apace. Yet already, more than 90 coastal communities in the United States are battling chronic flooding, meaning the kind of flooding that's so unmanageable it prompts people to move away.

"That number is expected to roughly double to more than 170 communities in less than 20 years.

"Those new statistics, compiled in the first comprehensive mapping of the entire coastline of the Lower 48 states, paint a troubling picture, especially for the East and Gulf coasts, which are home to some of the nation's most populated areas.

"By the end of the century, chronic flooding will be occurring from Maine to Texas and along parts of the West Coast. It will affect as many as 670 coastal communities, including Cambridge, Massachusetts; Oakland, California; Miami and St. Petersburg, Florida; and four of the five boroughs of New York City. The magnitude of the coming calamity is so great, the ripple effects will reach far into the interior."

Just as an iceberg the size of Delaware broke away from an ice shelf in Antarctica

[7] http://news.nationalgeographic.com/2017/07/sea-level-rise-flood-global-warming-science/

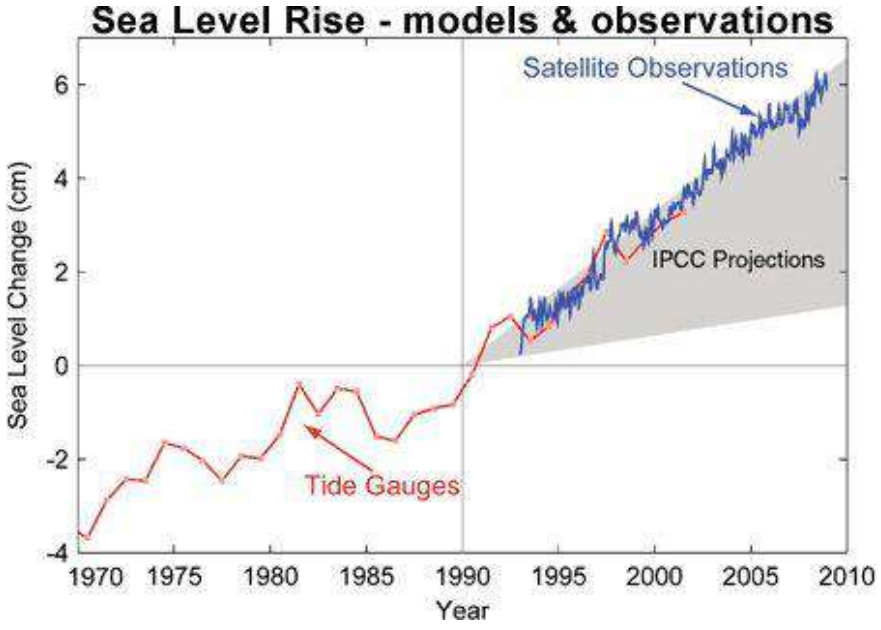

Figure 8.10: **Observed sea-level rise, 1970-2010.**

Wednesday, July 12, 2017, scientists released findings that up to 668 U.S. communities could face chronic flooding from rising sea levels by the end of the century.

The Union of Concerned Scientists recently published a report entitled "When Rising Seas Hit Home: Hard Choices Ahead for Hundreds of US Coastal Communities"[8] The report states that "Chronic inundation will dramatically alter the landscape and the livability rise of just three feet would submerge the Maldives and make them uninhabitable of many coastal communities." rise of just three feet would submerge the Maldives and make them uninhabitable

Island nations threatened by rising oceans

The US National Academy of Sciences predictions from 2009 suggest that by 2100, sea level could increase by anywhere from 16 inches to 56 inches, depending how the Earth responds to changing climate.

The Maldives, consisting of over 1,100 islands to the west of India, is the world's lowest-lying nation. On average the islands are only 1.3 meters above sea level. The 325,000 (plus 100,000 expatriate workers who are not counted in the census) residents of the islands are threatened by rising sea levels. A rise of just three feet would submerge the Maldives and make them uninhabitable. Many island nations in the Pacific are also severely threatened by sea level rise.

[8]http://www.ucsusa.org/sites/default/files/attach/2017/07/when-rising-seas-hit-home-full-report.pdf

Figure 8.11: **Today the beautiful city of Venice is flooded. Tomorrow unless urgent climate action is taken, all coastal cities will be under water.**

Displacement of populations in Southeast Asia

A World Bank press release has stated that "Bangladesh will be among the most affected countries in South Asia by an expected 2^oC rise in the world's average temperatures in the next decades, with rising sea levels and more extreme heat and more intense cyclones threatening food production, livelihoods, and infrastructure as well as slowing the reduction on poverty, according to a new scientific report released today by the World Bank Group.

" 'Bangladesh faces particularly severe challenges with climate change threatening its impressive progress in overcoming poverty,' said Johannes Zutt, World Bank Country Director for Bangladesh and Nepal. 'Bangladesh has demonstrated itself as a leader in moving the climate change agenda forward'-

"In Bangladesh, 40% of productive land is projected to be lost in the southern region of Bangladesh for a 65cm sea level rise by the 2080s. About 20 million people in the coastal areas of Bangladesh are already affected by salinity in drinking water. Rising sea levels and more intense cyclones and storm surges could intensify the contamination of groundwater and surface water causing more diarrhea outbreak."

Important rice-growing river delta regions of Viet Nam will also be lost during the present century.

Figure 8.12: **The *World Scientists' Warning of a Climate Emergency* was published in Bioscience on 5 November, 2019. The article states that "Scientists have a moral obligation to clearly warn humanity of any catastrophic threat and to 'tell it like it is.' On the basis of this obligation and the graphical indicators presented below, we declare, with more than 11,000 scientist signatories from around the world, clearly and unequivocally that planet Earth is facing a climate emergency...Despite 40 years of global climate negotiations... we have generally conducted business as usual and have largely failed to address this predicament."**

Effects on the Netherlands, Danish islands, and Venice

Although the Netherlands, the Danish islands and Venice have had many years of experience in coping with floods due to high sea levels and storm surges, these European areas may have difficulties during the present century.

Greenland's icecap is melting much faster than was predicted by the IPCC, and sea level rise may exceed 100 cm. before 2100. Hurricanes are also becoming more severe, as has already been shown by Katrina and Sandy. Future hurricanes hitting Europe's Atlantic coasts will produce dangerous storm surges. In Venice, the danger from hurricanes is less severe, but Venice already experiences severe flooding and the rise of sea levels during the present century may endanger the priceless cultural monuments of the famous ancient city.

8.15 Long-term sea level rise

A 2012 article by Jevrejeva, S., Moore, J. C. and Grinsted, A. in the in the Journal of Global and Planetary Change[9] deals with sea level rise until 2500. Of course, the long-term future runs over hundreds of millennia, but nevertheless, the article, entitled "Sea level projections to AD2500 with a new generation of climate change scenarios" is of interest.

The article states that "Sea level rise over the coming centuries is perhaps the most damaging side of rising temperature. The economic costs and social consequences of coastal flooding and forced migration will probably be one of the dominant impacts of global warming. To date, however, few studies on infrastructure and socio-economic planning include provision for multi-century and multi-meter rises in mean sea level...

"We estimate sea level rise of 0.57 - 1.10 m by 2100 with four new RCP scenarios. Sea level will continue to rise for several centuries reaching 1.84 - 5.49 m by 2500. Due to long response time most rise is expected after stabilization of forcing. 200-400 years will require dropping the rate to the 1.8 mm/yr- 20th century average."

According to an article published by the Potsdam Institute for Climate Impact Research [10] "The Greenland ice sheet is likely to be more vulnerable to global warming than previously thought. The temperature threshold for melting the ice sheet completely is in the range of 0.8 to 3.2 degrees Celsius global warming, with a best estimate of 1.6 degrees above pre-industrial levels, shows a new study by scientists from the Potsdam Institute for Climate Impact Research (PIK) and the Universidad Complutense de Madrid. Today, already 0.8 degrees global warming has been observed. Substantial melting of land ice could contribute to long-term sea-level rise of several meters and therefore it potentially affects the lives of many millions of people.

"The time it takes before most of the ice in Greenland is lost strongly depends on the level of warming. 'The more we exceed the threshold, the faster it melts,' says Alexander

[9] Volumes 80-81, January 2012, Pages 14.20

[10] https://www.pik-potsdam.de/news/press-releases/archive/2012/gronlands-eismassen-konnten-komplett-schmelzen-bei-1-6-grad-globaler-erwarmung

Robinson, lead-author of the study now published in Nature Climate Change. In a business-as-usual scenario of greenhouse-gas emissions, in the long run humanity might be aiming at 8 degrees Celsius of global warming. This would result in one fifth of the ice sheet melting within 500 years and a complete loss in 2000 years, according to the study. 'This is not what one would call a rapid collapse,' says Robinson. 'However, compared to what has happened in our planet's history, it is fast. And we might already be approaching the critical threshold.'

"In contrast, if global warming would be limited to 2 degrees Celsius, complete melting would happen on a timescale of 50.000 years. Still, even within this temperature range often considered a global guardrail, the Greenland ice sheet is not secure. Previous research suggested a threshold in global temperature increase for melting the Greenland ice sheet of a best estimate of 3.1 degrees, with a range of 1.9 to 5.1 degrees. The new study's best estimate indicates about half as much.

"'Our study shows that under certain conditions the melting of the Greenland ice sheet becomes irreversible. This supports the notion that the ice sheet is a tipping element in the Earth system,' says team-leader Andrey Ganopolski of PIK. 'If the global temperature significantly overshoots the threshold for a long time, the ice will continue melting and not re-grow - even if the climate would, after many thousand years, return to its preindustrial state- This is related to feedbacks between the climate and the ice sheet: The ice sheet is over 3000 meters thick and thus elevated into cooler altitudes. When it melts its surface comes down to lower altitudes with higher temperatures, which accelerates the melting. Also, the ice reflects a large part of solar radiation back into 'Our study shows that under certain conditions the melting of the Greenland ice sheet becomes irreversible. This supports the notion that the ice sheet is a tipping element in the Earth system,' says team-leader Andrey Ganopolski of PIK.'If the global temperature significantly overshoots the threshold for a long time, the ice will continue melting and not re-grow - even if the climate would, after many thousand years, return to its preindustrial state.' This is related to feedbacks between the climate and the ice sheet: The ice sheet is over 3000 meters thick and thus elevated into cooler altitudes. When it melts its surface comes down to lower altitudes with higher temperatures, which accelerates the melting. Also, the ice reflects a large part of solar radiation back into space. When the area covered by ice decreases, more radiation is absorbed and this adds to regional warming.space. When the area covered by ice decreases, more radiation is absorbed and this adds to regional warming."

8.16 Populations displaced by sea level rise

In a recent article[11] discussed the long-term effects of sea level rise and the massive refugee crisis that it might create. By 2060, about 1.4 billion people could be climate change refugees, according to the paper, and that number could reach 2 billion by 2100.

[11] Geisler C. et al,, *Impediments to inland resettlement under conditions of accelerated sea level rise* , Land Use Policy, Vol **55**, July 2017, Pages 322-330

The lead author, Prof. Emeritus Charles Geisler of Cornell University says: "The colliding forces of human fertility, submerging coastal zones, residential retreat, and impediments to inland resettlement is a huge problem. We offer preliminary estimates of the lands unlikely to support new waves of climate refugees due to the residues of war, exhausted natural resources, declining net primary productivity, desertification, urban sprawl, land concentration, 'paving the planet' with roads and greenhouse gas storage zones offsetting permafrost melt."

We should notice that Prof. Geisler's estimate of 2 billion climate refugees by 2100 includes all causes, not merely sea level rise. However, the number of refugees from sea level rise alone will be very large, since all the world's coastal cities, and many river deltas will be at risk.

8.17 Populations displaced by drought and famine

Climate change could produce a refugee crisis that is "unprecedented in human history", Barack Obama has warned as he stressed global warming was the most pressing issue of the age.

Speaking at an international food conference in Milan, the former US President said rising temperatures were already making it more difficult to grow crops and rising food prices were "leading to political instability".

If world leaders put aside "parochial interests" and took action to reduce greenhouse gas emissions by enough to restrict the rise to one or two degrees Celsius, then humanity would probably be able to cope.

Failing to do this, Mr. Obama warned, increased the risk of "catastrophic" effects in the future, "not only real threats to food security, but also increases in conflict as a consequence of scarcity and greater refugee and migration patterns".

"If you think about monsoon patterns in the Indian subcontinent, maybe half a billion people rely on traditional rain patterns in those areas,"

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Chapter 9

THE GLOBAL HUMAN FOOTPRINT

9.1 How many earths does it take to support us?

The total ecological footprint of humanity is a concept used to measure the relationship between the resources that humans demand from their environment, compared with the ability of nature to provide those resources. In recent years humans have been asking the earth to provide the with much more than the earth can regenerate. Our collective footprint on the face of nature has become too large.

Here are some quotations from the homepage of the Footprint Network organization:[1]

"If a population's Ecological Footprint exceeds the region's biocapacity, that region runs an ecological deficit. Its demand for the goods and services that its land and seas can provide - fruits and vegetables, meat, fish, wood, cotton for clothing, and carbon dioxide absorption - exceeds what the region's ecosystems can renew. A region in ecological deficit meets demand by importing, liquidating its own ecological assets (such as overfishing), and/or emitting carbon dioxide into the atmosphere. If a region's biocapacity exceeds its Ecological Footprint, it has an ecological reserve.

"Conceived in 1990 by Mathis Wackernagel and William Rees at the University of British Columbia, the Ecological Footprint launched the broader Footprint movement, including the carbon Footprint, and is now widely used by scientists, businesses, governments, individuals, and institutions working to monitor ecological resource use and advance sustainable development.

"A rich introduction to the theory and practice of the approach is available in the book Ecological Footprint: Managing Our Biocapacity Budget (2019)."

[1] https://www.footprintnetwork.org/our-work/ecological-footprint/

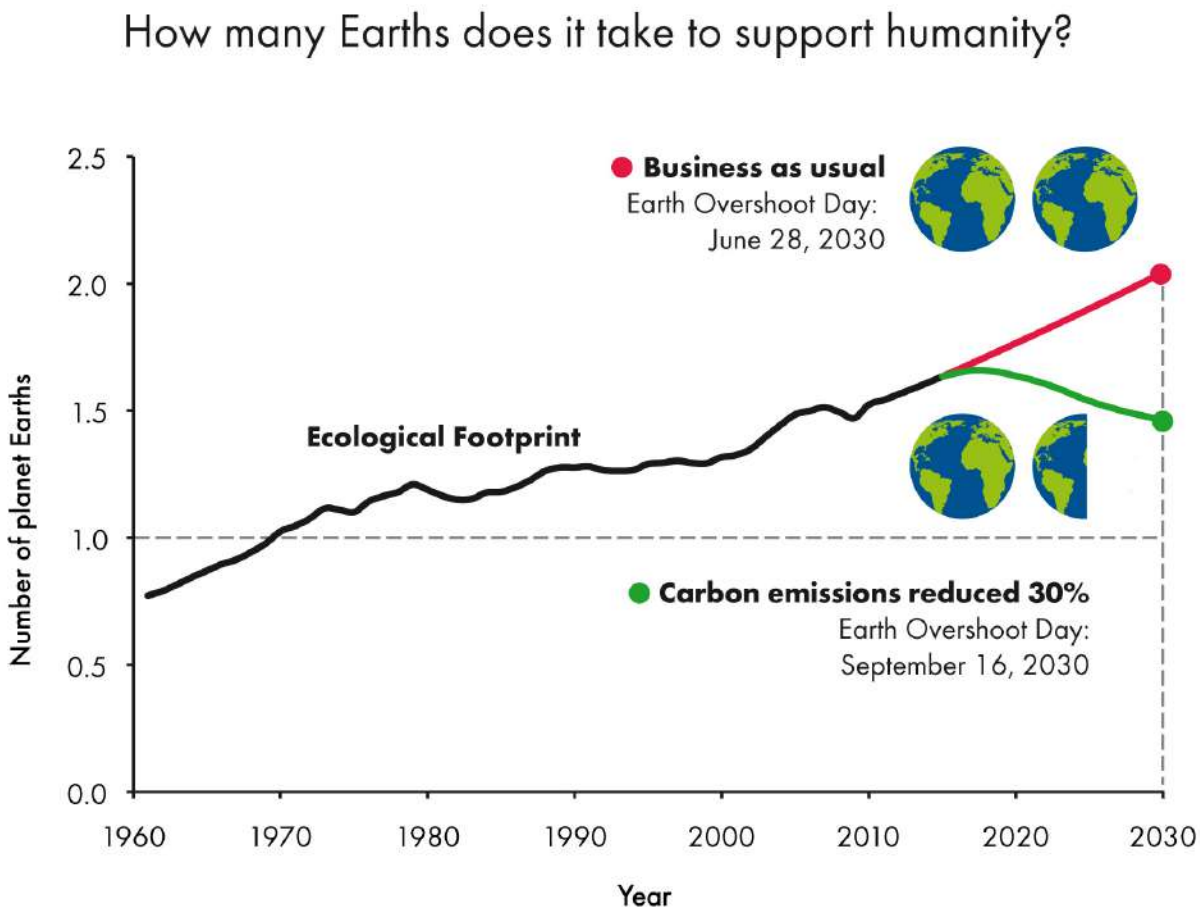


Figure 9.1: **The business as usual course would lead us to disaster.**

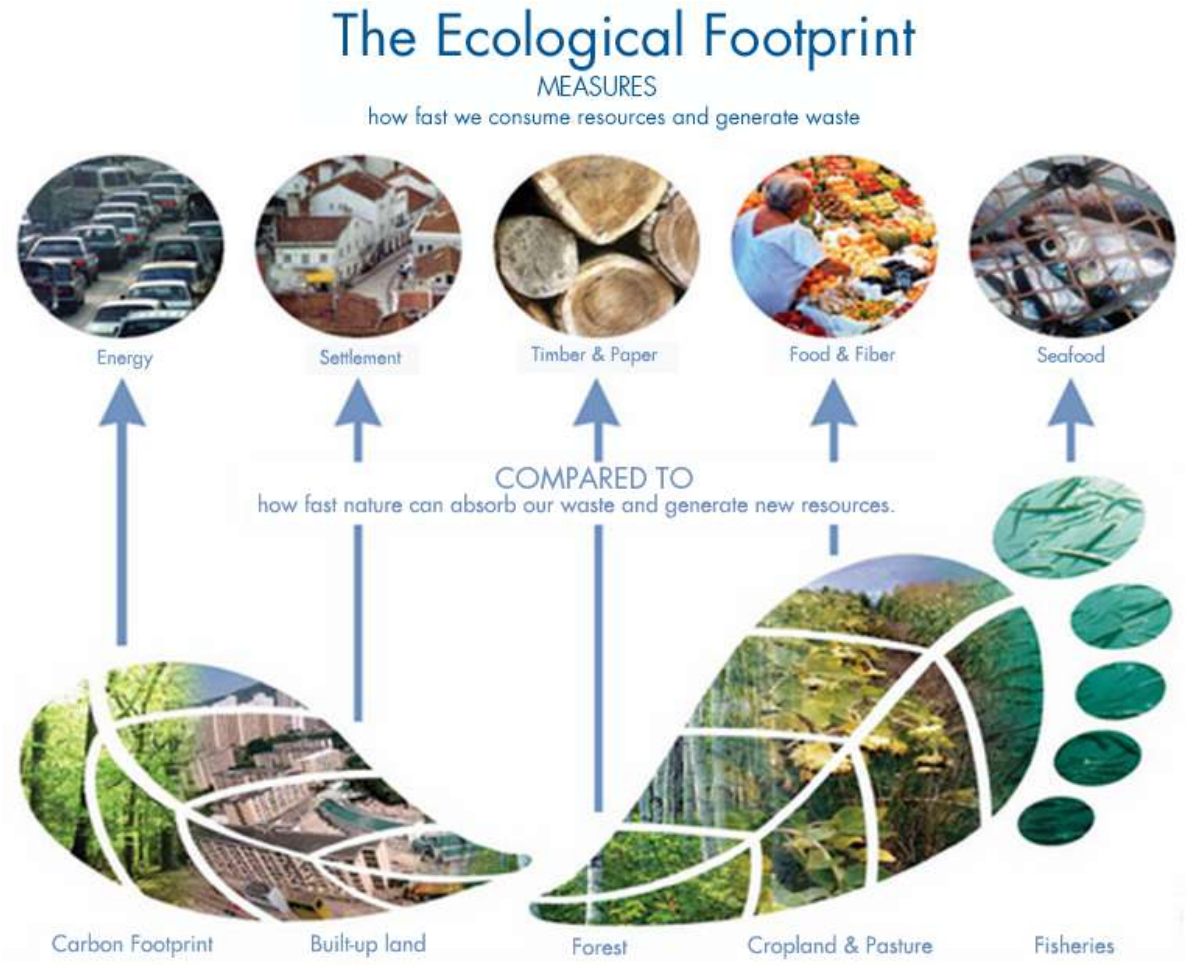


Figure 9.2: **Both the Ecological Footprint and biocapacity are expressed in global hectares - globally comparable, standardized hectares with world average productivity.**

9.2 Overuse of pesticides and the insect apocalypse

Loss of flying insects, especially bees

Studies have shown an annual decline of 5.2% in flying insect biomass found in nature reserves in Germany - about 75% loss in 26 years.

In the United States the managed bee populations have declined dramatically. According to one study, for the single year, from April 1, 2018, to April 1, 2019, the managed bee population decreased by 40.7%.

Overuse of pesticides degrades topsoil

It is not only the loss of bees and other pollinator insects that is dangerous to agriculture. The excessive use of pesticides and other agricultural chemicals also degrades topsoil. Normally, topsoil contains richly numerous and diverse populations of tiny worms and bacteria, that aid the recycling of crop residue from previous years into nutrients for plant growth. However, the overuse of pesticides and other agricultural chemicals kills these vitally important populations. Carbon from the dead topsoil is released into the atmosphere, thus increasing the concentrations of dangerous greenhouse gases. Having killed the living topsoil, farmers then find that they need increased quantities of petroleum-derived fertilizers to make their crops grow.

The Stockholm Convention on Persistent Organic Pollutants

An environmental treaty, signed in 2001 and effective since May, 2004, aims at restricting the production and use of persistent organic pollutants (POPs). These are defined by the United Nations Environmental Institute as "chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment". Besides DDT, the Stockholm Treaty also lists Aldrin, α-Hexachlorocyclohexane, β-Hexachlorocyclohexane, Chlordane, Chlordecone, Decabromodiphenyl ether, Dicofol, Dieldrin, Endosulfan, Endrin, Heptachlor, Hexabromobiphenyl, Hexabromocyclododecane, Hexabromdiphenylether, Hexachlorobenzene, Hexachlorobutadiene, Lindane, Mirex, Pentachlorobenzene, Pentachlorophenol, Perfluorooctanoic acid, Perfluorooctane sulfonic acid, Polychlorinated biphenyls, Polychlorinated dibenzodioxins, Polychlorinated naphthalenes, Tetrabromodiphenyl ether, Short-chain chlorinated paraffins, and Toxaphene.

Although some critics have claimed that the treaty is responsible for the continuing death toll from malaria, in reality it specifically permits the public health use of DDT for the control of malaria-carrying mosquitoes. In 2016, there were 216 million cases of malaria worldwide, resulting in an estimated 445,000 to 731,000 deaths.

Figure 9.3: **20 May 2019, Rome - The global decline in bee populations poses a serious threat to a wide variety of plants critical to human well-being and livelihoods, and countries should do more to safeguard our key allies in the fight against hunger and malnutrition, FAO stressed today as it marked UN World Bee Day. Bees and other pollinator are declining in abundance in many parts of the world largely due to intensive farming practices, mono-cropping, excessive use of agricultural chemicals and higher temperatures associated with climate change, affecting not only crop yields but also nutrition. If this trend continues, nutritious crops such as fruits, nuts, and many vegetables will be substituted increasingly by staple crops like rice, corn, and potatoes, eventually resulting in an imbalanced diet.**

9.3 The Silent Spring

Dangers from pesticide pollution

Rachel Carson's most influential book, *The Silent Spring*, was published in 1962, when she was already suffering from breast cancer. Eventually it sold over two million copies. The book expresses Carson's worries about the environmental consequences of overuse of pesticides, such as DDT, which were killing not only their targeted pests, but also many vitally important insects, as well as causing health problems in humans. Part of the anger that Carson expressed in the book may have come because the cancer from which she was suffering could have been caused by mutagenic pesticides.

The town was fictitious, but the problems were real

The Silent Spring begins by describing a fictitious Midwestern American town, where people are mysteriously suffering and dying from a variety of unexplained illnesses previously unseen by doctors. Sheep and cattle, fish in the river, and birds, all sicken and die. Orchards bear no fruit add vegetation withers. It gradually becomes clear that the people of the town are themselves to blame. That have been poisoning themselves and their environment by overuse of pesticides.

Some quotations from *The Silent Spring*

Here are two quotations from the book:

As crude a weapon as the cave man's club, the chemical barrage has been hurled against the fabric of life - a fabric on the one hand delicate and destructible, on the other miraculously tough and resilient, and capable of striking back in unexpected ways... It is our alarming misfortune that so primitive a science has armed itself with the most modern and terrible weapons, and that in turning them against the insects it has also turned them against the earth...

Among the herbicides are some that are classified as 'mutagens,' or agents capable of modifying the genes, the materials of heredity. We are rightly appalled by the genetic effects of radiation; how then, can we be indifferent to the same effect in chemicals that we disseminate widely in our environment?

Although extremely ill with cancer and in constant pain, Carson gave newspaper interviews and appeared on television to make her case. In July, 1962, the US Department of agriculture issued the following statement: **"Miss Carson provides a lucid description of the real and potential dangers of misusing chemical pesticides... She expresses the concern of many people about the effect of chemical pesticides on birds, animals and people. We are fully aware of and share this concern."**

'Silent Spring' Is Now Noisy Summer

Pesticides Industry Up in Arms Over a New Book

Rachel Carson Stirs Conflict—Producers Are Crying 'Foul'

By JOHN M. LEE

The $500,000,000 pesticides industry has been highly irritated by a quiet woman author whose previous works on science have been praised for the beauty and precision of the writing.

The author is Rachel Carson, whose "The Sea Around Us" and "The Edge of the Sea" were best sellers in 1951 and 1955. Miss Carson, trained as a marine biologist, wrote gracefully of sea and shore life.

In her latest work, however, Miss Carson is not so gentle,

lending the use of their products. Meetings have been held in Washington and New York. Statements are being drafted and counter-attacks plotted.

A drowsy midsummer has suddenly been enlivened by the greatest uproar in the pesticides industry since the cranberry scare of 1959.

Miss Carson's new book is entitled "Silent Spring." The title is derived from an idealized situation in which Miss Carson envisions an imaginary town where chemical pollution has silenced "the voices of nature."

Figure 9.4: **Rachel Carson's book, *The Silent Spring*, was controversial, to say the least, but it focused public attention on problems of ecology.**

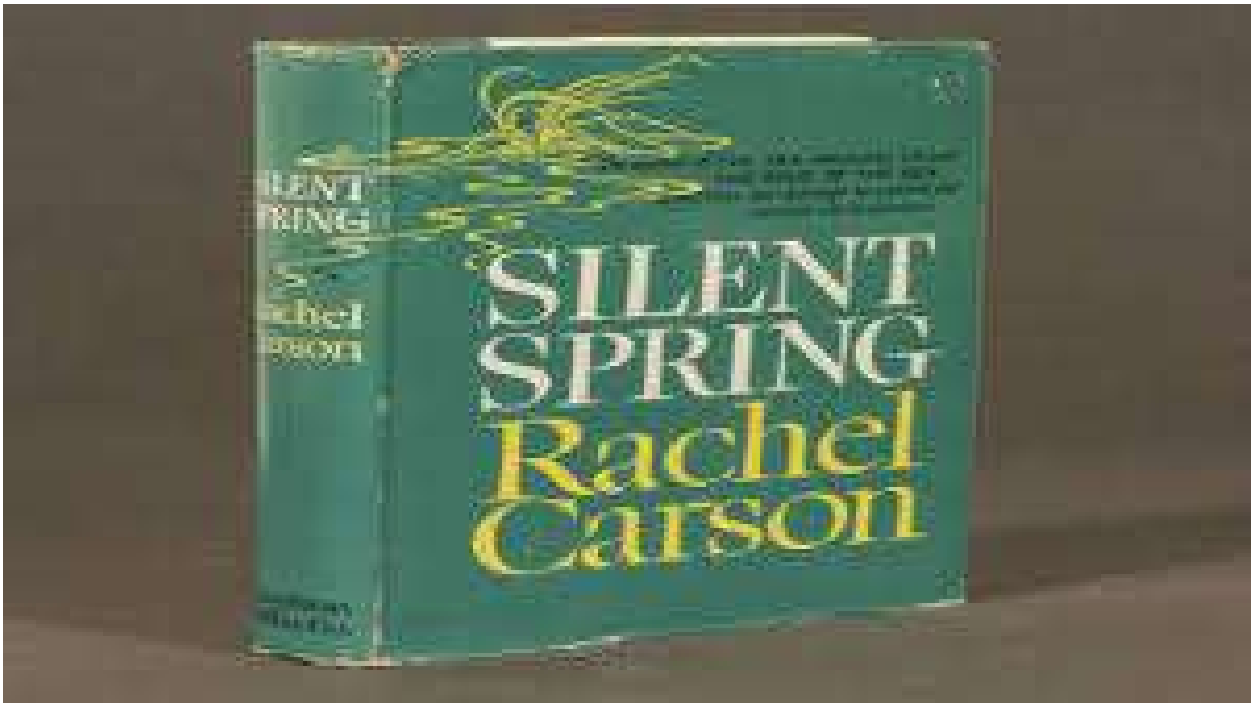


Figure 9.5: ***The Silent Spring*** **was an international best-seller, and it ignited the environmental movement.**

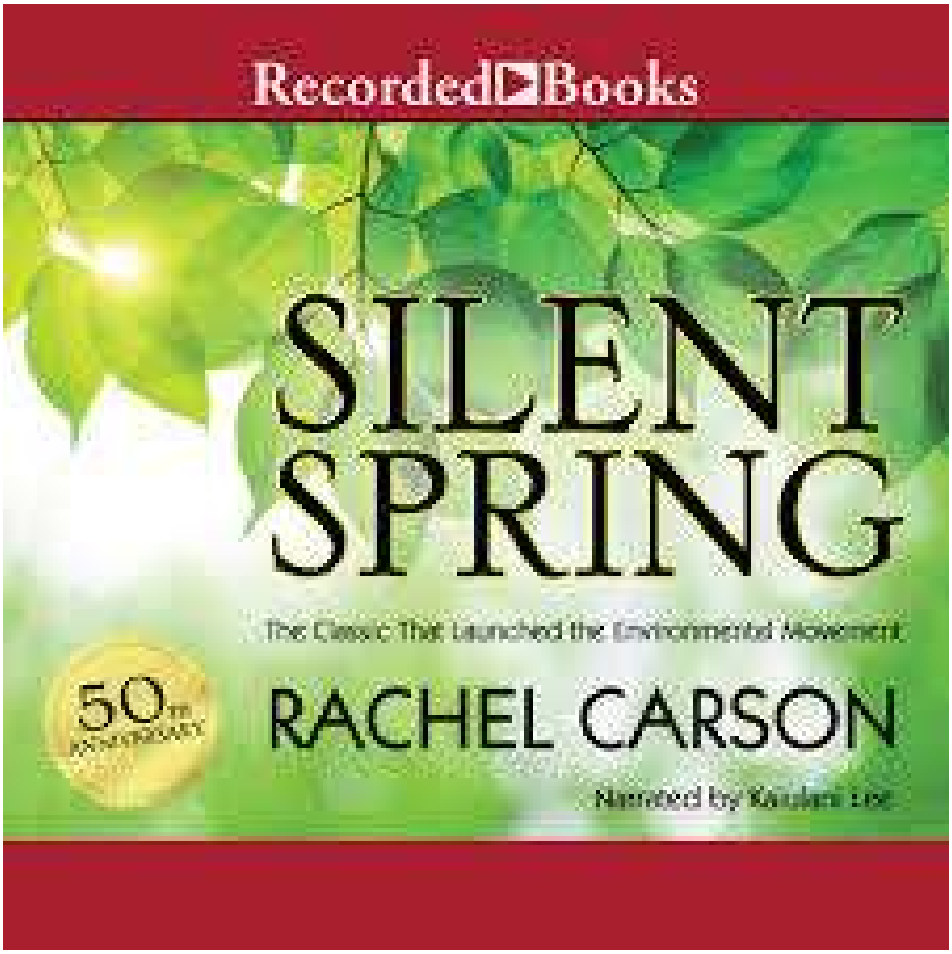


Figure 9.6: **An audio version of *The Silent Spring*.**

Figure 9.7: **As Rachel Carson's influence increased, she began speaking to large audiences.**

Figure 9.8: **Statue of Carson at the Museo Rocsen, Nono, Argentina.**

9.4 Biodiversity loss

According to Wikipedia's article on *Biodiversity Loss*,

"The current rate of global diversity loss is estimated to be 100 to 1000 times higher than the (naturally occurring) background extinction rate and expected to still grow in the upcoming years...

"According to the UN's Global Biodiversity Outlook 2014 estimates that 70 percent of the projected loss of terrestrial biodiversity are caused by agriculture use. Moreover, more than 1/3 of the planet's land surface is utilized for crops and grazing of livestock. Agriculture destroys biodiversity by converting natural habitats to intensely managed systems and by releasing pollutants, including greenhouses gases. Food value chains further amplify impacts including through energy use, transport and waste. The direct effects of urban growth on habitat loss are well understood: Building construction often results in habitat destruction and fragmentation. The rise of urbanization greatly reduced biodiversity when large areas of natural habitat are fragmented. Small habitat patches are unable to support the same level of genetic or taxonomic diversity as they formerly could while some of the more sensitive species may become locally extinct.

"Pollution from burning fossil fuels such as oil, coal and gas can remain in the air as particle pollutants or fall to the ground as acid rain. Acid rain, which is primarily composed of sulfuric and nitric acid, causes acidification of lakes, streams and sensitive forest soils, and contributes to slower forest growth and tree damage at high elevations. Moreover, Carbon dioxide released from burning fossil fuels and biomass, deforestation, and agricultural practices contributes to greenhouse gases, which prevent heat from escaping the earth's surface. With the increase in temperature expected from increasing greenhouse gases, there will be higher levels of air pollution, greater variability in weather patterns, and changes in the distribution of vegetation in the landscape. These two factors play a huge role towards biodiversity loss and entirely depended on human-driven factors."

9.5 Illegal burning for palm oil plantations

According to a recent article published by the Union of Concerned Scientists, "One huge source of global warming emissions associated with palm oil is the draining and burning of the carbon-rich swamps known as peatlands. Peatlands can hold up to 18 to 28 times as much carbon as the forests above them; when they are drained and burned, both carbon and methane are released into the atmosphere - and unless the water table is restored, peatlands continue to decay and release global warming emissions for decades.

"As if that wasn't bad enough, the burning of peatlands releases a dangerous haze into

the air, resulting in severe health impacts and significant economic losses. Each year, more than 100,000 deaths in Southeast Asia can be attributed to particulate matter exposure from landscape fires, many of which are peat fires.

"Beyond its global warming and human health impacts, palm oil production also takes a toll on biodiversity and human rights. Only about 15 percent of native animal species can survive the transition from primary forest to plantation. Among the species vulnerable to palm oil expansion are orangutans, tigers, rhinoceros, and elephants. Furthermore, palm oil growers have also been accused of using forced labor, seizing land from local populations, and other human rights abuses."

Licences to burn forests for palm oil plantations are often granted by corrupt government officials Fortunately, through the efforts of NGO's the public has become increasingly aware of the problem, and supermarkets are being urged to purchase products containing deforestation-free palm oil.

Another recent article[2] states that " Indonesia is being deforested faster than any other country in the world, and it has everything to do with one product: palm oil.

"According to a new study in the journal Nature Climate Change, deforestation in the Southeast Asian archipelago is nearly double the rate in the Amazon. Indonesia is said to have lost 840,000 hectares (3,250 square miles) of forest in 2012 while Brazil - which has four times Indonesia's rainforest - lost a still-massive 460,000 hectares.

"The report's authors found that government figures underestimated the true toll of forest clearing by as much as half. In the last 12 years, it's possible that the destruction of one million hectares of 'primary forest' went unreported.

"The tree-killing spree is largely due to slashing and burning vegetation for the expansion of palm oil plantations to feed growing demand in countries like China and India. Americans and Europeans are still far and away the top consumers per capita - it's estimated that palm oil can be found in roughly half the manufactured goods in any supermarket or drug store. Everything from peanut butter to soap to cosmetics contains the oil in its various forms.

"In Indonesia, where much of the land consists of carbon-rich soil known as peat, the problem is acute. Water-logged peat is commonly found in the jungles of Sumatra and Borneo, and merely exposing it to the air releases carbon dioxide into the atmosphere."

9.6 Jair Bolsonaro's attack on the Amazon rainforest

Beef is killing the rainforest

Beef Production is Killing the Amazon Rainforest. That is the title of an article published by onegreenplanet.org[3]. Here are some excerpts from the article

"The Amazon rainforest has been facing severe deforestation problems for several decades - it has lost about a fifth of its forest in the past three. While there are many

[2]https://news.vice.com/article/indonesia-is-killing-the-planet-for-palm-oil

[3]http://www.onegreenplanet.org/animalsandnature/beef-production-is-killing-the-amazon-rainforest/

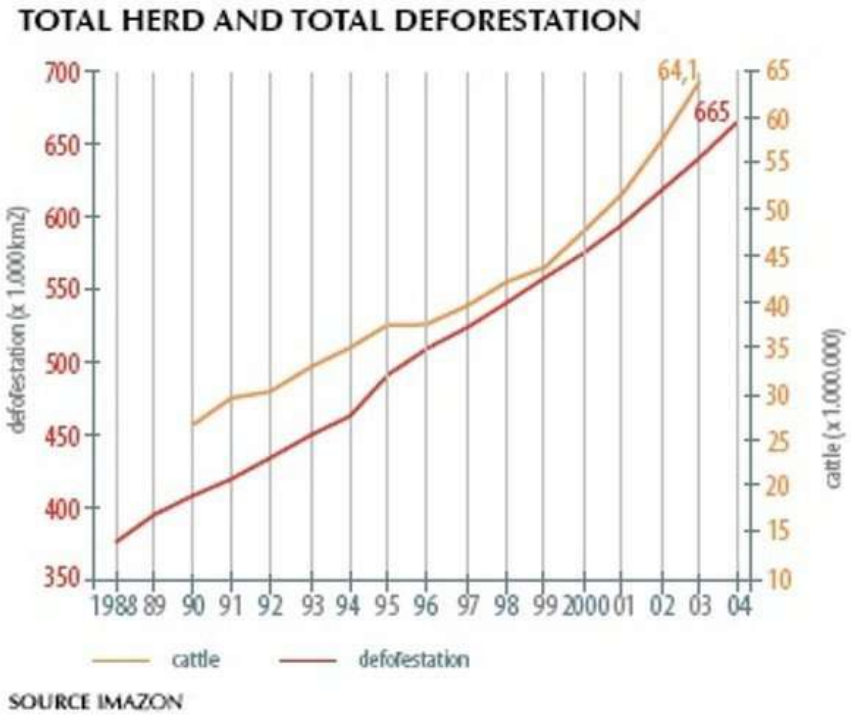


Figure 9.9: **Total cattle herds and total deforestation in Amazonia between 1988 and 2104. Deforestation is measured in thousands of square kilometers, while herd size is measured in millions.**

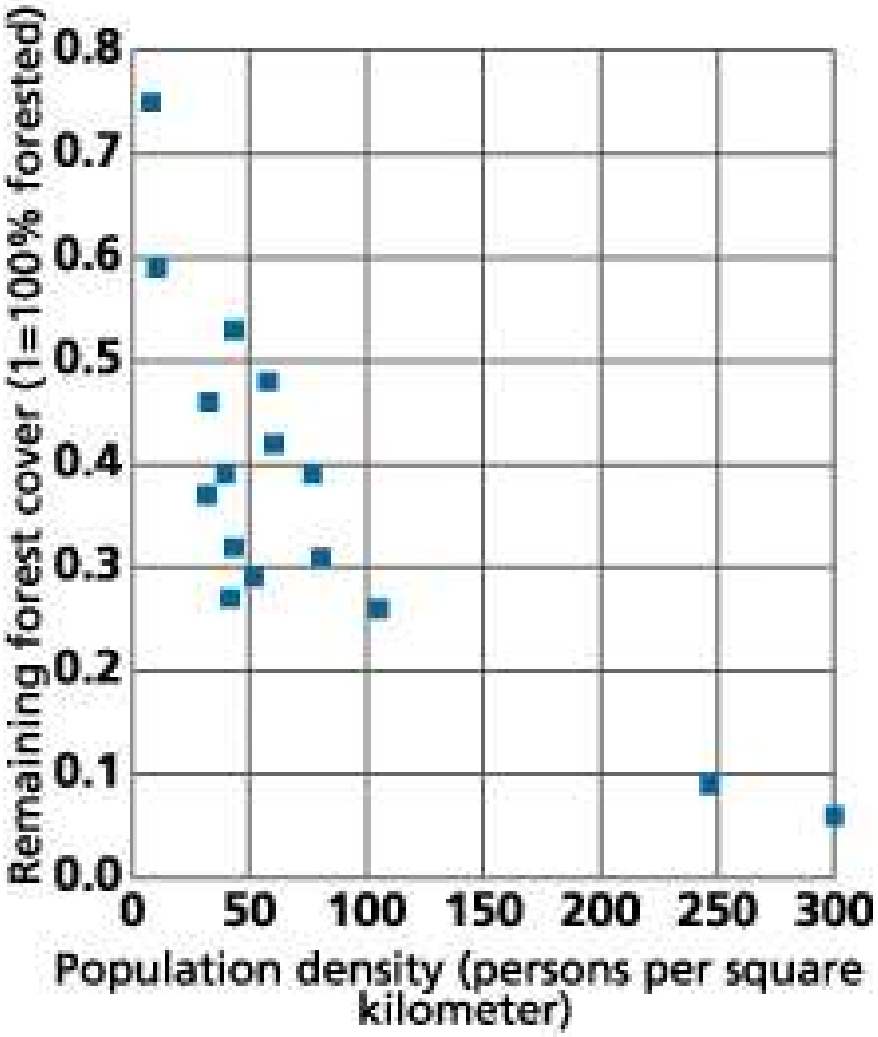


Figure 9.10: **Population density and forest size.**

causes, one of the main causes is cattle ranching, particularly in Brazil. Trees are cut and the land is converted into a pasture for cattle grazing. According to one report, an estimated 70 percent of deforestation in the Amazon basin can be attributed to cattle ranching. Using these numbers, cattle ranching in the Amazon has resulted in the loss of an area larger than the state of Washington.

"The government of Brazil offers loans of billions of dollars to support the expansion of its beef industry. Approximately 200 million pounds of beef is imported by the United States from Central America every year. While the chief importers of Brazilian beef were previously Europe and North America, nowadays Asian countries such as China and Russia consume more Brazilian beef than the European market. So, the demand is increasing day by day.

"With increasing population and increased per capita meat consumption, the rate of deforestation is increasing every day as well. It is expected that by 2018, the beef export will increase 93 percent, thereby increasing Brazil's beef market share of world exports to 61 percent. Beef is the most carbon-intensive form of meat production on the planet. The United Nations Food and Agriculture Organization finds that beef production gives rise to more greenhouse gases than the transportation industry."

Beef production and methane

A cow (or a bull) releases between 70 and 120 kg of methane per year. Methane is a greenhouse gas like carbon dioxide, but the negative effect on the climate of methane (CH_4) is 23 times higher than the effect of CO2. Therefore the release of about 100 kg methane per year for each cow is equivalent to about 2,300 kg CO_2 per year.

World.wide, there are about 1.5 billion cows and bulls. All ruminants (animals which regurgitates food and re-chews it) on the world emit about two billion metric tons of CO_2, equivalents per year. In addition, clearing of tropical forests and rain forests to get more grazing land and farm land is responsible for an extra 2.8 billion metric tons of CO2 emission per year!

According to the Food and Agriculture Organization of the United Nations (FAO) agriculture is responsible for 18% of the total release of greenhouse gases world-wide (this is more than the whole transportation sector). Cattle-breeding is taking a major factor for these greenhouse gas emissions according to FAO. Says Henning Steinfeld, Chief of FAO's Livestock Information and Policy Branch and senior author of the report: "Livestock are one of the most significant contributors to today's most serious environmental problems. Urgent action is required to remedy the situation."

Livestock now use 30 percent of the earth's entire land surface, mostly permanent pasture but also including 33 percent of the global arable land used to producing feed for livestock, the report notes. As forests are cleared to create new pastures, it is a major driver of deforestation, especially in Latin America where, for example, some 70 percent of former forests in the Amazon have been turned over to grazing.

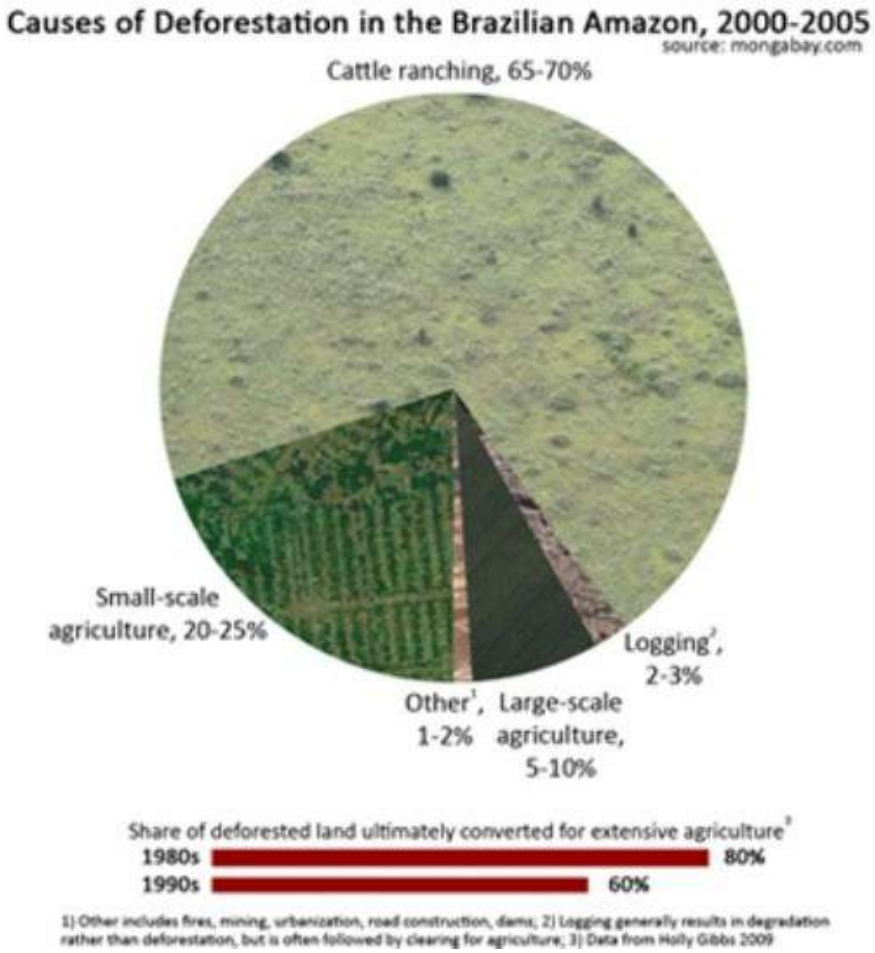


Figure 9.11: **This figure shows the causes of Amazonian deforestation. The largest is beef production.**

Dietary changes can help

You and I can help to save our common future by changing our diets, especially by cutting out beef. Not only does beef production produce methane and destroy rainforests, it also requires much more land per calorie than other forms of agriculture. By switching from beef to other protein-rich foods, we not only substantially reduce greenhouse gas emissions, but we also shorten the food chain, so that more grain will be available to feed the world's growing population. Furthermore a changed diet with less meat would improve our health, since animal fats have been linked with heart disease, circulatory problems and strokes.

9.7 Growing populations and forest loss

Deforestation is occurring at alarming rates, especially in countries that have high levels of population growth.[4] The following table shows the forest loss in some countries where it is particularly high, together with there present and projected populations[5]. In the table, the annual rate of forest loss in the period 2000-2010. measured both in thousands of hectares and in percent. Populations in millions in 2010 are shown, together with projected populations in 2050.

country	forest loss	percent	pop. 2010	pop. 2050
Brazil	-2642	-0.49	194.9	222.8
Australia	-562	-0.37	22.3	31.4
Indonesia	-498	-0.51	239.9	293.5
Nigeria	-410	-3.67	158.4	389.6
Tanzania	-403	-1.13	44.8	138.3
Zimbabwe	-327	-1.88	12.6	20.6
Dem. Rep. Congo	.311	-0.20	66.0	148.5
Myanmar	-310	-0.93	47.9	55.3
Bolivia	-290	-0.49	9.9	16.8
Venezuela	-288	-0.60	28.0	41.8

The main mechanism through which rapid population growth is linked to forest loss is felling forests for the sake of agriculture.

Notice that Nigeria is loosing 3.67% of its forests each year. The population of Nigeria is projected to more than double by 2050, but rising death rates from heat, famine and

[4] http://www.prb.org/Publications/Articles/2004
/PopulationGrowthandDeforestationACriticalandComplexRelationship.aspx

[5] Population Action International, *Why Population Matters to Forests*

conflicts may prevent this. In general, rising death rates from these causes may ultimately lead populations in the tropics to decrease rather than increase.

Population Action International points out that "Deforestation threatens the well-being and livelihoods of millions of people who heavily depend on forest resources. It is particularly devastating for women and children in poor rural communities." The organization recommends that information and materials for family planning be made available to all through universal provision of primary health care.

9.8 Desertification and soil erosion

The Princeton University Dictionary defines *desertification* as "the process of fertile land transforming into desert typically as a result of deforestation, drought or improper/inappropriate agriculture". It is estimated that approximately a billion people are under threat from further expansions of deserts.

Southward expansion of the Gobi desert

The Gobi desert is the fastest moving desert on earth. The rapid southward expansion of the Gobi is mainly due to human activities, such as overgrazing, deforestation and overuse of water. Dust storms from the Gobi desert are becoming more and more frequent. Sand dunes are reportedly forming only 70 km north of Beijing.

The Sahel

Another region in which the threat of desertification is extremely acute is the Sahel, which is the boundary between Africa's Sahara desert to the north and a region of savanna to the south. The Sahel stretches between the Atlantic Ocean and the Red Sea. During the last 50 years, the Sahel has lost approximately 650,000 km^2 of fertile land to the desert, and the boundary of the Sahara has moved 250 km southward.

The southward expansion of the Sahara has been caused partly by climate change, and partly by human activities. Growing human populations have put pressure on the fragile arid environment by overgrazing, tree-cutting for firewood and inappropriate agriculture.

9.9 Forest drying and wildfires: a feedback loop

When climate change produces aridity in a forested region, wildfires produced by lightning, stray sparks from falling stones, or human carelessness become increasingly likely. Forest fires contribute to global warming by releasing CO_2 into the atmosphere and by destroying climate-friendly tree-covered areas. Thus a dangerous feedback loop can be formed, and as was discussed in Chapter 4, with every feedback loop there is an associated tipping point, In the case of forest drying and wildfires, passing the tipping point means that forest cover will be lost irrevocably. We must avoid passing wildfire tipping points through human

activities, such as the deliberate burning of rainforests for the sake of oil palm plantations.

9.10 Degraded forests are carbon emitters

According to an article published in the journal *Science* on 28 September, 2017 [6], degraded tropical forest throughout the world have stopped being carbon absorbers, and are now carbon emitters.

Reporting on the study, *The Guardian*,[7] noted that "Researchers found that forest areas in South America, Africa and Asia - which have until recently played a key role in absorbing greenhouse gases - are now releasing 425 teragrams of carbon annually, which is more than all the traffic in the United States.

"The study went further than any of its predecessors in measuring the impact of disturbance and degradation - the thinning of tree density and the culling of biodiversity below an apparently protected canopy - usually as a result of selective logging, fire, drought and hunting.

"Overall, more carbon was lost to degradation and disturbance than deforestation. The researchers stressed this was an opportunity as well as a concern because it was now possible to identify which areas are being affected and to restore forests before they disappeared completely."

9.11 Replanting forests

Around the world, people interested in replanting forests can take inspiration from the Green Belt Movement, which was founded in 1977 by Wangari Maathai.

The Green Belt Movement organizes women in rural Africa to combat deforestation by planting trees. In this way they restore their main source of fuel for cooking, generate income and stop soil erosion. Since its foundation in 1977, the movement has planted 51 million trees. Over 30,000 women have been trained in forestry, food processing, beekeeping, and other trades. The movement emphasizes economic justice and empowerment of women. This work is particularly valuable in regions of water scarcity, because besides preventing soil erosion, forests prevent the rapid run-off of water.

In order to combat climate change and to prevent southward expansion of the Sahara. the African Union has initiated a project called the Great Green Wall. The project aims at creating a mosaic of green and productive landscapes stretching across Africa, the Sahel region to the Horn of Africa, a strip of forested land 15 km wide and 7,500 km long, stretching from Dakar to Djibouti.

[6] A. Baccini et al., *Tropical forests are a net carbon source based on aboveground measurements of gain and loss*, DOI: 10.1126/science.aam5962

[7] https://www.theguardian.com/environment/2017/sep/28/alarm-as-study-reveals-worlds-tropical-forests-are-huge-carbon-emission-source

Figure 9.12: **Nobel Laureate Wangari Maathai (1940-2011).**

Figure 9.13: **Wangari Maathai speaks about deforestation.**

In China, the Green Great Wall project aims at preventing the expansion of the Gobi desert by planting a 4,500-kilometer-long windbreaking line of forests. The project is expected to be completed by 2050.

Reforestation initiatives also exist in other countries, for example in India, Lebanon, Philippines, Japan, Germany, Canada and the United States.

9.12 Human ecology

By definition, **"Human Ecology is the study of the interactions between man and nature in different cultures. Human Ecology combines the ideas and methods from several disciplines, including anthropology, sociology, biology, economic history and archeology."**

9.13 Paul R. Ehrlich and Anne H. Ehrlich

Education

Paul R. Ehrlich was born in 1932 in Philadelphia, Pennsylvania. He studied zoology at the University of Pennsylvania, and later received a Ph.D. from the University of Kansas, where he specialized in the study of insects. In 1959. Ehrlich joined the staff of Stanford University, where he was appointed to the Bing Professorship in Zoology in 1977.

Involvement in the population debate

In 1967, a lecture on population that Ehrlich gave at the Commonwealth Club of California was broadcast on the radio. Because of the publicity that followed the radio broadcast, Ehrlich was invited by the Sierra Club and Ballantine Books to write a book on the dangers of a human population explosion. Paul R. Ehrlich and his wife, Anne H. Ehrlich together wrote a book entitled *The Population Bomb*, which was published in 1968. Although the book was a joint husband and wife production, the publisher insisted that only Paul's name should appear as author. Although others had written about the dangers of overpopulation, it was this book that brought the problem to a wide audience.

Books by Paul R. Ehrlich

- *How to Know the Butterflies* (1960)
- *Process of Evolution* (1963)
- *Butterflies and Plants: A Study in Coevolution* (1964)
- *The Population Bomb* (1968, revised 1971, updated 1978, re-issued 1988, 1998, 2008 and 2018)
- *Population, Resources, Environments: Issues in Human Ecology* (1970)
- *How to Be a Survivor* (1971)

- *Man and the Ecosphere: Readings from Scientific American* (1971)
- *Population, Resources, Environments: Issues in Human Ecology* Second Edition (1972)
- *Human Ecology: Problems and Solutions* (1973)
- *Introductory Biology* (1973)
- *The End of Affluence* (1975)
- *Biology and Society* (1976)
- *Ecoscience: Population, Resources, Environment* (1978)
- *The Race Bomb* (1978)
- *Extinction* (1981)
- *The Golden Door: International Migration, Mexico, and the United States* (1981)
- *The Cold and the Dark: The World after Nuclear War* (1984, with Carl Sagan, Donald Kennedy, and Walter Orr Roberts)
- *The Machinery of Nature: The Living World Around Us and How it Works* (1986)
- *Earth* (1987, co-authored with Anne Ehrlich)
- *Science of Ecology* (1987, with Joan Roughgarden)
- *The Cassandra Conference: Resources and the Human Predicament* (1988)
- *The Birder's Handbook: A field Guide to the Natural History of North American Birds* (1988, with David S. Dobkin and Darryl Wheye)
- *New World, New Mind: Moving Towards Conscious Evolution* (1988, co-authored with Robert E. Ornstein)
- *The Population Explosion* (1990, with Anne Ehrlich)
- *Healing the Planet: Strategies for Resolving the Environmental Crisis* (1991, co-authored with Anne Ehrlich)
- *Birds in Jeopardy: The Imperiled and Extinct Birds of the United States and Canada, Including Hawaii and Puerto Rico* (1992, with David S. Dobkin and Darryl Wheye)
- *The Stork and the Plow : The Equity Answer to the Human Dilemma* (1995, with Anne Ehrlich and Gretchen C. Daily)
- *A World of Wounds: Ecologists and the Human Dilemma* (1997)
- *Betrayal of Science and Reason: How Anti-Environment Rhetoric Threatens Our Future* (1998, with Anne Ehrlich)
- *Wild Solutions: How Biodiversity is Money in the Bank* (2001, with Andrew Beattie)
- *Human Natures: Genes*, Cultures, and the Human Prospect (2002)
- *One With Nineveh: Politics, Consumption, and the Human Future* (2004, with Anne Ehrlich)
- *On the Wings of Checkerspots: A Model System for Population Biology* (2004, edited volume, co-edited with Ilkka Hanski)
- *The Dominant Animal: Human Evolution and the Environment* (2008, with Anne Ehrlich)
- *Humanity on a Tightrope: Thoughts on Empathy, Family, and Big Changes for a Viable Future* (2010, with Robert E. Ornstein)
- *Conservation Biology for All* (2010, edited volume, co-edited with Navjot S. Sodhi)
- *Hope on Earth: A Conversation* (2014, co-authored with Michael Charles Tobias)

Figure 9.14: **Paul R. Ehrlich in 1974.**

- *Killing the Koala and Poisoning the Prairie: Australia, America and the Environment* (2015, co-authored with Corey J. A. Bradshaw)
- *The Annihilation of Nature: Human Extinction of Birds and Mammals* (2015, with Anne Ehrlich and Gerardo Ceballos)

Figure 9.15: **Ehrlich speaking in 2008.**

Figure 9.16: **Anne H. Ehrlich, Paul Ehrlich's wife, is the co-author of many of his books. I know her personally because of the many Pugwash Conferences that we both have attended. I also know John P. Holdren for the same reason,**

9.14 John P. Holdren

Education

John P. Holdren was born in Pennsylvania in 1944, but grew to in California. He graduated from MIT with a B.Sc. degree in 1965, and was awarded a Ph,D. by Stanford University in 1070, having studied aeronautics, astronautics and plasma physics.

Professor of environmental science

Holdren taught for 13 years at Harvard, and later for more than 20 years at the University of California, Berkeley. His research interests centered on environmental questions. These included global environmental change, population stabilization, energy technologies and policies, ways to reduce the dangers from nuclear weapons and materials, and science and technology policy.

Pugwash Conferences on Science and World Affairs

John P. Holdren served as the Chairman of the Executive Committee of Pugwash Conferences on Science and World Affairs. The Russell-Einstein Manifesto of 1955 called for a meeting of scientists from both sides of the Cold War to try to minimize the danger of a thermonuclear conflict. The first meeting took place at the summer home of the Canadian philanthropist Cyrus Eaton at the small village of Pugwash, Nova Scotia.

From this small beginning, a series of conferences developed, in which scientists, especially physicists, attempted to work for peace, and tried to address urgent global problems related to science, and especially to reduce the danger of a thermonuclear war. In 1995, Pugwash Conferences, and its president, Sir Joseph Rotblat, shared the Nobel Peace Prize. John P. Holdren delivered the acceptance speech on behalf of the organization.

Some books and articles by John P. Holdren

Holdren has authored over 200 articles and papers and has co-authored and co-edited some 20 books and book-length reports including

- *Ecoscience : Population, Resources, Environment* by John P. Holdren, Paul R. Ehrlich, Ann H. Ehrlich
- *Global Ecology* by John P. Holdren and Paul R. Ehrlich
- *The Cassandra Conference : Resources and the Human Predicament* by John P. Holdren and Paul R. Ehrlich
- *Strategic Defense and the Future of the Arms Race : A Pugwash Symposium* by John P. Holdren
- *Energy* by John P. Holdren
- *Science in the White House*. Science, May 2009, 567.[
- *Policy for Energy Technology Innovation. Acting in Time on Energy Policy*, (with Laura Diaz Anadon, Max H. Bazerman, David T. Ellwood, Kelly Sims Gallagher, William H. Hogan, Henry Lee, and Daniel Schrag), Brookings Institution Press, 2009.
- *The Future of Climate Change Policy: The U.S.'s Last Chance to Lead*. Scientific American 2008 Earth 3.0 Supplement. October 13, 2008, 20-21.
- *Convincing the Climate Change Skeptics*. The Boston Globe, August 4, 2008.[
- *Ending the Energy Stalemate: A Bipartisan Strategy To Meet America's Energy Challenges*. Presentation at the National Academies 2008 Energy Summit, Washington, D.C., March 14, 2008.
- *Global Climatic Disruption: Risks and Opportunities*. Presentation at Investor Summit on Climate Risk, New York, February 14, 2008.
- *Meeting the Climate-Change Challenge*. The John H. Chafee Memorial Lecture, National Council for Science and the Environment, Washington, D.C., January 17, 2008.

Figure 9.17: **John P. Holdren held the position of Assistant to the President for Science and Technology between 2009 and 2017.**

Figure 9.18: **John P. Holdren with Barack Obama.**

Figure 9.19: **John P. Holdren: "Trump has no science policy to speak of".**

9.15 Barry Commoner

Early life and education

Barry Commoner (1917-2012) was born in Brooklyn, New York, the son of Jewish immigrants from Russia. After a B.Sc. from Colombia University, he received a doctoral degree in cell biology from Harvard. In 1947, he became a professor of plant physiology at Washington University, Sr. Louis. and he taught there for the next 34 years.

A pioneer of ecology

While teaching at Washington University, Barry Commoner established the Center for the Biology of Natural Systems to study "the science of the total environment". During the late 1050's, Commoner's attention was drawn to health and environmental consequences of nuclear testing. His Baby Tooth Survey demonstrated that radioactive substances, such as Strontium 90, were being incorporated in the teeth of infants as a result of the testing of nuclear weapons. Commoner wrote: "The greatest single cause of environmental contamination of this planet is radioactivity from test explosions of nuclear weapons in the atmosphere."

Barry Commoner's US presidential campaign

In 1980, Barry Commoner founded the Citizens Party, and he ran as the party's candidate for the US presidency. Although he received only a very small percentage of the votes in the election, the campaign nevertheless made a wide public aware of the seriousness of ecological problems. During the last phase of his career, Commoner returned to New York as a professor at Queens College, part of the City University of New York. Although he stepped down from his professorship in 2000, he remained a senior scientist at Queens College until his death in 2012 at the age of 95.

Books and reports by Barry Commoner

- *Science and Survival* (1966), New York: Viking OCLC 225105 - on "the uses of science and technology in relation to environmental hazards".
- *The Closing Circle: Nature, Man, and Technology* (1971), New York: Knopf.
- *The Poverty of Power: Energy and the Economic Crisis* (1976), New York: Random House.
- *The Politics of Energy* (1979), New York: Knopf.
- *Making Peace With the Plane*t (1990), New York: Pantheon.
- *Long-range Air Transport of Dioxin from North American Sources to Ecologically Vulnerable Receptors in Nunavut, Arctic Canada*, (2000), Commoner, Barry; Bartlett, Paul Woods; Eisl, Holger; Couchot, Kim; Center for the Biology of Natural Systems, Queens College, City University of New York, published by the North American Commission for Environmental Cooperation, MontrÃ©al, QuÃ©bec, Canada.

A few things that Barry Commoner said or wrote

The proper use of science is not to conquer nature but to live in it.

Everything is connected to everything else. Everything must go somewhere. Nature knows best. There is no such thing as a free lunch.

If you ask what you are going to do about global warming, the only rational answer is to change the way in which we do transportation, energy production, agriculture and a good deal of manufacturing. The problem originates in human activity in the form of the production of goods.

The environmental crisis is somber evidence of an insidious fraud hidden in the vaunted productivity and wealth of modern, technology-based society. This wealth has been gained by rapid short-term exploitation of the environmental system, but it has blindly accumulated a debt to nature - a debt so large and so pervasive that in the next generation it may, if unpaid, wipe out most of the wealth it has gained us.

Our assaults on the ecosystem are so powerful, so numerous, so finely interconnected, that although the damage they do is clear, it is very difficult to discover how it was done. By which weapon? In whose hand? Are we driving the ecosphere to destruction simply by our growing numbers? By our greedy accumulation of wealth? Or are the machines which we have built to gain this wealth-the magnificent technology that now feeds us out of neat packages, that clothes us in man-made fibers, that surrounds us with new chemical creations-at fault?

The environmental crisis arises from a fundamental fault: our systems of production - in industry, agriculture, energy and transportation - essential as they are, make people sick and die.

Sooner or later, wittingly or unwittingly, we must pay for every intrusion on the natural environment.

Air pollution is not merely a nuisance and a threat to health. It is a reminder that our most celebrated technological achievements - the automobile, the jet plane, the power plant, industry in general, and indeed the modern city itself - are, in the environment, failures.

All of the clean technologies are known, it's a question of simply applying them.

Figure 9.20: **Time reported in its February 1970 issue that "the national concern over the environment has reached an unprecedented level of intensity." On the cover, the visage of Barry Commoner projected a powerful image of ecology, which took the stage for the first time in the public eye.**

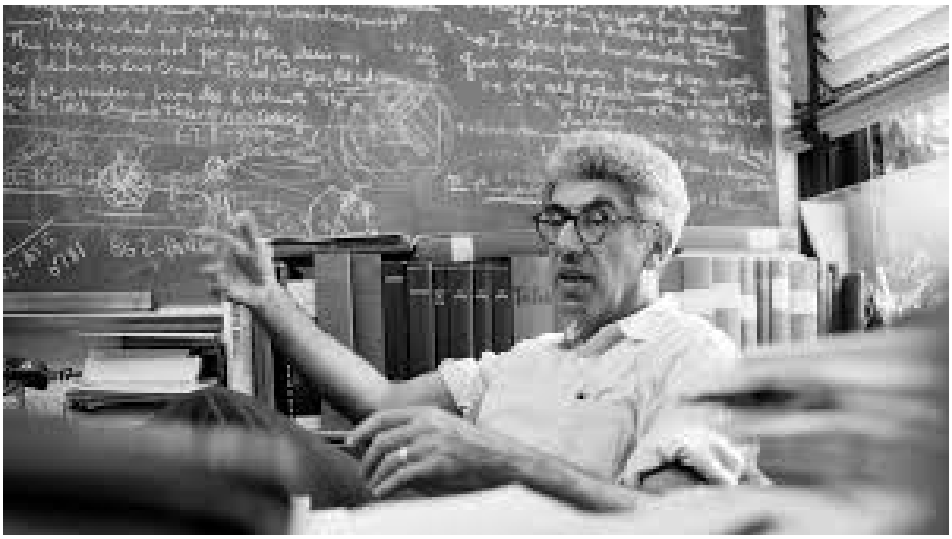
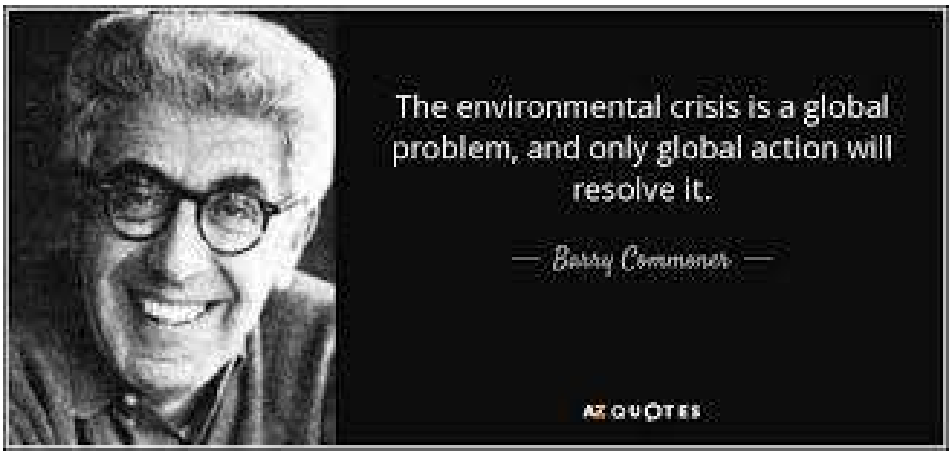


Figure 9.21: **Barry Commoner died at the age of 95 in 2012.**



The favorite statistic is that the U.S. contains 6 to 7% of the world population but consumes more than half the world's resources and is responsible for that fraction of the total environmental pollution. But this statistic hides another vital fact: that not everyone in the U.S. is so affluent.

Perhaps the simplest example is a synthetic plastic, which unlike natural materials, is not degraded by biological decay. It therefore persists as rubbish or is burned - in both cases causing pollution. In the same way, a substance such as DDT or lead, which plays no role in the chemistry of life and interferes with the actions of substances that do, is bound to cause ecological damage if sufficiently concentrated.

Because the global ecosystem is a connected whole, in which nothing can be gained or lost and which is not subject to over-all improvement, anything extracted from it by human effort must be replaced. Payment of this price cannot be avoided; it can only be delayed. The present environmental crisis is a warning that we have delayed nearly too long.

Despite the dazzling successes of modern technology and the unprecedented power of modern military systems, they suffer from a common and catastrophic fault. While providing us with a bountiful supply of food, with great industrial plants, with high-speed transportation, and with military weapons of unprecedented power, they threaten our very survival.

Suggestions for further reading

1. Rachel L. Carson *Under the Sea-Wind* Oxford University Press, 1952
2. Rachel L. Carson *The Sea Around Us* Oxford University Press, 1953
3. Rachel Carson *The Edge of the Sea* Houghton Mifflin, 1955
4. Rachel Carson *Silent Spring* Houghton Mifflin, 1962
5. Linda Lear *Rachel Carson: The Life of the Author of Silent Spring* Penguin Group, 1997
6. William Souder *On a Farther Shore: The Life and Legacy of Rachel Carson* Crown Publishers, 2012
7. C.H. Wood and David L. Skole, *Linking satellite, census, and survey data to study deforestation in the Brazilian Amazon,* in **People and Pixels**, ed. D. Liverman et al. (Washington, DC: National Academies Press, 1998).
8. Suzi Kerr, Alexander S. Pfaff, and Arturo Sanchez, *Development and Deforestation: Evidence From Costa Rica* (unpublished paper, 2003).
9. Frederick A.B. Meyerson, *Population, Biodiversity and Changing Climate*, Advances in Applied Biodiversity Science **4** (2003), Chapter 11 (2003): 83-90
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Appendix A

CHINA

A.1 China's use of coal

China's large reserves of coal lie near to the surface, and are thus very easily accessible. Mining of coal has driven the country's rapid industrial growth, but it has also produced a severe public health problem because of air pollution.

China goes on a coal spree

Here are some quotations from an article entitlrd "Despite Pledges to Cut Emissions, China Goes on a Coal Spree", by Michael Standert. It was published on March 24, 2021 in Yale University's *Yale Environment 360*[1]

"China is building large numbers of coal-fired power plants to drive its post-pandemic economy. The government has promised a CO2 emissions peak by 2030, but the new coal binge jeopardizes both China's decarbonization plans and global efforts to tackle climate change.

"China's National People's Congress meetings, which ended earlier this month, were shrouded in both a real and figurative haze about how strong its climate ambitions really are and how quickly the country can wean itself from its main source of energy - coal.

"During the Congress, air pollution returned to Beijing with a vengeance, hitting the highest levels since January 2019, as the economy hummed out of the pandemic. Steel, cement, and heavy manufacturing, predominantly backed by coal power, boosted China's carbon dioxide emissions 4 percent in the second half of 2020 compared to the same pre-pandemic period the year before. At the same time, the goals in the country's 14th Five-Year Plan on energy intensity, carbon intensity, and renewables were hazy as well, little more than vague commitments to tackle carbon dioxide emissions.

[1] https://e360.yale.edu/features/despite-pledges-to-cut-emissions-china-goes-on-a-coal-spree

Figure A.1: **A coal-fired power plant in China's Jiangsu province.**

"Coal remains at the heart of China's flourishing economy. In 2019, 58 percent of the country's total energy consumption came from coal, which helps explain why China accounts for 28 percent of all global CO2 emissions. And China continues to build coal-fired power plants at a rate that outpaces the rest of the world combined. In 2020, China brought 38.4 gigawatts of new coal-fired power into operation, more than three times what was brought on line everywhere else.

"A total of 247 gigawatts of coal power is now in planning or development, nearly six times Germany's entire coal-fired capacity. China has also proposed additional new coal plants that, if built, would generate 73.5 gigawatts of power, more than five times the 13.9 gigawatts proposed in the rest of the world combined. Last year, Chinese provinces granted construction approval to 47 gigawatts of coal power projects, more than three times the capacity permitted in 2019.

"China has pledged that its emissions will peak around 2030, but that high-water mark would still mean that the country is generating huge quantities CO2 - 12.9 billion to 14.7 billion tons of carbon dioxide annually for the next decade, or as much as 15 percent per year above 2015 levels, according to a Climate Action Tracker analysis..."

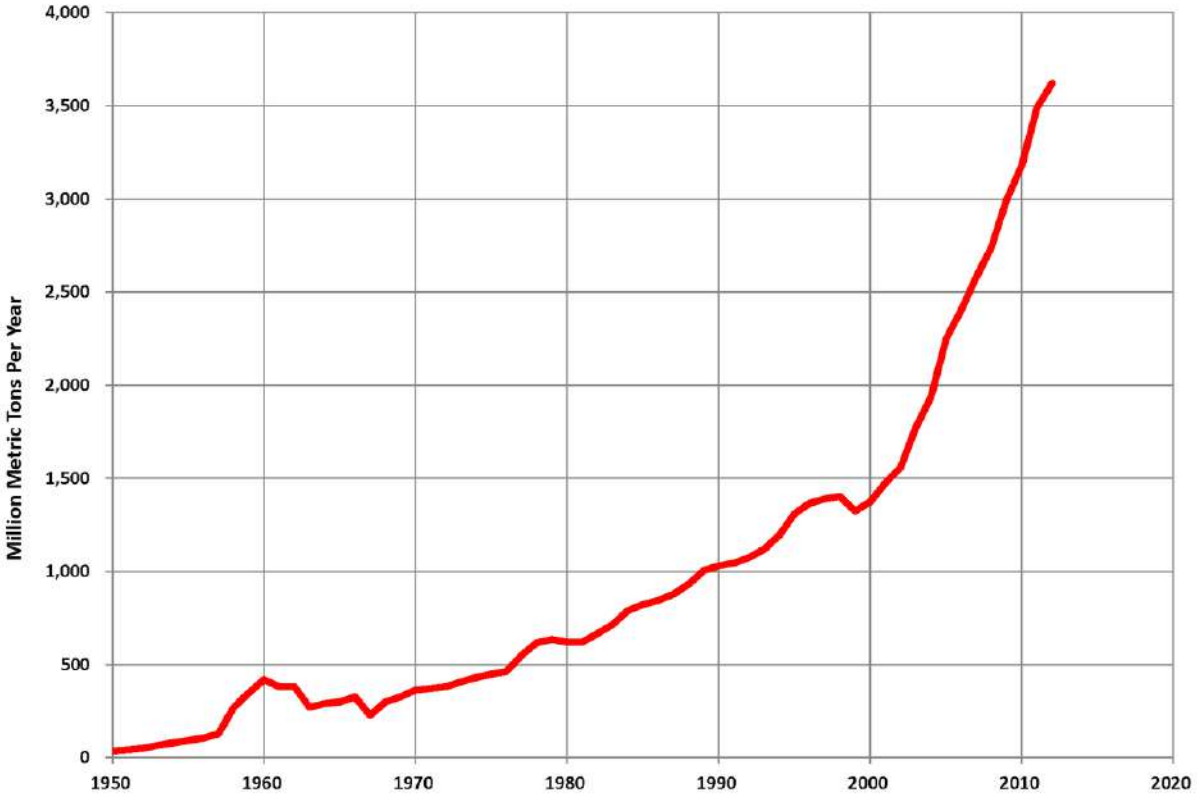

Figure A.2: **Coal production in China, 1950-2012.**

A.2 China's rate of economic growth

In April, 2017, China's rate of economic growth was 6.9%[2]. This rate of growth, if continued, would mean that China's economy would double every ten years. and increase by a factor of 1024 every century. Obviously this is impossible. Never-ending economic growth on a finite planet is a logical absurdity. China's high economic growth rate, is driven by its use of coal, and this must quickly stop if ecological disaster is to be avoided.

A.3 China's population

Table 2.1 shows the population of China at the start of various dynasties. In 125 AD, at the start of the Eastern Han Dynasty, the population was 48,690,789. The precision of this figure is surprising, and it is perhaps the result of the strength of the central government of China even at that early date. As seen in Table 2.1 the population seems to have fallen again, probably to famine and war. Fear of these terrible Malthusian forces explains the Chinese preference for a strong central government. At the start of the Qing dynasty in the 17th century, the population of China began to increase rapidly, probably because of improved flood control and irrigation methods. By 1901. the population of China had reached 426,447,325.

Figure 2.19 shows the growth of Chinese population between 1960 and the present. China's population continues to increase, dispute the government's one-child policy, and today the country has approximately 1.4 billion people. China's rate of population growth is currently only 0.59%.

The post-1949 Chinese government leaders at first viewed population growth as an asset. However, worries about falling water tables and the future availability of fresh water for agriculture, as well as the realization that rapid population growth would block economic development soon produced a policy switch; and the Chinese government began to strongly support both birth control and late marriage.

Since 1979, the Chinese government has advocated a one-child policy for both rural and urban areas. However, this policy admits many exceptions and has been most effective in cities, where the government is able to exert it power by giving apartments only to families with a single child. In 2016, the one-child policy began to be phased out.

[2]https://tradingeconomics.com/china/gdp-growth-annual

Figure A.3: **The one-child policy: A Chinese mother and her only child at a market in Jiayuguan. Recently China relaxed its one-child policy, allowing two children per family, and even more recently, three.**

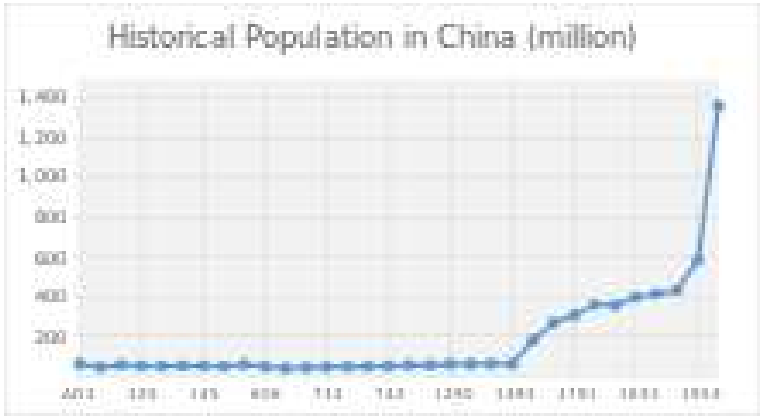

Figure A.4: **Historical estimates of China's population, in millions, from AD 2 until the present. After Ming and earlier period of Qing dynasty founded population moved around 100 million to 150 million until 1700s. In the period between 1749 and 1851, the population doubled in a century. During 1960-2015, the population doubled to nearly 1.4 billion .**

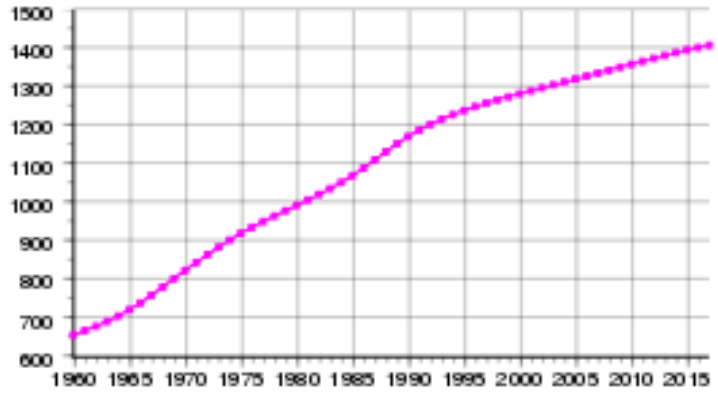

Figure A.5: **This graph shows the population growth of China, in billions, since 1900. Despite China's one-child policy, the country's population continues to grow because of exceptions to the policy and because so many young people are now reaching reproductive age.**

Figure A.6: **This figure shows China's economic growth rate in recent years. The doubling time for a quantity growing at the rate of 6.8% per year is only 11 years. This high rate of economic growth, compounded by China's still-growing population, cannot continue without producing an ecological catastrophe, the beginnings of which can already be seen in China.**

Table A.1: **China's Dynastic Census Data**

Dynasty	Date (AD)	Households	Population
Eastern Han	125	9,647,838	48,690,789
Western Jin	280	2,458,480	16,163,863
Tang	639	3,120,151	13,252,894
Song	1003	6,864,160	14,278,040
Ming	1398	10,699,399	58,323,933
Qing	1661	not recorded	58,323,933
Qing	1722	not recorded	103,053,992
Qing	1812	not recorded	333,700,560
Qing	1901	not recorded	426,447,325

Suggestions for further reading

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Appendix B

INDIA

B.1 India's use of coal

The MIT Technology Review recently published an important article entitled *India's Energy Crisis*[1].

The article makes alarming reading in view of the world's urgent need to make a very rapid transition from fossil fuels to 100% renewable energy. We must make this change quickly in order to avoid a tipping point beyond which catastrophic climate change will be unavoidable.

The MIT article states that "Since he took power in May, 2014, Prime Minister Narendra Modi has made universal access to electricity a key part of his administration's ambitions. At the same time, he has pledged to help lead international efforts to limit climate change. Among other plans, he has promised to increase India's total power generating capacity to 175 gigawatts, including 100 gigawatts of solar, by 2022. (That's about the total power generation of Germany.)"

However India plans to expand its industrial economy, and to do this, it is planning to very much increase its domestic production and use of coal. The MIT article continues, pointing out that

However India plans to expand its industrial economy, and to do this, it is planning to very much increase its domestic production and use of coal. The MIT article continues, pointing out that "Such growth would easily swamp efforts elsewhere in the world to curtail carbon emissions, dooming any chance to head off the dire effects of global climate change. (Overall, the world will need to reduce its current annual emissions of 40 billion tons by 40 to 70 percent between now and 2050.) By 2050, India will have roughly 20 percent of the world's population. If those people rely heavily on fossil fuels such as coal to expand the economy and raise their living standards to the level people in the rich world have enjoyed for the last 50 years, the result will be a climate catastrophe regardless of anything the United States or even China does to decrease its emissions. Reversing these trends will require radical transformations in two main areas: how India produces electricity, and how

[1] http://www.technologyreview.com/featuredstory/542091/indias-energy-crisis/

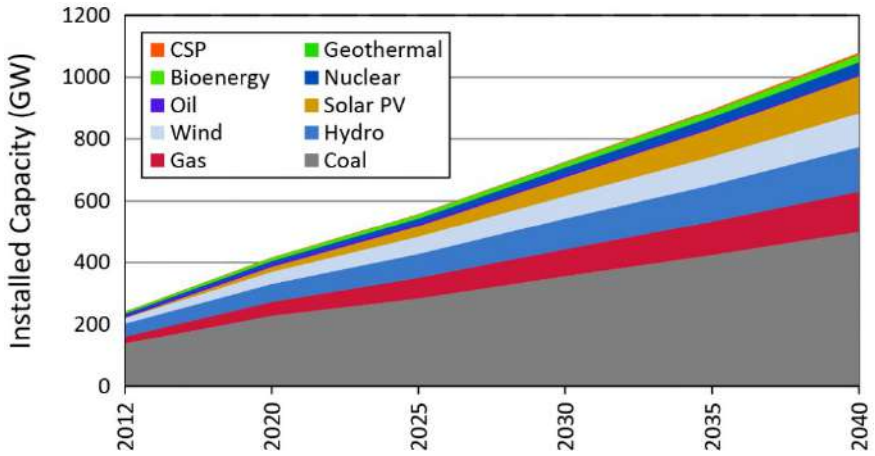

Figure B.1: **India's installed and future energy mix, as visualized by the World Coal Association**

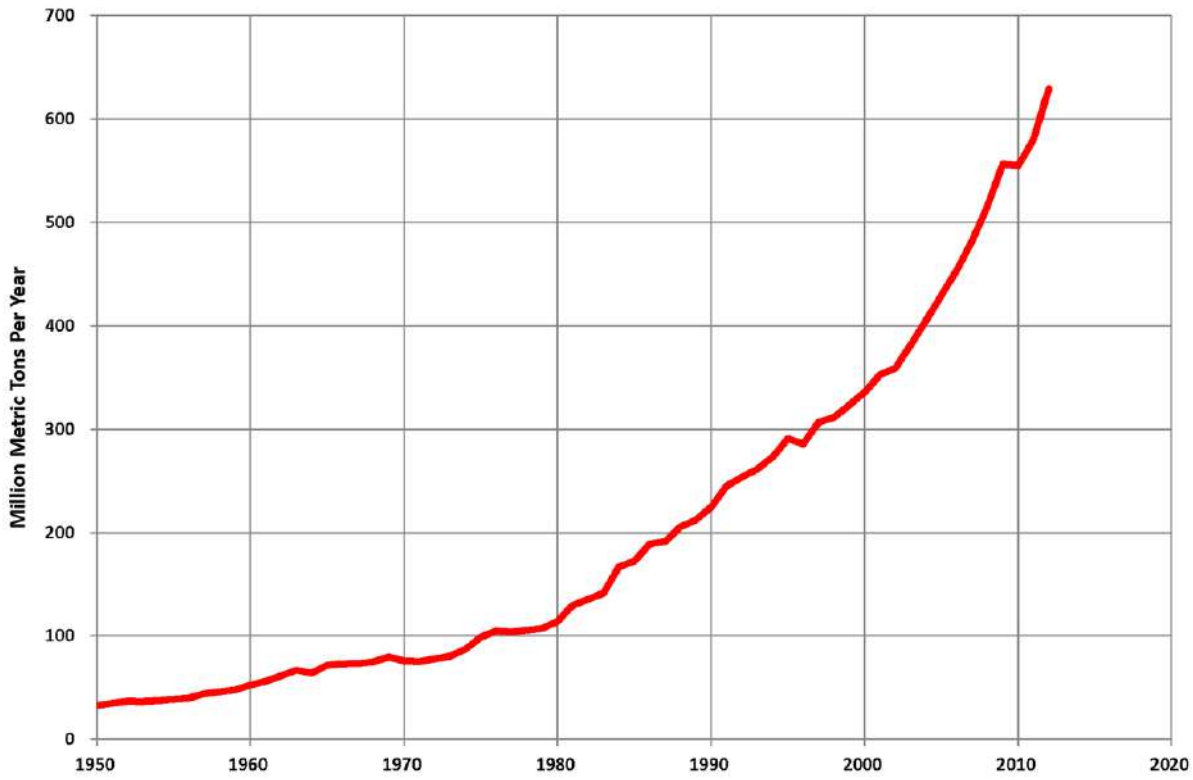

Figure B.2: **Coal production in India, 1950-2012.**

it distributes it."

The Indian Minister of Power, Piyush Goyal, is an enthusiastic supporter of renewable energy expansion, but he also supports, with equal enthusiasm, the large-scale expansion of domestic coal production in India.

Meanwhile, the consequences of global warming are being felt by the people of India. For example, last May, a heat wave killed over 1,400 people and melted asphalt streets.[2]

Have India's economic planners really thought about the long-term future? Have they considered the fact that drastic climate change could make India completely uninhabitable?

B.2 India's population explosion

[2]https://www.rt.com/news/262641-india-heat-wave-killed/

Table B.1: **World Population in 2050 (in billions)**

Region	2000	2050	growth
Asia	3.73	5.26	41%
Africa	0.82	2.53	209%
Europe	0.73	0.72	-2%
Latin America	0.53	0.78	48%
North America	0.31	0.43	39%
Oceania	0.03	0.06	84%
World	6.14	9.77	60%

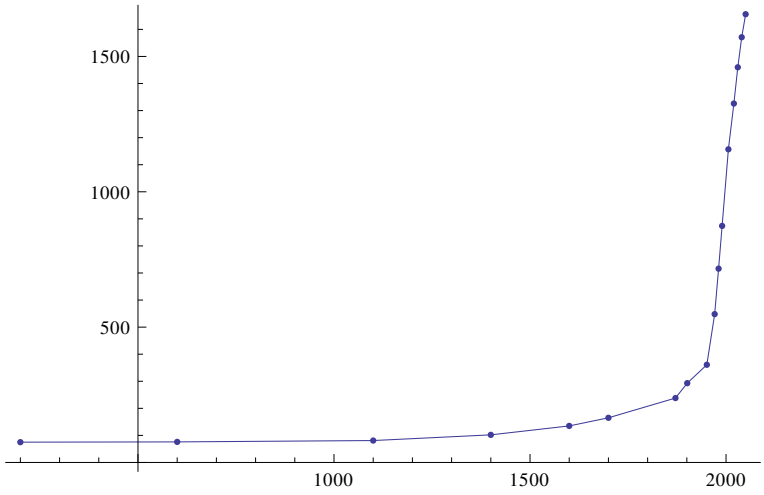

Figure B.3: **The historical and projected population of India as a function of time, from 200 AD to 2050, based on data from the Wikipedia article on *Demographics of India*. If the projections hold, there will be 1.4 billion people in India by 2050, making it the most populous country in the world. However, there is a danger that death rates may rise sharply because of famine and because of deaths due to rising temperatures.**

B.3 Paris, India and Coal

Here are quotations from an article that I wrote for Human Wrongs Watch in 2015:[3]

The MIT Technology Review recently published an important article entitled "India's Energy Crisis". The article makes alarming reading in view of the world's urgent need to make a very rapid transition from fossil fuels to 100% renewable energy.

We must make this change quickly in order to avoid a tipping point beyond which catastrophic climate change will be unavoidable.

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[3] https://human-wrongs-watch.net/2015/11/30/paris-india-and-coal/

"By 2050, India will have roughly 20 percent of the world's population. If those people rely heavily on fossil fuels such as coal to expand the economy and raise their living standards to the level people in the rich world have enjoyed for the last 50 years, the result will be a climate catastrophe regardless of anything the United States or even China does to decrease its emissions. Reversing these trends will require radical transformations in two main areas: how India produces electricity, and how it distributes it."

Appendix C

RUSSIA

C.1 Russia

According to Wikipedia, "The petroleum industry in Russia is one of the largest in the world. Russia has the largest reserves, and is the largest exporter, of natural gas. It has the second largest coal reserves, the eighth largest oil reserves, and is one of the largest producer of oil. It is the third largest energy user."

One of the difficulties of reducing Russia's fossil fuel production is that the Russian economy depends so heavily on its oil and gas industries. Many European countries also depend on natural gas from Russia for winter heating of homes and workplaces.

Russia is the third largest producer of fossil fuels in the world, holds second largest proven reserves of natural gas, and the world's third largest reserve base of coal. As for oil, the country holds 6.4% of global reserves and is the world's third largest producer after the United States and Saudi Arabia.

The contribution of the oil and gas sector to the country's industrial production increased in 2018, at 38.9%. At the same time, fossil fuels accounted for as much as 63.2% of Russia's exports in 2017 according to the Federal Customs Service. Oil and gas revenues contributed to 36% of the country's federal budget in 2016.

The Arctic is burning! A northeastern Siberian town, north of the Arctic Circle, is likely to have set a record for the highest temperature documented in the Arctic Circle, with a reading of 100.4 degrees (38 Celsius) recorded in June, 2020. The dangerous greenhouse gas methane is bubbling up from melting permafrost in the Arctic and from the shallow seas north of Siberia. Furthermore, wildfires in the Arctic are emitting an unprecedented amount of CO2.

The methane hydrate feedback loop involves vast quantities of the powerful greenhouse gas methane, CH4, frozen in a crystalline form surrounded by water molecules. 10,000 gigatons of methane hydrates are at present locked in Arctic tundra or the continental shelves of the world's oceans. Although oceans warm very slowly because of thermal inertia, the long-term dangers from the initiation of a methane-hydrate feedback loop are very great. There is a danger that a very large-scale anthropogenic extinction event could

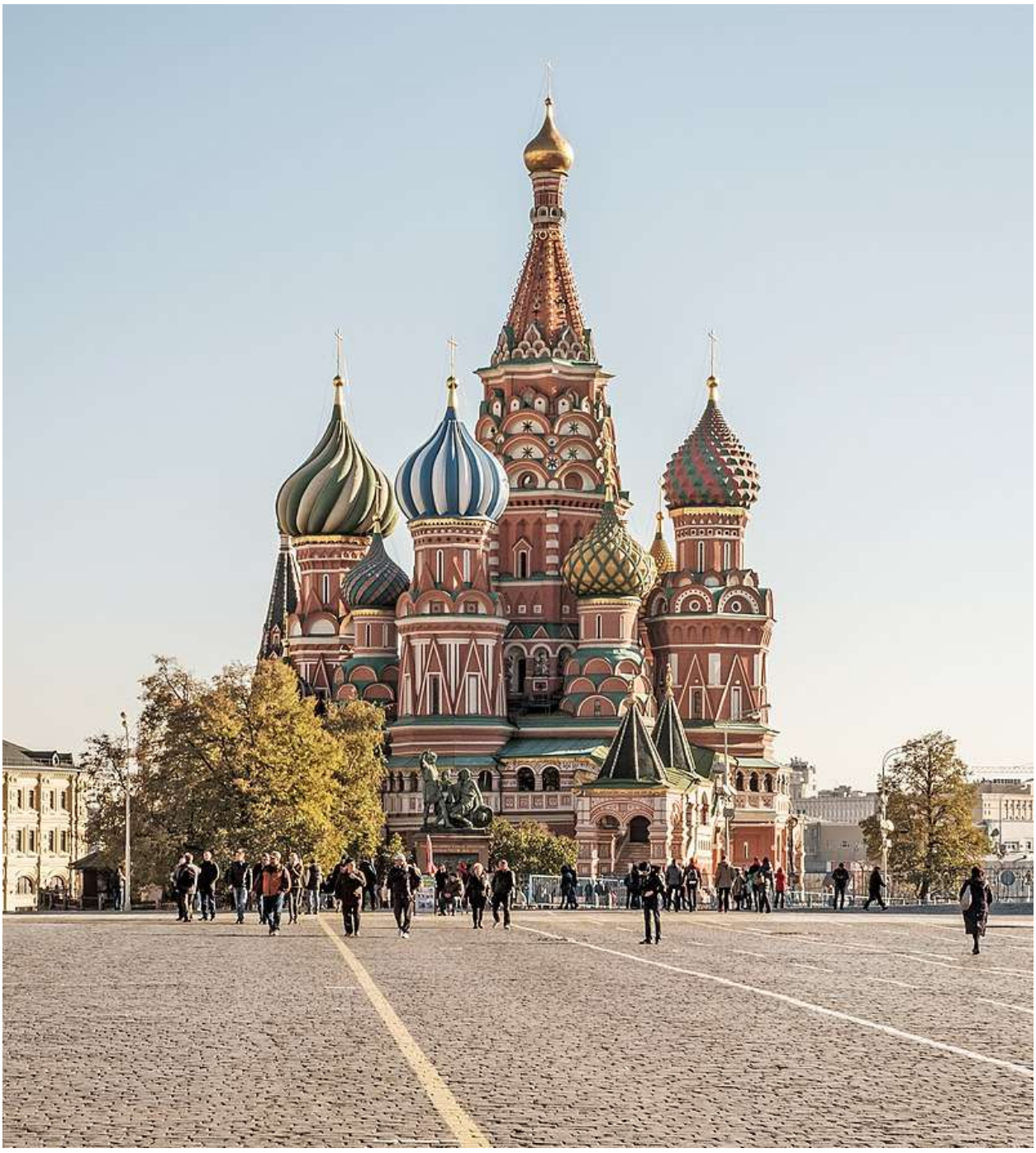

Figure C.1: **Saint Basil's Cathedral (1482-1495) in Moscow.**

Figure C.2: **Peterhof Palace (1714-1755).**

Figure C.3: **Oil production on the shelf in the Russian Arctic.**

be initiated unless immediate steps are taken to drastically reduce the release of greenhouse gases.

C.2 Methane from melting permafrost

Here are some quotations from an article by Charles J. Hanley[1]

...Researchers say air temperatures ... in Siberia and elsewhere in the Arctic have risen more than 2.5 C (4.5 F) since 1970 - much faster than the global average. The summer thaw is reaching deeper into frozen soil, at a rate of 4 centimeters (1.5 inches) a year, and a further 7 C (13 F) temperature rise is possible this century, says the authoritative, U.N.-sponsored Intergovernmental Panel on Climate Change (IPCC).

In 2007, air monitors detected a rise in methane concentrations in the atmosphere, apparently from far northern sources. Russian researchers in Siberia expressed alarm, warning of a potential surge in the powerful greenhouse gas, additional warming of several degrees, and unpredictable consequences for Earth's climate...

Permafrost, tundra soil frozen year-round and covering almost one-fifth of Earth's land surface, runs anywhere from 50 to 600 meters (160 to 2,000 feet) deep in this region. Entombed in that freezer is carbon - plant and animal matter accumulated through millennia.

As the soil thaws, these ancient deposits finally decompose, attacked by microbes, producing carbon dioxide and - if in water - methane. Both are greenhouse gases, but methane is many times more powerful in warming the atmosphere.

Researchers led by the University of Florida's Ted Schuur last year calculated that the top 3 meters (10 feet) of permafrost alone contain more carbon than is currently in the atmosphere...

C.3 Methane from shallow seas north of Siberia

Here are some quotations from an article by Lauren Morello, published in ClimateWire[2]

A large amount of methane is bubbling up from the ocean floor east of Siberia at a surprising rate and could accelerate climate change, researchers said yesterday.

The gas is bubbling up from the East Siberian Arctic Shelf because warming ocean water is thawing permafrost, allowing methane trapped underneath to

[1] https://abcnews.go.com/Technology/JustOneThing/story?id=8457650

[2] https://www.scientificamerican.com/article/methane-siberia-climate-change/

escape. The amount of methane emitted by that one patch of seabed roughly equals the amount scientists believed was released by all of the world's oceans.

But just how the discovery will affect projections of future warming is hard to say, according to a team of scientists from the United States, Russia and Sweden who published their findings yesterday in the journal *Science*.

"Seabed deposits [of methane] were considered until recently to be reliably sealed by subsea permafrost," said the study's lead author, Natalia Shakhova of the University of Alaska, Fairbanks. "But what we are having now is up to 10 million tons annually escaping from this seabed. This means permafrost does not serve as an impermeable cap or seal to prevent this leakage any longer."...

Suggestions for further reading

1. Bartlett, Roger P. *A history of Russia* (2005) online
2. Brown, Archie et al. eds. *The Cambridge Encyclopedia of Russia and the Former Soviet Union (2nd ed. 1994)* 664 pages online
3. Dutkiewicz, Piotr et al. *The Social History of Post-Communist Russia* (Routledge, 2016) online
4. Florinsky, Michael T. ed. *McGraw-Hill Encyclopedia of Russia and the Soviet Union* (1961).
5. Frye, Timothy. Weak Strongman: *The Limits of Power in Putin's Russia* (2021) excerpt
6. Greene, by Samuel A. and Graeme B. Robertson. *Putin v. the People: the Perilous Politics of a Divided Russia* (Yale UP, 2019) excerpt
7. Hosking, Geoffrey A. *Russia and the Russians: a history*, (2011) online
8. Gill, Graeme and James Young, eds. *Routledge Handbook of Russian Politics and Society* (2008)
9. Kort, Michael. *A brief history of Russia* (2008) online Lowe, Norman. *Mastering Twentieth Century Russian History* (2002) excerpt
10. Millar, James R. ed. *Encyclopedia of Russian History* (4 vol 2003). online Paxton, John. Encyclopedia of Russian History (1993) online
11. Riasanovsky, Nicholas V., and Mark D. Steinberg. *A History of Russia* (9th ed. 2018) 9th edition 1993 online
12. Rosefielde, Steven. *Putin's Russia: Economy, Defence and Foreign Policy* (2020) excerpt
13. Sakwa, Richard. *Russian Politics and Society* (4th ed. 2008).
14. Service, Robert. *A History of Modern Russia: From Tsarism to the Twenty-First Century* (Harvard UP, 3rd ed., 2009) excerpt
15. Smorodinskaya, Tatiana, and Karen Evans-Romaine, eds. *Encyclopedia of Contemporary Russian Culture* (2014) excerpt; 800 pp covering art, literature, music, film, media, crime, politics, business, and economics.
16. Walker, Shauin. *Long hangover: Putin's new Russia and the ghosts of the past* (2018, Oxford UP) excerpt

Appendix D

NORTH AMERICA

D.1 Canadian oil sands

Canada's oil-sands deposits contain an amount of carbon comparable to the world's total reserves of conventional oil. Oil is currently being extracted by methods that release four times as much carbon into the atmosphere as is contained in the refined oil from the deposits. Nevertheless, the government of Canada wholeheartedly supports extraction of oil from the tar sands.

The position of the Canadian government has been strongly criticized by leading climate scientist Professor James Hansen. A recent article in *The Guardian*[1], reported him as saying; "To leave our children with a manageable situation, we need to leave the unconventional fuel in the ground. Canada's ministers are acting as salesmen for those people who will gain from the profits of that industry. But I don't think they are looking after the rights and wellbeing of the population as a whole.

"The thing we are facing overall is that the fossil fuel industry has so much money that they are buying off governments. Our democracies are seriously handicapped by the money that is driving decisions in Washington and other capitals."

Fracking in the United States

According to the US Department of Energy (DOE), in 2013 at least two million oil and gas wells in the US have been hydraulically fractured, and that of new wells being drilled, up to 95% are hydraulically fractured. The output from these wells makes up 43% of the oil production and 67% of the natural gas production in the United States.

Because of earthquakes and poisoning of water supplies caused by fracking, this practice has been banned by several states in the US, and nine countries or regions in Europe: France, Bulgaria, Roumania, Germany, The Czech Republic, Luxembourg, Northern Ireland, Spain and Switzerland,

[1] https://www.theguardian.com/environment/2013/may/19/tar-sands-exploitation-climate-scientist

Figure D.1: **Get rich quick at the oil sands.**

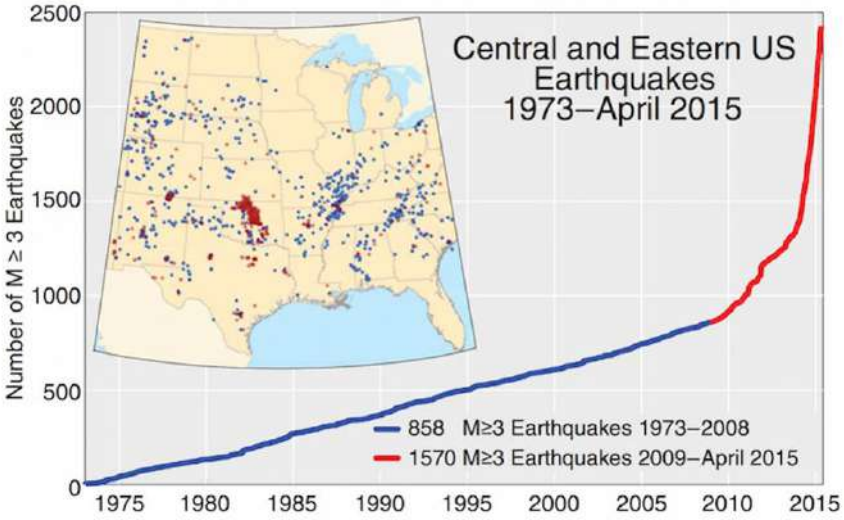

Figure D.2: **The sharply increased number of earthquakes in the United States has been linked to fracking. The use of fracking has also caused poisoning of water supplies.**

D.2 Donald Trump's climate change denial

In a recent article, climate expert Dr. Andrew Glickson wrote: "The train has left the station and global heating is advancing toward +2 and then toward+4 degrees Celsius, as projected by the IPCC and in the words of Joachim Hans Schellnhuber, Germany's chief climate scientist, signifies the breakdown of civilization. Largely ignored or watered down by much of the mainstream media , betrayed by most political parties, including those who used to regard climate change as "the greatest moral issue of our time", the population continues to be distracted by bread and circuses. Nowadays even some of the Greens appear to consider plastic bags and the tampon tax as greater vote winners than the demise of the biosphere."

Why did Professor Noam Chomsky call the US Republican Party "The most dangerous organization in the history of the world"? In the primary that preceded the 2016 presidential election, every single Republican candidate with a chance of being nominated was a climate change denier. All received amazingly generous checks from giant fossil fuel organizations. When elected, Donald Trump not only pulled the United States out of the Paris Agreement; he also sabotaged the Environmental Protection Agency to such an extent that the carefully collected facts on climate change that the agency had accumulated had to be secretly saved by scientists to prevent their destruction by the Trump administration. Furthermore, Donald Trump not only subsidizes giant coal corporations. He also has sabotages renewable energy initiatives in the United States.

Here are some quotations from an article by Coral Davenport and Mark Landler, May 27, 2019[2]:

President Trump has rolled back environmental regulations, pulled the United States out of the Paris climate accord, brushed aside dire predictions about the effects of climate change, and turned the term "global warming" into a punch line rather than a prognosis.

Now, after two years spent unraveling the policies of his predecessors, Mr. Trump and his political appointees are launching a new assault.

In the next few months, the White House will complete the rollback of the most significant federal effort to curb greenhouse-gas emissions, initiated during the Obama administration. It will expand its efforts to impose Mr. Trump's hard-line views on other nations, building on his retreat from the Paris accord and his recent refusal to sign a communiqué to protect the rapidly melting Arctic region unless it was stripped of any references to climate change.

And, in what could be Mr. Trump's most consequential action yet, his administration will seek to undermine the very science on which climate change policy rests.

Mr. Trump is less an idealogue than an armchair naysayer about climate change, according to people who know him. He came into office viewing agencies like the Environ-

[2]https://www.nytimes.com/2019/05/27/us/politics/trump-climate-science.html

Figure D.3: **There is so much wrong with Donald Trump that one hardly knows where to start. He is a bully, braggart, narcissist, racist, misogynist, habitual liar, and tax evader, in addition to being demonstrably ignorant. He has contempt for both domestic and international law, as well as for the US Constitution. In the words of Michael Moore, he is a "part-time clown and full-time sociopath". However, it is Trump's climate change denial, withdrawal from the Paris agreement, and sponsorship of fossil fuels that pose the greatest threats to the future of humans society and the biosphere. The general support of the Republican Party for the fossil fuel industry is the reason why Prof. Noam Chomsky has called the party "the most dangerous organization in history".**

mental Protection Agency as bastions of what he calls the "deep state," and his contempt for their past work on the issue is an animating factor in trying to force them to abandon key aspects of the methodology they use to try to understand the causes and consequences of a dangerously warming planet.

As a result, parts of the federal government will no longer fulfill what scientists say is one of the most urgent jobs of climate science studies: reporting on the future effects of a rapidly warming planet and presenting a picture of what the earth could look like by the end of the century if the global economy continues to emit heat-trapping carbon dioxide pollution from burning fossil fuels...

The administration's prime target has been the National Climate Assessment, produced by an interagency task force roughly every four years since 2000. Government scientists used computer-generated models in their most recent report to project that if fossil fuel emissions continue unchecked, the earth's atmosphere could warm by as much as eight degrees Fahrenheit by the end of the century. That would lead to drastically higher sea levels, more devastating storms and droughts, crop failures, food losses and severe health consequences.

D.3 The Evangelicals believe that there is no need to act

Here is an excerpt from an article by Bernard Daley Zaleha and Andrew Szasz entitled *Why conservative Christians don't believe in climate change*[3]:

American Christians have become increasingly polarized on issues of climate change and environmental regulation. In recent years, mainline Protestant denominations and the Roman Catholic Church have made explicit declarations of support for global climate action. Prominent Southern Baptists and other evangelical Protestants, on the other hand, have issued statements that are strikingly similar to the talking points of secular climate skeptics, and have attempted to stamp out "green" efforts within their own ranks. An analysis of resolutions and campaigns by evangelicals over the past 40 years shows that anti-environmentalism within conservative Christianity stems from fears that "stewardship" of God's creation is drifting toward neo-pagan nature worship, and from apocalyptic beliefs about "end times" that make it pointless to worry about global warming. As the climate crisis deepens, the moral authority of Christian leaders and organizations may play a decisive role in swaying public policy toward (or away from) action to mitigate global warming.

The highly dangerous beliefs of the Evangelicals are in strong contrast to the courageous and enlightened leadership of Pope Francis, who urges us to act resolutely to prevent

[3]Bulletin of the Atomic Scientists 2015, Vol. 71(5) 19-30

catastrophic climate change.

D.4 Alt-right

The Associated Press gives the following definition of the alt-right movement:

"The 'alt-right' or 'alternative right' is a name currently embraced by some white supremacists and white nationalists to refer to themselves and their ideology, which emphasizes preserving and protecting the white race in the United States in addition to, or over, other traditional conservative positions such as limited government, low taxes and strict law-and-order. The movement has been described as a mix of racism, white nationalism and populism ... criticizes 'multiculturalism' and more rights for non-whites, women, Jews, Muslims, gays, immigrants and other minorities. Its members reject the American democratic ideal that all should have equality under the law regardless of creed, gender, ethnic origin or race."

Wikipedia states that "The alt-right, an abbreviation of alternative right, is a loosely connected far-right, white supremacist, white nationalist, white separatist, anti-immigration and sometimes antisemitic movement based in the United States. A largely online phenomenon, the alt-right originated in the U.S. during the 2010s although it has since established a presence in various other countries. The term is ill-defined, having been used in different ways by various self-described 'alt-rightists', media commentators, and academics.

"In 2010, the American white nationalist Richard B. Spencer launched The Alternative Right webzine to disseminate his ideas. Spencer's 'alternative right' was influenced by earlier forms of American white nationalism, as well as paleoconservatism, the Dark Enlightenment, and the Nouvelle Droite. Critics charged it with being a rebranding of white supremacism. His term was shortened to "alt-right" and popularised by far-right participants of /pol/, the politics board of web forum 4chan. It came to be associated with other white nationalist websites and groups, including Andrew Anglin's Daily Stormer, Brad Griffin's Occidental Dissent, and Matthew Heimbach's Traditionalist Worker Party...

"The alt-right is a white nationalist, biologically racist movement. Part of its membership supports anti-immigrationist policies to ensure a continued white majority in the United States. Others call for the breakup of the country to form a white separatist ethno-state in North America. Some alt-rightists seek to make white nationalism socially respectable in the U.S., while others - known as the '1488' scene - adopt openly white supremacist and neo-Nazi stances. Some alt-rightists are anti-semitic, promoting a conspiracy theory that there is a Jewish plot to bring about white genocide; other alt-rightists view most Jews as members of the white race. The alt-right is anti-feminist, advocates for a more patriarchal society, and intersects with the men's rights movement and other sectors of the online manosphere...

"Membership was overwhelmingly white and male, with academic and anti-fascist observers linking its growth to deteriorating living standards and prospects, anxieties about the place of white masculinity, and anger at increasingly visible left-wing forms of identity

Figure D.4: **Prominent alt-rightists were instrumental in organizing the "Unite the Right" rally in Charlottesville, Virginia in August 2017. Here, rally participants carry Confederate battle flags, Gadsden flags and a Nazi flag.**

politics like the Black Lives Matter movement. Constituent groups using the "alt-right" label have been characterized as hate groups,[2][3] while alt-right material has been a contributing factor in the radicalization of young white men responsible for a range of far-right murders and terrorist attacks in the U.S. since 2014."

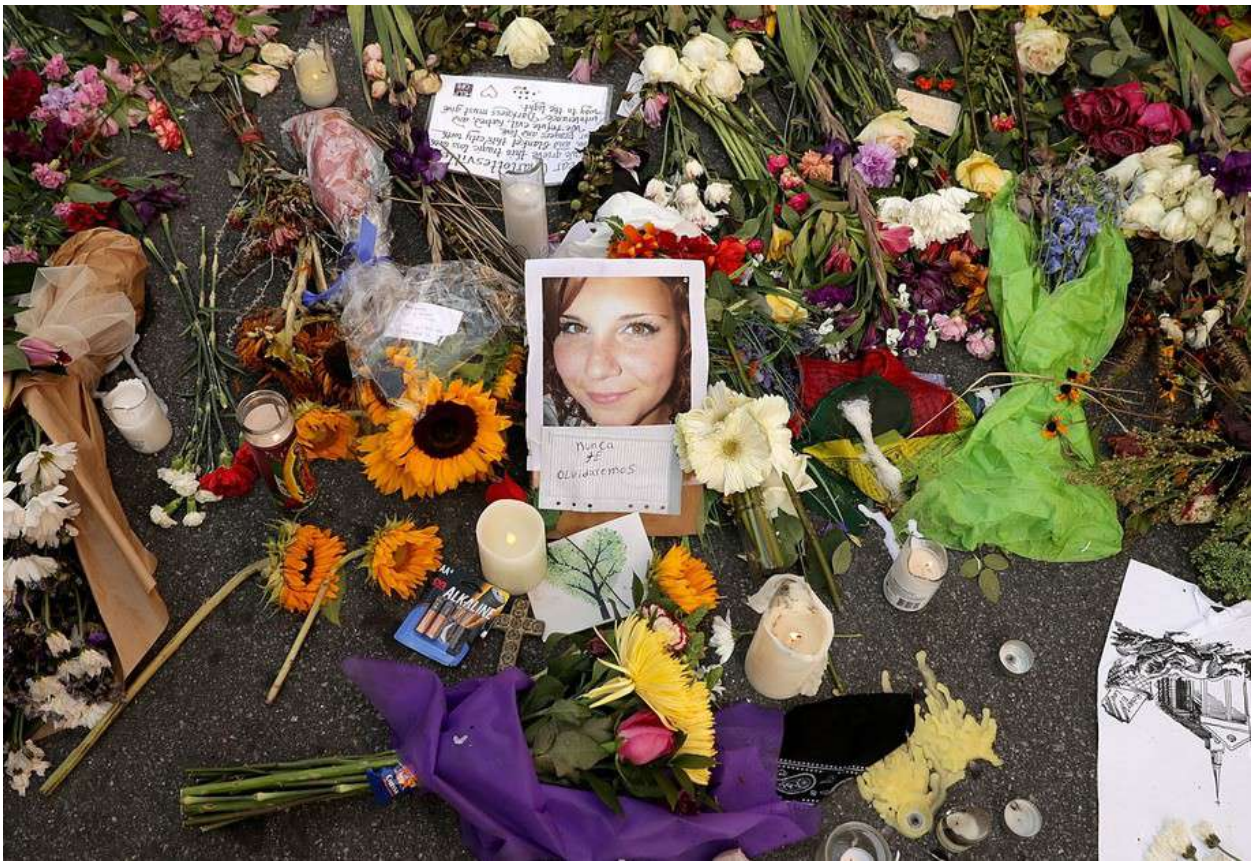

Figure D.5: **Heather Heyer was murdered in 2017 by a white nationalist rally participant in Charlottesville. Since then, mass shootings in Poway, Gilroy, and El Paso and elsewhere have been each linked to white nationalist beliefs.**

Figure D.6: **Breitbart News amplified and popularised alt-right ideas under the editorship of "alt-lite" figure Steve Bannon.**

Figure D.7: **The alt-right largely rallied behind the presidential candidacy of Donald Trump, although he later distanced himself from the movement.**

Figure D.8: **A participant at the Unite the Right rally giving a Nazi salute in front of counter-protesters.**

Figure D.9: **The alt-rightist was then punched in an altercation with counter-protesters.**

Figure D.10: **Protestors at the 2017 Unite the Right rally, which was promoted by the alt-right. One man carries the logo of Vanguard America, and another has a t-shirt praising German Nazi leader Adolf Hitler.**

Figure D.11: **An attendee at the Unite the Right rally carrying a firearm and wearing a Confederate Battle Flag T-shirt.**

Figure D.12: **"Trump is Alt-Right with Us." Anti-Trump protesters highlight what they regard as his links to the alt-right and to historical fascism by dressing as Hitler and Mussolini.**

D.5 Drought and wildfires in North America

Today, California and the southwestern states are plagued by drought. The Colorado River is reduced to a trickle when it reaches the Pacific, Water tables are falling. The Ogallala aquifer is overdrawn and disappears as it flows southward. Wildfires caused by extremely dry conditions have hit California and the Pacific Northwest in recent years.

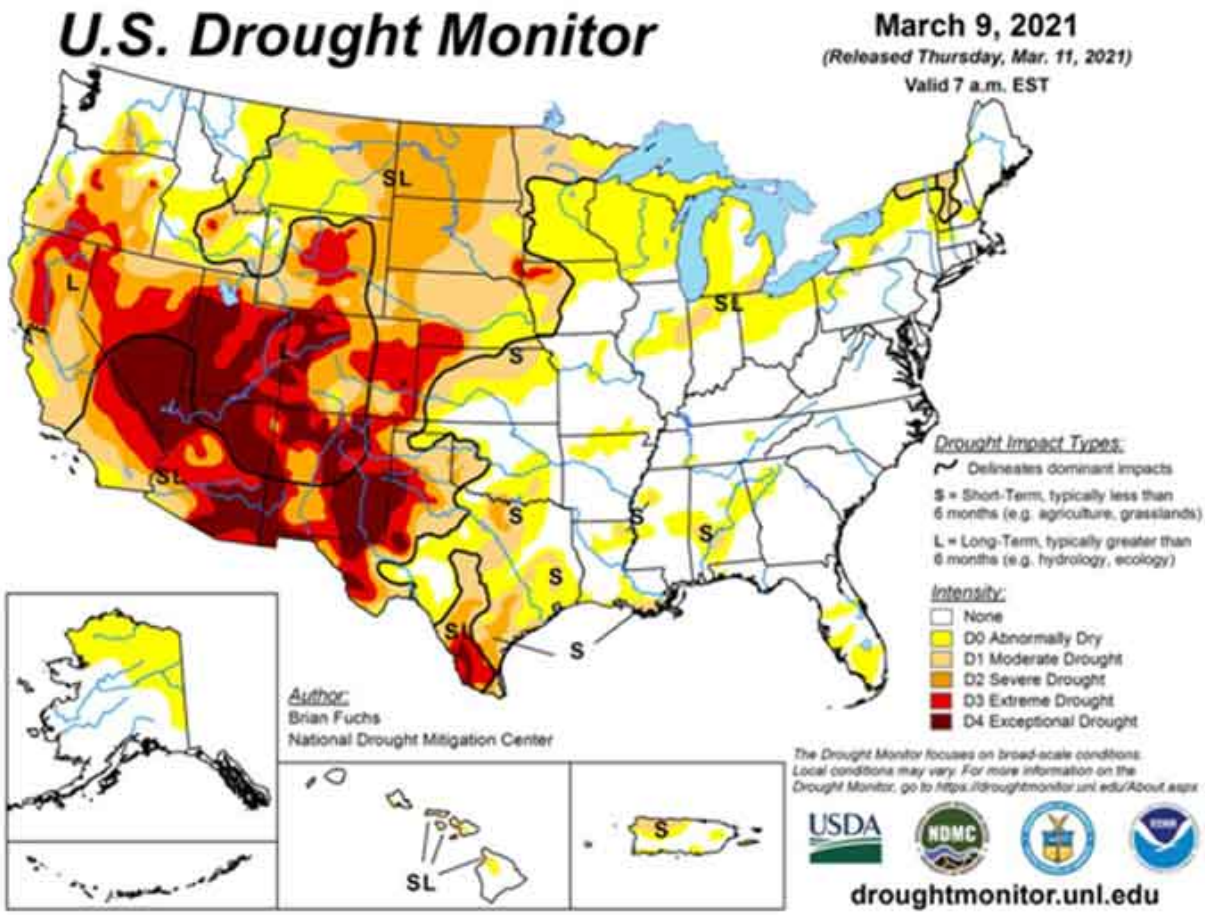

Figure D.13: **Figure from an article entitled "Worst drought in modern history may hit Western U.S." published in "Countercurrents" on April 12, 2021. The article states that "Extreme drought may be going to hit across the Western U.S. Some scientists saying the region is on the precipice of permanent drought."**

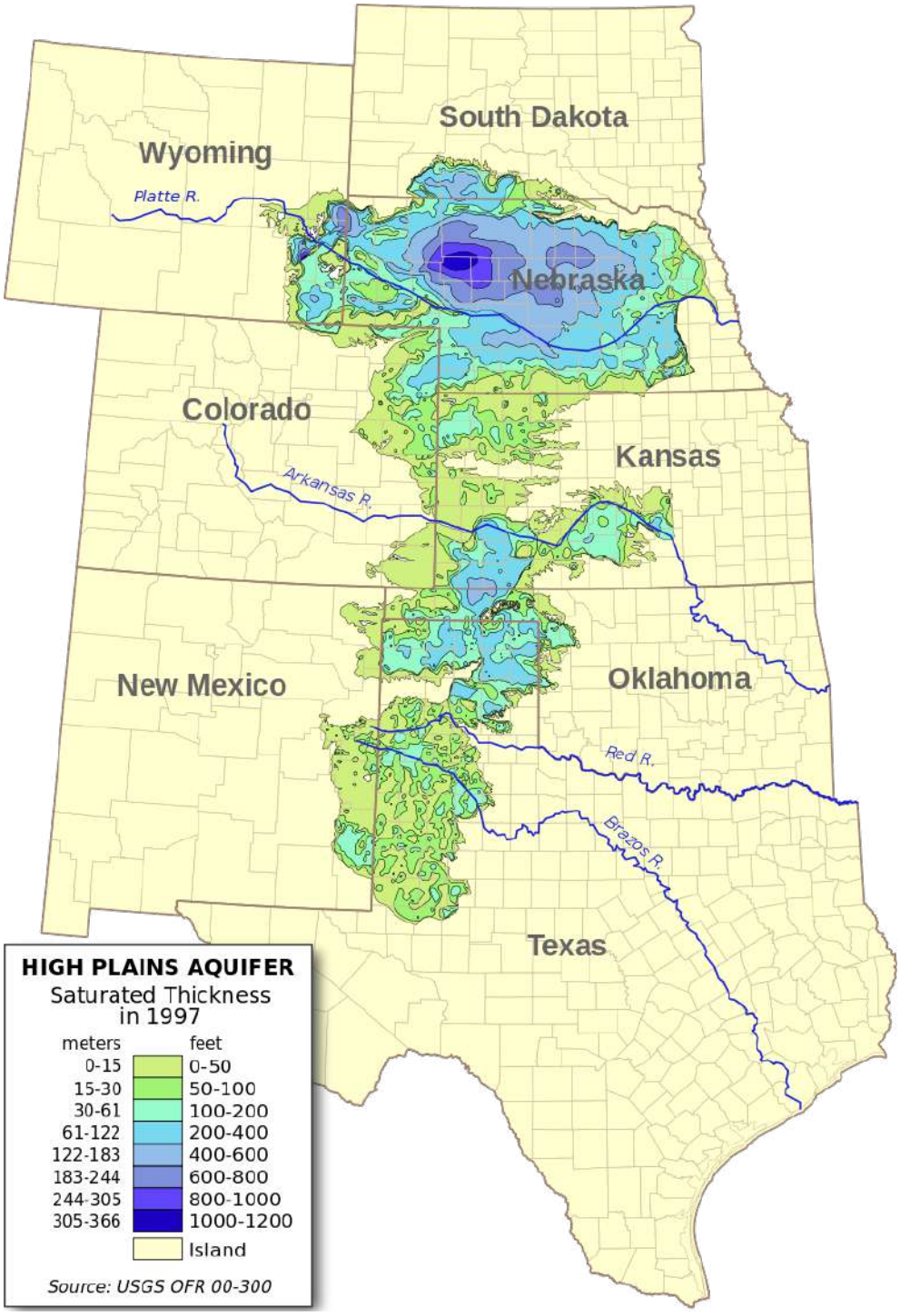

Figure D.14: **he Ogallala Aquifer has been overdrawn, and can no longer be relied on to irrigate states such as Oklahoma, New Mexico and Texas. The diagram shows the saturated thickness of the Ogallala Aquifer in 1997 after several decades of intensive withdrawals. The breadth and depth of the aquifer generally decrease from north to south.**

D.6 Drying of forests and forest fires

According to a recent article in *Nature*[4], "Across the American west, the area burned each year has increased significantly over the past several decades, a trend that scientists attribute both to warming and drying and to a century of wildfire suppression and other human activities. Allen suggests that the intertwined forces of fire and climate change will take ecosystems into new territory, not only in the American west but also elsewhere around the world. In the Jemez, for example, it could transform much of the ponderosa pine (Pinus ponderosa) forest into shrub land. 'We're losing forests as we've known them for a very long time,' says Allen. 'We're on a different trajectory, and we're not yet sure where we're going.'

"All around the American west, scientists are seeing signs that fire and climate change are combining to create a 'new normal'. Ten years after Colorado's largest recorded fire burned 56,000 hectares southwest of Denver, the forest still has not rebounded in a 20,000-hectare patch in the middle, which was devastated by an intense crown fire. Only a few thousand hectares, which the US Forest Service replanted, look anything like the ponderosa-pine stands that previously dominated the landscape."

[4] http://www.nature.com/news/forest-fires-burn-out-1.11424

Figure D.15: **Fighting a fire in California, caused by the unusually hot and dry weather of the summer of 2018. The very dry weather also caused uncontrollable fires in the Arctic, in Sweden, Russia, Northern Canada and Alaska.**

Figure D.16: **Over two million acres have burned in the state this year alone, as California faces the worst fires in its history. This photo shows the Creek Fire as it burns along a hillside in the Cascadel Woods community of Madera County.**

Figure D.17: **The Rim Fire burned more than 250,000 acres (1,000 km2) of forest near Yosemite National Park, in 2013.**

Figure D.18: **Lightning-sparked wildfires are frequent occurrences during the dry summer season in Nevada.**

Figure D.19: **"Elk Bath", an award winning photograph of elk avoiding a wildfire in Montana.**

Appendix E

BRAZIL

E.1 Extraction of oil in Brazil

According to a recent article in *The Guardian*[1] "The discovery of tens of billions of barrels of oil in fields far off the coast of Rio de Janeiro was billed as one of the biggest finds of this century when it was announced in 2006.

"Many hoped it would deliver a bonanza for education and health and make Brazil one of world's major economies.

"But with the country's biggest energy company, Petrobras, mired in debt and scandal, the low price of oil and the dangers of a second Deepwater Horizon, the viability of this massive undertaking has never been under more scrutiny."

The Brazilian offshore deposits are called "presalt oil", since they lie under a thick layer of salt deposits.

According to the article in *The Guardian*, "Suggestions by climate campaigners that this reservoir of fossil fuel is a 'carbon bomb' that should be left in the ground, are dismissed as hypocrisy."

The article quotes the geologist who discovered the off-shore fields as saying "The big countries of the world today developed without any concern for the environment. The base of US development was the oil in the Gulf of Mexico. The base of the UK's industrial revolution was coal. How can they now say we can't use our own pre-salt?"

E.2 Jair Bolsonaro, the Trump of the Tropics

The newly elected President of Brazil, Jair Bolsonaro, has praised Pinochet, expressed support for torturers and called for political opponents to be shot, earning him the label of "the most misogynistic, hateful elected official in the democratic world". Bolsonaro speaks nostalgically about the country's 1964-1985 military dictatorship and has promised to fill his government with current and former military leaders. Here, in his own words, are some

[1] https://www.theguardian.com/environment/ng-interactive/2015/jun/25/brazils-gamble-on-deep-water-oil-guanabara-bay

Figure E.1: **Jair Bolsonaro visiting Donald Trump in Washington. Like Trump, he is an utterly despicable person, but (again like Trump) his worst crime is against the future of human civilization and the biosphere. Under Bolsonaro, the vitally important Amazon rainforests are being destroyed, a terrible blow to our efforts to avoid catastrophic ciliate change.**

of his ideas:

On refugees: "The scum of the earth is showing up in Brazil, as if we didn't have enough problems of our own to sort out." (September 2015)

On gay people: "I would be incapable of loving a homosexual son. I'm not going to be a hypocrite: I'd rather my son died in an accident than showed up with some bloke with a moustache." (June 2011)

On democracy and dictatorship: "You'll never change anything in this country through voting. Nothing. Absolutely nothing. Unfortunately, things will only change when a civil war kicks off and we do the work the [military] regime didn't. Killing some 30,000... Killing them! If a couple of innocents die, that's OK." (May 1999)

On human rights: "I'm in favour of torture." (May 1999)

On women: "I said I wouldn't rape you because you don't deserve it." (December 2014, to politician Maria do Rosário, repeating a comment first made to her in 2003).

Figure E.2: **The indigenous peoples of the Amazon are the guardians of the lungs of Planet Earth. Within hours of taking office on 1 January, 2019, the Trump of the Tropics, aka the new President of Brazil, Jair Bolsonaro, launched an all-out assault against the Amazon rainforest and its indigenous communities, potentially paving the way for large scale deforestation by agricultural, mining and oil companies.**

Indigenous rights activists fear Bolsonaro's avowed plan to wring riches from the Amazon - whether from expanding agriculture into indigenous lands, building roads and other infrastructure projects, or allowing mining on public lands - will unleash a tide of violence and environmental devastation.

"All indigenous communities are afraid right now," says Felipe Milanez, professor of humanities at the Universidade Federal de Bahia. "There is a risk of brutal, violent attack." Milanez fears that indigenous efforts to patrol and protect their own lands from outsiders, such as the Forest Guardians recently covered in National Geographic magazine, will be banned and persecuted.

"His economic project is to destroy the Amazon, to transform the Amazon into commodities for export," Milanez says.

Human rights activists are concerned that a surge in violent land conflicts will accompany an increase in environmentally destructive development in the Amazon. "There is no doubt that devastation will spread in the region," says Diogo Cabral, an attorney with the Sociedade Maranhense de Direitos Humanos. "At the same time, he aims to extinguish policies that protect human rights defenders in Brazil. Under Bolsonaro, human life will have no value."

The indigenous peoples' website Mongabay [2] states that "The potentially resulting wholesale deforestation could be a disaster to indigenous peoples, biodiversity, and even the regional and global climate."

It adds: "Bolsonaro's proposed Amazon policies, if carried out, could ultimately help dash the world's hopes of achieving the global climate goals agreed to in Paris, a failure that could lead to climate chaos."

Leading Brazilian researchers, from the National Institute of Space Research (INPE), have calculated that Bolsonaro's policies could triple deforestation in the Amazon from present levels of 6,900 square kilometers (2,664 square miles) annually, to 25,600 square kilometers (9,884 square miles) per year by 2020.

E.3 Brazil and the COVID-19 pandemic

In Brazil, between 3 January, 2020 and 7 June, 2021, there have been 472,531 deaths from COVID-19.

Miguel Lago, executive director of the Institute for Health Policy Studies in Rio de Janeiro, said "Brazil had a lot of opportunity to address the pandemic successfully. We cannot blame the health system or the shortages. The man to blame is Jair Bolsonaro. He has tried to sabotage any kind of response."

Bolsonaro has called COVID-19 "a little flu", has undermined face-masks and the vaccine, and suggested that Brazilians "stop whining" about the pandemic. He has vetoed legislation aimed at controlling the spread of SARS-CoV-2. The result has been Brazil's massive death toll.

[2] https://news.mongabay.com/2019/01/bolsonaro-hands-over-indigenous-land-demarcation-to-agriculture-ministry/?fbclid=IwAR3UG-jneDheuddVEWVcCrcWKk4bnnsdE1uIBMLlnLtS6zGqMmGSPxtgEzM

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