HUMANITY'S MASSIVE FOOTPRINT ON THE FACE OF NATURE

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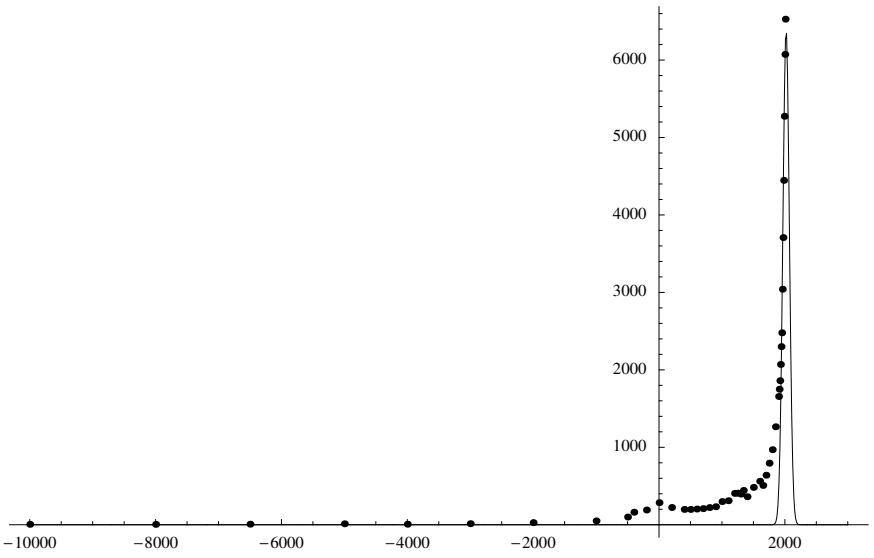

Introduction[1]

A graph showing the explosive rise of human population

When the global population of humans is plotted as a function of time over a period of twelve thousand years, and the uses of fossil fuels is plotted on the same plot, as is shown on the graph (above), the two curves are seen to rise abruptly and simultaneously during the last two or three centuries. In the graph, one sees population plotted as dots, while the use of fossil fuels is shown as a smooth curve. The use of fossil fuels will stop in a few centuries because of depleted resources, but it must stop much more abruptly if catastrophic climate change is to be avoided. The graph raises the question of whether human population is headed for a crash in the post-fossil-fuel era.

The threat of an extremely large-scale famine

There is a danger that by the middle of the present century, population growth, the end of the fossil fuel era, and the effect of climate change on

[1]This book makes heavy use of my previously published book chapters, but some new material has been added.

agriculture will combine to produce an extremely large-scale famine, affecting billions of people rather than millions. Glaciers are melting in the Himalayas and the Andes, depriving India, China, and many South American countries of summer water supplies for agriculture. Aquifers are overdrawn and water tables are falling many places in the world. There is a danger that rising sea levels will drown fertile low-lying rice-producing areas, such as Bangladesh. Also, the high-yield agriculture of the "Green Revolution" is heavily dependent on the use of fossil fuels. Studies by Giampetro and Pimental have shown that in modern agriculture, ten fossil fuel calories are required to produce one food calorie.

The available cropland per person throughout the world is rapidly decreasing because of population growth, desertification, loss of topsoil through erosion, and paving-over of fertile land due to urban sprawl.

In many regions of the world, for example northern Nigeria, South Somalia, Yemen, South Sudan, Malawi, Sudan, Afghanistan, the Democratic Republic of Congo, and Syria, the beginnings of tragic famine can already be seen, often linked with armed conflicts.

Loss of species

The Harvard biologist, E.O. Wilson, estimates that the rate of extinction resulting from deforestation in the tropics may now exceed 4,000 species per year - 10,000 times

If catastrophic climate change is not avoided, most parts of the earth will become uninhabitable. My own opinion is that the human species will not then become extinct, because there will still be places, such as Arctic and Antarctic regions, and high mountain plateaus, where humans will still be able to live. However, the global population of humans will be very much reduced, and there is a danger of severe conflicts as this happens. Meanwhile, if catastrophic climate change is not avoided, many plant and animal species will become extinct as a consequence of increasing temperatures.

Recent studies have shown that humans and their domestic animals currently constitute 96% of the mass of all land vertebrates, while wild vertebrates constitute only 4%.[2]

[2]https://popularresistance.org/the-climate-response-cliff/

Economics and ecology

The relationship between the two disciplines is illustrated by a recent cartoon in which an economist, lecturing to his ecological colleague, says "The thing that you ecologists need to understand is that destruction of the planet may be the price that we have to pay for a healthy economy". Sadly, at the COP26 meeting in Glasgow, the economist's point of view prevailed. A healthy economy was prioritized, and the steps needed to avoid destruction of the planet were not really put in place.

The need for a new economic system

Most economists, with a few notable and honorable exceptions, such as the members of the Club of Rome, are addicted almost religiously to the doctrine of economic growth. The limitless growth of anything physical on a finite planet is a logical impossibility, but economists avoid confronting this impossibility with self-imposed myopia. They refuse to look more than a decade or two into the future.[3] [4]

Since economic growth cannot continue much longer, we obviously need a new economic system, which is based, not on endless growth, but on a sustainable steady state. The concept of steady-state economics already has a strong theorist and advocate: Professor Herman Daly, born in 1938. He was a senior economist at the World Bank from 1988 to 1994, He received the Right Livelihood Award (sometimes called "the alternative Nobel Prize") for "defining a path of ecological economics that integrates the key elements of ethics, quality of life, environment and community."

Henry David Thoreau and our relationship with nature

In the 19th century the American writer, Henry David Thoreau (1817-1862), pioneered the concept of a simple life, in harmony with nature. Today, his classic book, "Walden", has become a symbol for the principles of ecology, simplicity, and respect for nature.

[3] http://eacpe.org/app/wp-content/uploads/2020/12/Madmen-and-Economists-by-John-Scales-Avery.pdf

[4] https://www.johnavery.info/wp-content/uploads/2020/12/Need-for-a-New-Economic-System.pdf

Thoreau wrote: “Most of the luxuries, and many of the so-called comforts of life, are not only not indispensable, but positive hindrances to the elevation of mankind. With respect to luxuries, the wisest have ever lived a more simple and meager life than the poor. The ancient philosophers, Chinese, Hindoo, Persian, and Greek, were a class than which none has been poorer in outward riches, none so rich in inward.”

In one of his essays, Thoreau wrote: “If a man walk in the woods for love of them half of each day, he is in danger of being regarded as a loafer; but if he spends his whole day as a speculator, shearing off those woods and making the earth bald before her time, he is esteemed an industrious and enterprising citizen.”

Elsewhere, Thoreau remarks, “It is never too late to give up your prejudices”, and he also says, “Why should we be in such desperate haste to succeed, and in such desperate enterprises? If a man does not keep pace with his companions, perhaps it is because he hears a different drummer.” Other favorite quotations from Thoreau include “Rather than love, than money, than fame, give me truth”, “Beware of all enterprises that require new clothes”, “Most men lead lives of quiet desperation” and “Men have become tools of their tools.”

Contents

Chapter 1

ADDICTION TO GROWTH

1.1 Madmen and economists

"Anyone who believes in indefinite growth in anything physical, on a physically finite planet, is either mad or an economist". Kenneth E. Boulding (1910-1993)

Why are economists addicted to growth?

Economists (with a few notable exceptions) have long behaved as though growth were synonymous with economic health. If the gross national product of a country increases steadily by 4 percent per year, most economists express approval and say that the economy is healthy. If the economy could be made to grow still faster (they maintain), it would be still more healthy. If the growth rate should fall, economic illness would be diagnosed. However, it is obvious that on a finite Earth, neither population growth nor economic growth can continue indefinitely.

But why do economists cling almost religiously to the idea of growth? In general, growth brings profits to speculators. For example, purchase of land on the outskirts of a growing city will be rewarded as the land increases in value.; and when the economy grows, stocks rise in value. '

Today, as economic growth falters, the defects and injustices of our banking system have come sharply into focus, and light has also been thrown onto the much-too-cozy relationship between banking and government. The collapse of banks during the subprime mortgage crisis of 2008 and their subsequent bailout by means of the taxpayer's money can give us an insight into both phenomena - the faults of our banking system and its infiltration into the halls of government. The same can be said of the present national debt crisis in the Euro zone and elsewhere.

1.2 Fractional reserve banking

One feature of banking that cries out for reform is "fractional reserve banking", i.e. the practice whereby private banks keep only a tiny fraction of the money entrusted to them by their depositors, and lend out all the remaining amount. By doing so, the banks are in effect coining their own money and putting it into circulation, a prerogative that ought to be reserved for governments. Under the system of fractional reserve banking, profits from any expansion of the money supply go to private banks rather than being used by the government to provide social services. This is basically fraudulent and unjust; the banks are in effect issuing their own counterfeit money.

When the economy contracts instead of expanding, the effect of fractional reserve banking is still worse. In that case the depositors ask the banks for their money, which it is their right to do. But the banks do not have the money - they have lent it out, and thus they fail. However, the bankers have insured themselves against this eventuality by buying the votes of government officials. Thus the banks are bailed out and the taxpayers are left with the bill, as in the recent example in which the US Federal Reserve secretly gave 7.7 trillion of the taxpayers' dollars to bail out various banks.

Inside Job

The Academy-Award-Winning documentary film **Inside Job**[1] tells the shocking story of the corruption of the financial sector that led to the 2008 subprime mortgage crisis and bank bailout. The film can be seen online free of charge, and is well worth viewing. Of particular interest are discussions of the history of bank deregulation, governmental collusion, and the destabilizing effects of the enormous derivative market.

1.3 Information-driven population growth

Today we are able to estimate the population of the world at various periods in history, and we can also make estimates of global population in prehistoric times. Looking at the data, we can see that the global population of humans has not followed an exponential curve as a function of time, but has instead followed a hyperbolic trajectory.

At the time of Christ, the population of the world is believed to have been approximately 220 million. By 1500, the earth contained 450 million people, and by 1750, the global population exceeded 700 million. As the industrial and scientific revolution has accelerated, global population has responded by increasing at a break-neck speed: In 1930, the population of the world reached two billion; in 1958 three billion; in 1974 four billion; in 1988 five billion, and in 1999, six billion. In 2020, we reached 7.753 billion, and roughly a billion people are being added to the world's population every twelve years.

As the physicist Murray Gell-Mann has pointed out, a simple mathematical curve which closely approximates the global population of humans over a period of several thousand years is a hyperbola of the form $P = 190{,}000{,}000{,}000/(2025-t)$. Here P represents the global population of humans and t is the year.

How are we to explain the fact that the population curve is not an exponential? We can turn to Malthus for an answer: According to his model, population does not increase exponentially, except under special circumstances, when the food supply is so ample that the increase of population is entirely unchecked.

Malthus gives us a model of culturally-driven population growth. He tells us that population increase tends to press against the limits of the food supply, and since these limits are culturally determined, population density is also culturally-determined. Hunter-gatherer societies need large tracts of land for their support; and in such societies, the population density is necessarily low. Pastoral methods of food production can support populations of a higher

[1] https://www.theguardian.com/film/2011/feb/17/inside-job-review
https://topdocumentaryfilms.com/inside-job/

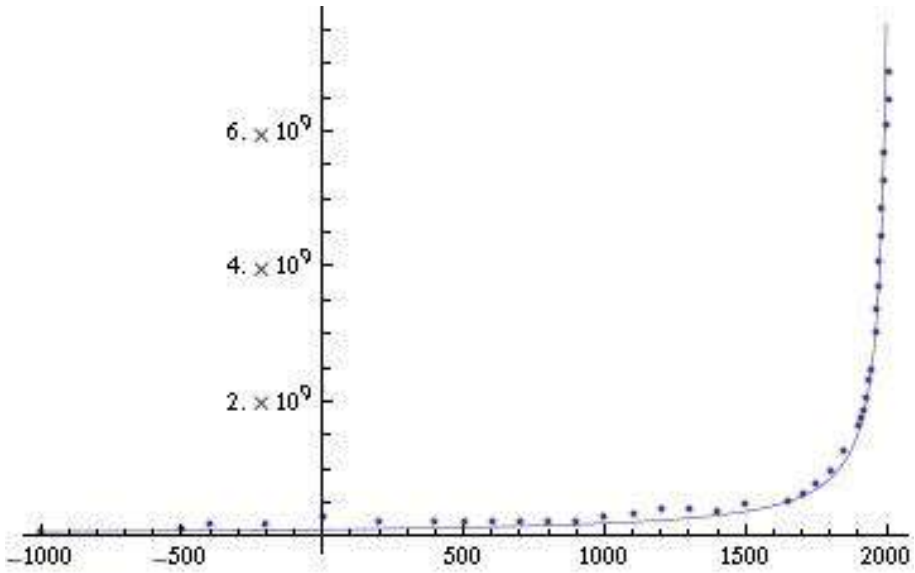

Figure 1.1: **The simple mathematical curve that fits best to human population data over the last 3,000 years is not an exponential increase, but rather a hyperbola of the form P=C/(2025-t). Here P represents population, C=190,000,000,000 and t is the year. The curve goes to infinity at t=2025 (only a few years away), which is of course impossible. Global population has already started to fall away from the hyperbolic trajectory. Will it level off, or will it crash disastrously? Because of the enormous amount of human suffering that would be involved in a population crash, the question has great importance.**

density. Finally, extremely high densities of population can be supported by modern agriculture. Thus, Gell-Mann's hyperbolic curve, should be seen as describing the rapidly-accelerating growth of human culture, this being understood to include methods of food production.

If we look at the curve, P=C/(2025-t), it is obvious that human culture has reached a period of crisis. The curve predicts that the world's population will rise to infinity in the year 2025, which of course is impossible. Somehow the actual trajectory of global population as a function of time must deviate from the hyperbolic curve, and in fact, the trajectory has already begun to fall away from the hyperbola.

Because of the great amount of human suffering which may be involved, and the potentially catastrophic damage to the earth's environment, the question of how the actual trajectory of human population will come to deviate from the hyperbola is a matter of enormous importance. Will population overshoot the sustainable limit, and crash? Or will it gradually approach a maximum? In the case of the second alternative, will the checks which slow population growth be later marriage and family planning? Or will the grim Malthusian forces - famine, disease and war - act to hold the number of humans within the carrying capacity of their environment?

We can anticipate that as the earth's human population approaches 10 billion, severe famines will occur in many developing countries. The beginnings of this tragedy can already be seen. It is estimated that roughly 30,000 children now die every day from starvation, or from a combination of disease and malnutrition.

Beyond the fossil fuel era

An analysis of the global ratio of population to cropland shows that we have probably already exceeded the sustainable limit of population through our dependence on petroleum: Between 1950 and 1982, the use of cheap synthetic fertilizers increased by a factor of 8. Much of our present agricultural output depends on their use, but their production is expensive in terms of energy. Furthermore, petroleum-derived synthetic fibers have reduced the amount of cropland needed for growing natural fibers, and petroleum-driven tractors have replaced draft animals which required cropland for pasturage.

Also, petroleum fuels have replaced fuelwood and other fuels derived for biomass. The reverse transition, from fossil fuels back to renewable energy sources, will require a considerable diversion of land from food production to energy production. For example, 1.1 hectares are needed to grow the sugarcane required for each alcohol-driven Brazilian automobile. This figure may be compared with the steadily falling average area of cropland available to each

person in the world: .24 hectares in 1950, .16 hectares in 1982.

Thus there is a danger that just as global population reaches the unprecedented level of 10 billion or more, the agricultural base for supporting it may suddenly collapse. Ecological catastrophe, possibly compounded by war and other disorders, could produce famine and death on a scale unprecedented in history - a disaster of unimaginable proportions, involving billions rather than millions of people.

What would Malthus say today?

What would Malthus tell us if he were alive today? Certainly he would say that we have reached a period of human history where it is vital to stabilize the world's population if catastrophic environmental degradation and famine are to be avoided. He would applaud efforts to reduce suffering by eliminating poverty, widespread disease, and war; but he would point out that, since it is necessary to stop the rapid increase of human numbers, it follows that whenever the positive checks to population growth are removed, it is absolutely necessary to replace them by preventive checks. Malthus' point of view became more broad in the successive editions of his Essay; and if he were alive today, he would probably agree that family planning is the most humane of the preventive checks.

Eliminating poverty and war

In most of the societies which Malthus described, a clear causal link can be seen, not only between population pressure and poverty, but also between population pressure and war. As one reads his Essay, it becomes clear why both these terrible sources of human anguish saturate so much of history, and why efforts to eradicate them have so often met with failure: The only possible way to eliminate poverty and war is to reduce the pressure of population by preventive checks, since the increased food supply produced by occasional cultural advances can give only very temporary relief.

Today, the links between population pressure, poverty, and war are even more pronounced than they were in the past, because the growth of human population has brought us to the absolute limits imposed by ecological constraints. Furthermore, the development of nuclear weapons has made war prohibitively dangerous.

How many people can the earth support in comfort?

The resources of the earth and the techniques of modern science can support a global population of moderate size in comfort and security; but the optimum size is undoubtedly smaller than the world's present population. Given a sufficiently small global population, renewable sources of energy can be found to replace disappearing fossil fuels. Technology may also be able to find renewable substitutes for many disappearing mineral resources for a global population of a moderate size. What technology cannot do, however, is to give a global population of 10 billion people the standard of living which the industrialized countries enjoy today.

1.4 Economics without growth

According to Adam Smith, the free market is the dynamo of economic growth. The true entrepreneur does not indulge in luxuries for himself and his family, but reinvests his profits, with the result that his business or factory grows larger, producing still more profits, which he again reinvests, and so on. This is indeed the formula for exponential economic growth.

Economists (with a few notable exceptions such as Aurelio Peccei and Herman Daly) have long behaved as though growth were synonymous with economic health. If the gross national product of a country increases steadily by 4% per year, most economists express approval and say that the economy is healthy. If the economy could be made to grow still faster (they maintain), it would be still more healthy. If the growth rate should fall, economic illness would be diagnosed. However, the basic idea of Malthus is applicable to exponential increase of any kind. It is obvious that on a finite Earth, neither population growth nor resource-using and pollution-generating economic growth can continue indefinitely.

A "healthy" economic growth rate of 4% per year corresponds to an increase by a factor of 50 in a century. (The reader is invited to calculate the factor of increase in five centuries. The answer is $50^5 = 312,500,000$.) No one can maintain that this type of growth is sustainable except by refusing to look more than a short distance into the future. Sooner or later (perhaps surprisingly soon) an entirely new form of economics will be needed - not the empty-world economics of Adam Smith, but what might be called "full-world economics", or "steady-state economics".

Economic activity is usually divided into two categories, 1) production of goods and 2) provision of services. It is the rate of production of goods that will be limited by the carrying capacity of the global environment. Services that have no environmental impact will not be constrained in this way. Thus a

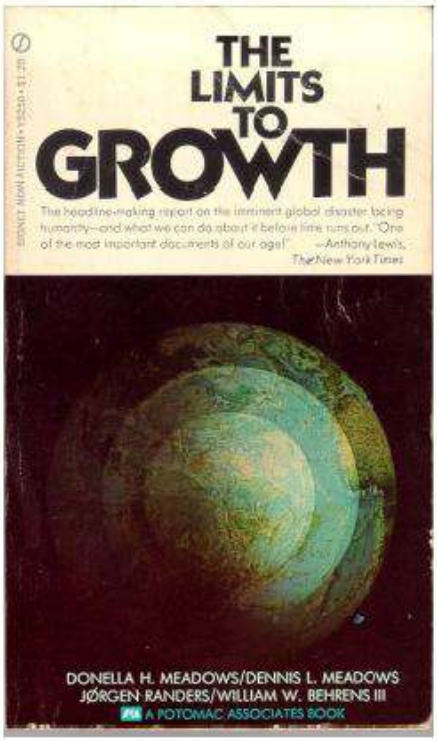

Figure 1.2: **In 1968 Aurelio Peccei, Thorkil Kristensen and others founded the Club of Rome, an organization of economists and scientists devoted to studying the predicament of human society. One of the first acts of the organization was to commission an MIT study of future trends using computer models. The result was a book entitled "Limits to Growth", published in 1972. From the outset the book was controversial, but it became a best-seller.** (Great Change)

smooth transition to a sustainable economy will involve a shift of a large fraction the work force from the production of goods to the provision of services.

In his recent popular book *The Rise of the Creative Class*, the economist Richard Florida points out that in a number of prosperous cities - for example Stockholm - a large fraction of the population is already engaged in what might be called creative work - a type of work that uses few resources, and produces few waste products - work which develops knowledge and culture rather than producing material goods. For example, producing computer software requires few resources and results in few waste products. Thus it is an activity with a very small ecological footprint. Similarly, education, research, music, literature and art are all activities that do not weigh heavily on the carrying capacity of the global environment. Furthermore, cultural activities lead in a natural way to global cooperation and internationalism. Florida sees this as a pattern for the future, and maintains that everyone is capable of creativity. He visualizes the transition to a sustainable future economy as one in which a large fraction of the work force moves from industrial jobs to information-related work. Meanwhile, as Florida acknowledges, industrial workers feel uneasy and threatened by such trends.

The present use of resources by the industrialized countries is extremely wasteful. A growing national economy must, at some point, exceed the real needs of the citizens. It has been the habit of the developed countries to create artificial needs by means of advertising, in order to allow economies to grow beyond the point where all real needs have been met; but this extra growth is wasteful, and in the future it will be important not to waste the earth's diminishing supply of non-renewable resources.

Thus, the times in which we live present a challenge: We need a revolution in economic thought. We must develop a new form of economics, taking into account the realities of the world's present situation - an economics based on real needs and on a sustainable equilibrium with the environment, not on the thoughtless assumption that growth can continue forever.

Adam Smith was perfectly correct in saying that the free market is the dynamo of economic growth; but rapid growth of human population and economic activity have brought us, in a surprisingly short time, from the empty-world situation in which he lived to a full-world situation. 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. Full-world economics, the economics of the future, will no longer be able to rely on growth to give profits to stockbrokers or to solve problems of unemployment or to alleviate poverty. In the long run, growth of any kind is not sustainable (except perhaps growth of culture and knowledge); and we are now nearing the environmentally-imposed limits.

Transition to a sustainable economy

Like a speeding bus headed for a brick wall, the earth's rapidly-growing population of humans and its rapidly-growing resource-using and pollution-generating economic activity are headed for a collision with a very solid barrier - the carrying capacity of the global environment. As in the case of the bus and the wall, the correct response to the situation is to apply the brakes in time - but fear prevents us from doing this. What will happen if we slow down very suddenly? Will not many of the passengers be injured? Undoubtedly. But what will happen if we hit the wall at full speed? Perhaps it would be wise, after all, to apply the brakes!

The memory of the great depression of 1929 makes us fear the consequences of an economic slowdown, especially since unemployment is already a serious problem in many parts of the world. Although the history of the 1929 depression is frightening, it may nevertheless be useful to look at the measures which were used then to bring the global economy back to its feet. A similar level of governmental responsibility may help us to avoid some of the more painful consequences of the necessary transition from the economics of growth to steady-state economics.

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), 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.

The Worldwatch Institute, Washington D.C., lists the following steps as necessary for the transition to sustainability[2]:

1. Stabilizing population

2. Shifting to renewable energy

[2]L.R. Brown and P. Shaw, 1982.

Figure 1.3: **Lester R. Brown, founder of the Worldwatch Institute, and for many years its President. He is now the leader of the Earth Policy Institute. His recent book, "Plan B", gives important information about the ecological crisis now facing the world. It may be downloaded free of charge from the website of the Earth Policy Institute.** (Famous Birthdays)

3. Increasing energy efficiency
4. Recycling resources
5. Reforestation
6. Soil Conservation

All of these steps are labor-intensive; and thus, wholehearted governmental commitment to the transition to sustainability can help to solve the problem of unemployment.

In much the same spirit that Roosevelt (with Keynes' approval) used governmental powers to end the great depression, we must now urge our governments to use their powers to promote sustainability and to reduce the trauma

of the transition to a steady-state economy. For example, an increase in the taxes on fossil fuels could make a number of renewable energy technologies economically competitive; and higher taxes on motor fuels would be especially useful in promoting the necessary transition from private automobiles to bicycles and public transportation. Tax changes could also be helpful in motivating smaller families.

The present economic recession offers us an opportunity to take steps towards the creation of a sustainable steady-state economic system. Government measures to avoid unemployment could at the same time shift the work force to jobs that promote sustainability, i.e., jobs in the areas listed by the Worldwatch Institute.

Governments already recognize their responsibility for education. In the future, they must also recognize their responsibility for helping young people to make a smooth transition from education to secure jobs. If jobs are scarce, work must be shared, in a spirit of solidarity, among those seeking employment; hours of work (and if necessary, living standards) must be reduced to insure a fair distribution of jobs. Market forces alone cannot achieve this. The powers of government are needed.

Population and goods per capita

In the distant future, the finite carrying capacity of the global environment will impose limits on the amount of resource-using and waste-generating economic activity that it will be possible for the world to sustain. The consumption of goods per capita will be equal to this limited total economic activity divided by the number of people alive at that time. Thus, our descendants will have to choose whether they want to be very numerous and very poor, or less numerous and more comfortable, or very few and very rich. Perhaps the middle way will prove to be the best.

Given the fact that environmental carrying capacity will limit the sustainable level of resource-using economic activity to a fixed amount, average wealth in the distant future will be approximately inversely proportional to population over a certain range of population values. Obviously, if the number of people is reduced to such an extent that it approaches zero, the average wealth will not approach infinity, since a certain level of population is needed to maintain a modern economy. However, if the global population becomes extremely large, the average wealth will indeed approach zero.

In the 1970's the equation $I = P \times A \times T$ was introduced in the course of a debate between Barry Commoner, Paul R. Ehrlich and John P. Holdren. Here I represents environmental impact, P is population, while A represents goods per capita, and T is an adjustable factor that depends on the technology

used to produce the goods. The assertion of the previous paragraph can be expressed by solving for A and setting I equal to a constant: $A = I/(P \times T)$. In the distant future, the environmental impact I will not be allowed to increase, and therefore for a given value of T, A will be inversely proportional to P.

If the environmental impact I is broken up into several components, a few of them have historically fallen with increasing values of $A \times P$ because of diminishing T (thus exhibiting the *environmental Kuznets curve*). However, most components of I, such as energy, land and resource use, have historically increased with increasing $A \times P$.

1.5 Entropy and economics

We urgently need to shift quickly from fossil fuels to renewable energy if we are to avoid a tipping point after which human efforts to avoid catastrophic climate change will be futile because feedback loops will have taken over. The dangerous methane hydrate feedback loop is discussed in an excellent short video made by Thom Hartmann and the Leonardo DiCaprio Foundation.[3]

Celebrated author and activist Naomi Klein has emphasized the link between need for economic reform and our urgent duty to address climate change.[4]

Rebel economist Prof. Tim Jackson discusses the ways in which our present economic system has failed us, and the specific reforms that are needed. In one of his publications, he says: "The myth of growth has failed us. It has failed the two billion people who still live on 2 dollars a day. It has failed the fragile ecological systems on which we depend for survival. It has failed, spectacularly, in its own terms, to provide economic stability and secure people's livelihood."
[5]

What is entropy?

Entropy is a quantity, originally defined in statistical mechanics and thermodynamics. It is a measure of the statistical probability of any state of a system: The greater the entropy, the greater the probability. The second law of thermodynamics asserts that entropy of the universe always increases with time.

[3] https://www.youtube.com/watch?v=sRGVTK-AAvw
http://lasthours.org/

[4] http://thischangeseverything.org/naomi-klein/
http://www.theguardian.com/profile/naomiklein

[5] http://www.theguardian.com/sustainable-business/rio-20-tim-jackson-leaders-green-economy?newsfeed=true
http://www.theguardian.com/sustainable-business/consumerism-sustainability-short-termism

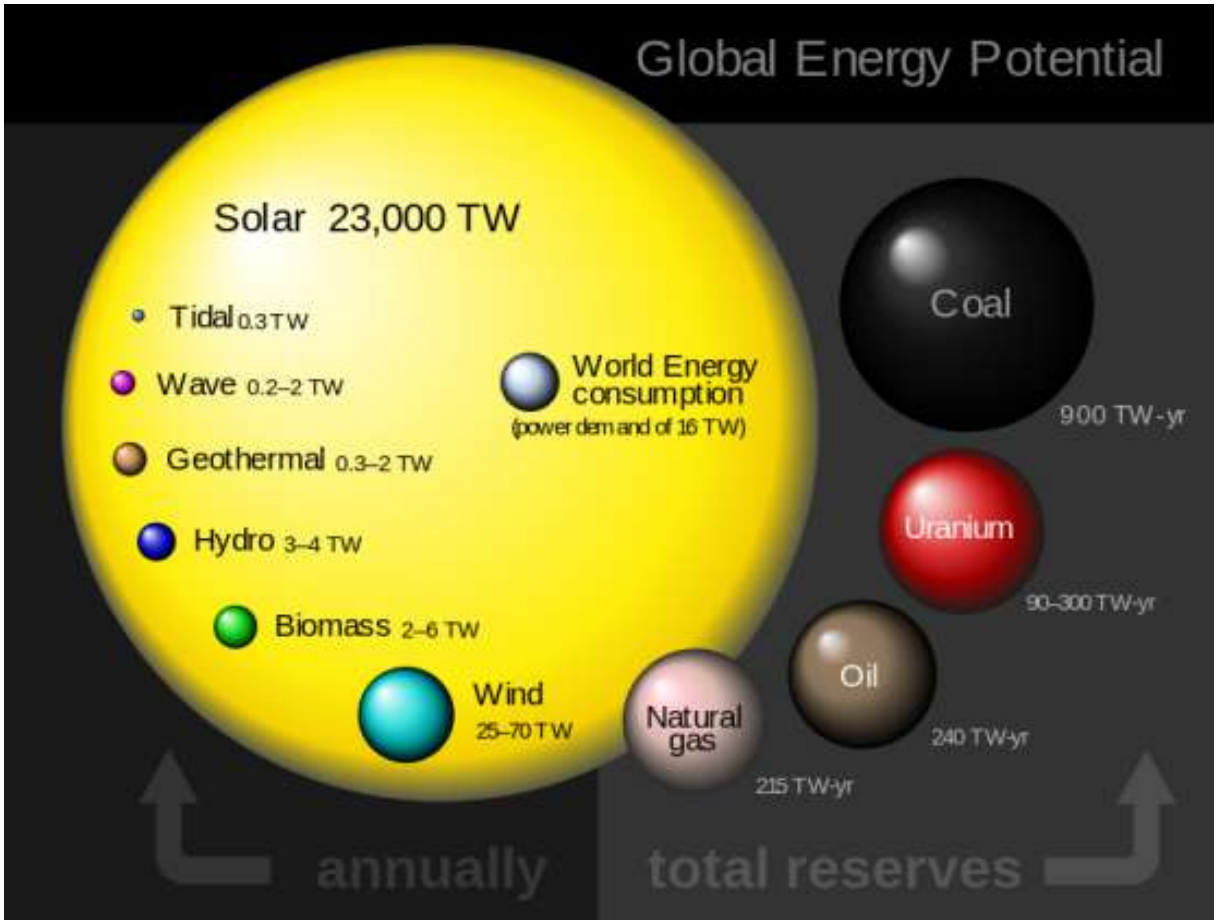

Figure 1.4: **Global energy potential. Comparison of renewable and conventional planetary energy reserves and sources. While renewables display their power potential in terawatts (TW) with the corresponding annual amount of energy, conventional sources display their total recoverable energy reserves in terawatt-years (TW-yr). Author: Rfassbind, Wikimedia Commons**

In other words, the universe as a whole is constantly moving towards states of greater and greater probability.

For any closed system, the same is true. Such systems move in time towards states of greater and greater probability. However, the earth, with its biosphere, is not a closed system. The earth constantly receives an enormous stream of light from the sun. The radiation which we receive from the sun brings us energy that can be used to perform work, and in physics this is called "free energy". Because of this flood of incoming sunlight, plants, animals and humans are able to create structures which from a statistical point of view are highly unlikely.

The disorder and statistical probability of the universe is constantly increasing, but because the earth is not a closed system, we are able to create local order, and complex, statistically improbable structures, like the works of Shakespeare, the Mona Lisa and the Internet. The human economy is driven by the free energy which we receive as income from the sun. Money is, in fact, a symbol for free energy, and free energy might be thought of as "negative entropy". There is also a link between free energy and information.[6]

Human society as a superorganism, with the global economy as its digestive system

A completely isolated human being would find it as difficult to survive for a long period of time as would an isolated ant or bee or termite. Therefore it seems correct to regard human society as a superorganism. In the case of humans, the analog of the social insects' nest is the enormous and complex material structure of civilization. It is, in fact, what we call the human economy. It consists of functioning factories, farms, homes, transportation links, water supplies, electrical networks, computer networks and much more.

Almost all of the activities of modern humans take place through the medium of these external "exosomatic" parts of our social superorganism. The terms "exosomatic" and "endosomatic" were coined by the American scientist Alfred Lotka (1880-1949). A lobster's claw is endosomatic; it is part of the lobster's body. The hammer used by a human is exosomatic, like a detachable claw. Lotka spoke of "exosomatic evolution", including in this term not only cultural evolution but also the building up of the material structures of civilization.

The economy associated with the human superorganism "eats" resources and free energy. It uses these inputs to produce local order, and finally excretes them as heat and waste. The process is closely analogous to food passing

[6] http://www.amazon.com/Information-Theory-And-Evolution-Edition/dp/9814401234

through the alimentary canal of an individual organism. The free energy and resources that are the inputs of our economy drive it just as food drives the processes of our body, but in both cases, waste products are finally excreted in a degraded form.

Almost all of the free energy that drives the human economy came originally from the sun's radiation, the exceptions being geothermal energy which originates in the decay of radioactive substances inside the earth, and tidal energy, which has its origin in the slowing of the motions of the earth-moon system. However, since the start of the Industrial Revolution, our economy has been using the solar energy stored in of fossil fuels. These fossil fuels were formed over a period of several hundred million years. We are using them during a few hundred years, i.e., at a rate approximately a million times the rate at which they were formed.

The present rate of consumption of fossil fuels is more than 14 terawatts and, if used at the present rate, fossil fuels would last less than a century. However, because of the very serious threats posed by climate change, human society would be well advised to stop the consumption of coal, oil and natural gas within the next two decades.

The rate of growth of of new renewable energy sources is increasing rapidly. These sources include small hydro, modern biomass, solar, wind, geothermal, wave and tidal energy. There is an urgent need for governments to set high taxes on fossil fuel consumption and to shift subsidies from the petroleum and nuclear industries to renewables. These changes in economic policy are needed to make the prices of renewables more competitive.

The shock to the global economy that will be caused by the end of the fossil fuel era will be compounded by the scarcity of other non-renewable resources, such as metals. While it is true (as neoclassical economists emphasize) that "matter and energy can neither be created nor destroyed", free energy can be degraded into heat, and concentrated deposits of minerals can be dispersed. Both the degradation of free energy into heat and the dispersal of minerals involve increases of entropy.

1.6 Frederick Soddy

One of the first people to call attention to the relationship between entropy and economics was the English radiochemist Frederick Soddy (1877-1956). Soddy won the Nobel Prize for Chemistry in 1921 for his work with Ernest Rutherford demonstrating the transmutation of elements in radioactive decay processes. His concern for social problems then led him to a critical study of the assumptions of classical economics. Soddy believed that there is a close

connection between free energy and wealth, but only a very tenuous connection between wealth and money.

Soddy was extremely critical of the system of "fractional reserve banking" whereby private banks keep only a small fraction of the money that is entrusted to them by their depositors and lend out the remaining amount. He pointed out that this system means that the money supply is controlled by the private banks rather than by the government, and also that profits made from any expansion of the money supply go to private corporations instead of being used to provide social services. Fractional reserve banking exists today, not only in England but also in many other countries. Soddy's criticisms of this practice cast light on the subprime mortgage crisis of 2008 and the debt crisis of 2011.

As Soddy pointed out, real wealth is subject to the second law of thermodynamics. As entropy increases, real wealth decays. Soddy contrasted this with the behavior of debt at compound interest, which increases exponentially without any limit, and he remarked:

"You cannot permanently pit an absurd human convention, such as the spontaneous increment of debt [compound interest] against the natural law of the spontaneous decrement of wealth [entropy]". Thus, in Soddy's view, it is a fiction to maintain that being owed a large amount of money is a form of real wealth.

Frederick Soddy's book, "Wealth, virtual wealth and debt: The solution of the economic paradox", published in 1926 by Allen and Unwin, was received by the professional economists of the time as the quixotic work of an outsider. Today, however, Soddy's common-sense economic analysis is increasingly valued for the light that it throws on the problems of our fractional reserve banking system, which becomes more and more vulnerable to failure as economic growth falters.[7]

Currency reform, and nationalization of banks

Frederick Soddy was writing at a time when England's currency was leaving the gold standard, and in order to replace this basis for the currency, he proposed an index system. Soddy's index was to be based on a standard shopping basket containing household items, such as bread, milk, potatoes and so on. If the price of the items in the basket rose, more currency would be issued by the nationalized central bank. If the price fell, currency would be withdrawn.

Nationalization of banks was proposed by Soddy as a means of avoiding the evils of the fractional reserve banking system. Today we see a revival of

[7] www.fadedpage.com/link.php?file=20140873-a5.pdf
http://human-wrongs-watch.net/2015/07/08/debt-slavery/

the idea of nationalized banks, or local user-owned cooperative banks. The Grameen Bank, founded by Prof. Muhammad Yunus, pioneered the idea of socially-motivated banks for the benefit poor people who would ordinarily be unable to obtain loans. The bank and its founder won a Nobel Peace Prize in 2006.[8]

1.7 Nicholas Georgescu-Roegen: Ecological Economics

The incorporation of the idea of entropy into economic thought also owes much to the mathematician and economist Nicholas Georgescu-Roegen (1906-1994), the son a Romanian army officer. Georgescu-Roegen's talents were soon recognized by the Romanian school system, and he was given an outstanding education in mathematics, which later contributed to his success and originality as an economist.

Between 1927 and 1930 the young Georgescu studied at the Institute de Statistique in Paris, where he completed an award-winning thesis: "On the problem of finding out the cyclical components of phenomena". He then worked in England with Karl Pearson from 1930 to 1932, and during this period his work attracted the attention of a group of economists who were working on a project called the Harvard Economic Barometer. He received a Rockefeller Fellowship to join this group, but when he arrived at Harvard, he found that the project had been disbanded.

In desperation, Georgescu-Roegen asked the economist Joseph Schumpeter for an appointment to his group. Schumpeter's group was in fact a remarkably active and interesting one, which included the future Nobel laureate Wassely Leontief; and there followed a period of intense intellectual activity during which Georgescu-Roegen became an economist.

Despite offers of a permanent position at Harvard, Georgescu-Roegen re-

[8]http://www.grameen-info.org/history/
http://www.ibtimes.com/greece-drawing-contingency-plans-nationalize-banks-bring-parallel-currency-report-1868830
http://www.quora.com/Why-were-banks-nationalized-in-India
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http://dissidentvoice.org/2015/07/whats-wrong-with-our-monetary-system-and-how-to-fix-it/

turned to his native Romania in the late 1930's and early 1940's in order to help his country. He served as a member of the Central Committee of the Romanian National Peasant Party. His experiences at this time led to his insight that economic activity involves entropy. He was also helped to this insight by Borel's monograph on Statistical Mechanics, which he had read during his Paris period.

Georgescu-Roegen later wrote: "The idea that the economic process is not a mechanical analogue, but an entropic, unidirectional transformation began to turn over in my mind long ago, as I witnessed the oil wells of the Plosti field of both World Wars' fame becoming dry one by one, and as I grew aware of the Romanian peasants' struggle against the deterioration of their farming soil by continuous use and by rains as well. However it was the new representation of a process that enabled me to crystallize my thoughts in describing the economic process as the entropic transformation of valuable natural resources (low entropy) into valueless waste (high entropy)."

After making many technical contributions to economic theory, Georgescu-Roegen returned to this insight in his important 1971 book, "The Entropy Law and the Economic Process" (Harvard University Press), where he outlines his concept of bioeconomics. In a later book, "Energy and Economic Myths" (Pergamon Press, New York, 1976), he offered the following recommendations for moving towards a bioeconomic society:

1. The complete prohibition of weapons production, thereby releasing productive forces for more constructive purposes;
2. Immediate aid to underdeveloped countries;
3. Gradual decrease in population to a level that could be maintained only by organic agriculture;
4. Avoidance, and strict regulation if necessary, of wasteful energy use;
5. Abandon our attachment to "extravagant gadgetry";
6. "Get rid of fashion";
7. Make goods more durable and repairable; and
8. Cure ourselves of workaholic habits by re-balancing the time spent on work and leisure, a shift that will become incumbent as the effects of the other changes make themselves felt.

Georgescu-Roegen did not believe that his idealistic recommendations would be adopted, and he feared that human society is headed for a crash.

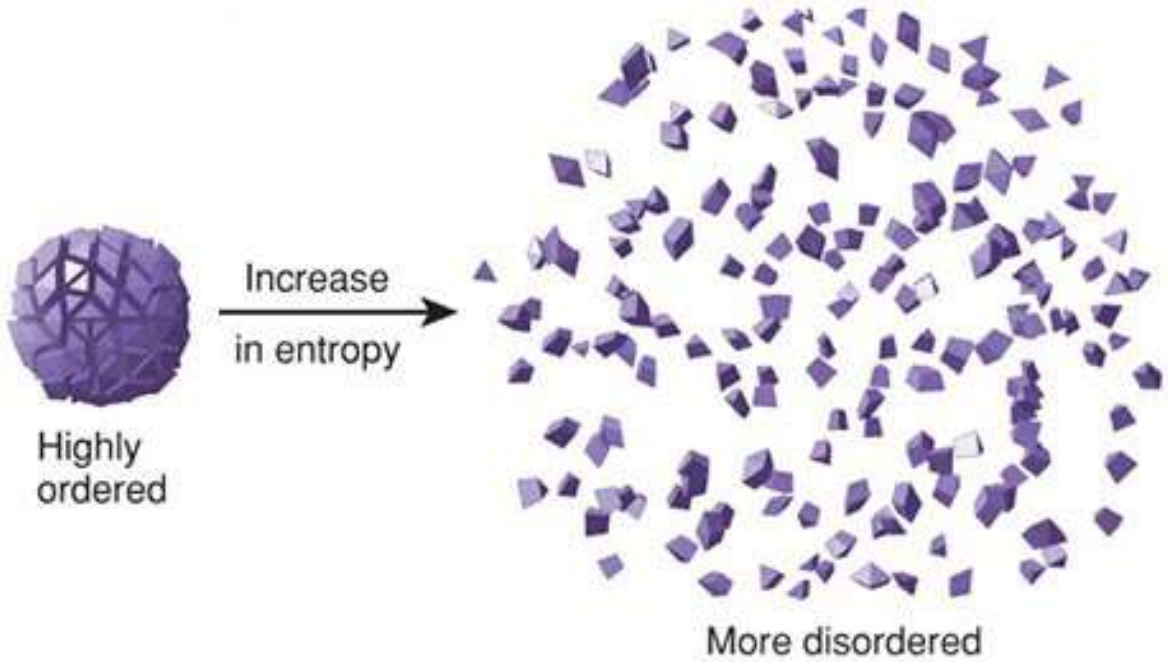

Figure 1.5: **According to the second law of thermodynamics, the entropy of the universe constantly increases. Increase of entropy corresponds to increase of disorder, and also to increase of statistical probability. Living organisms on the earth are able to achieve a high degree of order and highly improbable structures because the earth is not a closed system. It constantly receives free energy (i.e. energy capable of doing work) from the sun, and this free energy can be thought of as carrying thermodynamic information, or "negative entropy". Source: flowchainsensel.wordpress.co,**

Figure 1.6: **Wind, solar, and biomass are three emerging renewable sources of energy. Wind turbines in a rapeseed field in Sandesneben, Germany. Author: Jürgen from Sandesneben, Germany, Wikimedia Commons**

1.8 Herman E. Daly and Kozo Mayumi

Limits to growth

Nicholas Georgescu-Roegen's influence continues to be felt today, not only through his own books and papers but also through those of his students, the distinguished economists Herman E. Daly and Kozo Mayumi, who for many years have been advocating a steady-state economy. As they point out in their books and papers, it is becoming increasingly apparent that unlimited economic growth on a finite planet is a logical impossibility. However, it is important to distinguish between knowledge, wisdom and culture, which can and should continue to grow, and growth in the sense of an increase in the volume of material goods produced. It is growth in the latter sense that is reaching its limits.

Daly describes our current situation as follows: "The most important change in recent times has been the growth of one subsystem of the Earth, namely the economy, relative to the total system, the ecosphere. This huge shift from an 'empty' to a 'full' world is truly 'something new under the sun'... The closer the economy approaches the scale of the whole Earth, the more it will have to conform to the physical behavior mode of the Earth... The remaining natural world is no longer able to provide the sources and sinks for the metabolic throughput necessary to sustain the existing oversized economy, much less a growing one. Economists have focused too much on the economy's circulatory system and have neglected to study its digestive tract."[9]

In the future, the only way that we can avoid economic collapse is to build a steady-state economy. There exists much literature on how this can be achieved, and these writings ought to become a part of the education of all economists and politicians.

Suggestions for further reading

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[9] http://dalynews.org/learn/blog/
http://steadystate.org/category/herman-daly/
https://www.youtube.com/watch?v=EN5esbvAt-w
https://www.youtube.com/watch?v=wlR-VsXtM4Y
http://www.imf.org/external/pubs/ft/survey/so/2015/car031315a.htm

Figure 1.7: **Today, Nicholas Georgescu-Roegen's work for a sustainable steady.state economic system is ably carried forward by his two distinguished students, Professors Herman E. Daly (above) and Kozo Mayumi (below).**

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Chapter 2

THREATS TO THE ENVIRONMENT

"Some of the potential risks could be irreversible and could accelerate the process of global warming. Melting of permafrost in the Arctic could lead to the release of huge quantities of methane. Dieback of the Amazon forest could mean that the region starts to emit rather than to absorb greenhouse gases. These feedbacks could lead to warming that is at least twice as fast as current high-emission projections, leading to temperatures higher than seen in the last 50 million years. There are still uncertainties about how much warming would be needed to trigger these abrupt changes. Nevertheless, the consequences would be catastrophic if they do occur."

Stern Report Discussion Paper, January 31, 2006.

2.1 Introduction

The worst dangers from a disastrous increase in global temperatures lie in the distant future; but to avoid them, action must be taken immediately. The huge subsidies currently given to fossil fuel companies must be abolished, or, better yet, shifted to the support of renewable energy.

In the long-term future (in many centuries) climate change threatens to produce ocean level rises which will drown most of the world's coastal cities, and which will wipe out countries such as Bangladesh and Holland. At the same time, increases in temperature will make large parts of the Middle East, India and Africa uninhabitable.

Hope that catastrophic climate change can be avoided comes from the exponentially growing world-wide use of renewable energy and from the fact prominent public figures, such as Pope Francis, Leonardo DiCaprio, Elon Musk, Bill McKibben, Naomi Klein and Al Gore, are making the public increasingly aware of the long-term dangers. Short-term disasters due to climate change may also be sufficiently severe to wake us up.

We must work with dedication to save the future for our grandchildren and their grandchildren, a future, which we share with all other living creatures on earth. We must accept our responsibility for the long-term future of human civilization and the biosphere.

2.2 Malthus revisited

Avoiding the grim Malthusian forces

Malthus died in Bath in 1834, but debate on his ideas continued to rage, both in his own century and our own. Each year he is refuted, and each year revived. Despite impressive scientific progress since his time, the frightful Malthusian forces - poverty, famine, disease, and war - cast as dark a shadow in our own times as they did in the nineteenth century. Indeed, the enormous power of modern weapons has greatly intensified the dangers posed by war; and the rapid growth of global population has given new dimensions to the problems of poverty and famine.

In most developing countries, poverty and disease are still major problems. In other parts of the world, the optimistic prophecies of 18th century philosophers such as Condorcet and Godwin have been at least partially fulfilled. In the industrialized nations, Godwin's prophecy of automated agriculture has certainly come true. In the nations of the North, only a small percentage of the population is engaged in agriculture, while most of the citizens are free to pursue other goals than food production.

Scandinavia is an example of an area where poverty and war have both been eliminated locally, and where death from infectious disease is a rarity. These achievements would have been impossible without the low birth rates which also characterize the region. In Scandinavia, and in other similar regions, low birth rates and death rates, a stable population, high educational levels, control of infectious disease, equal status for women, democratic governments, and elimination of poverty and war are linked together in a mutually re-enforcing circle of cause and effect. By contrast, in many large third-world cities, overcrowding, contaminated water, polluted air, dense population without adequate sanitation, low status of women, high birth rates, rapidly increasing population, high unemployment levels, poverty, crime, ethnic conflicts, and resurgence of infectious disease are also linked in a self-perpetuating causal loop - in this case a vicious circle.

Population stabilization and sustainability

Does the contrast between the regions of our contemporary world mean that Malthus has been "proved wrong" in some regions and "proved right" in others? To answer this question, let us re-examine the basic assertion which Malthus puts forward in Books I and II of the 1803 version of his *Essay*. His basic thesis is that the maximum natural fertility of human populations is greatly in excess of replacement fertility. This being so, Malthus points out, human populations would always increase exponentially if they were not prevented from doing so by powerful and obvious checks.

In general, Malthus tells us, populations cannot increase exponentially because the food supply increases slowly, or is constant. Therefore, he concludes, in most societies and almost all periods of history, checks to population growth are operating. These checks may be positive, or they may be preventive, the positive checks being those which raise the death rate, while the preventive checks lower the birth rate. There are, however, Malthus says, exceptional periods of history when the populations of certain societies do actually increase exponentially because of the opening of new lands or because of the introduction of new methods of food production. As an example, he cites the growth of the population of the United States, which doubled every 25 years over a period of 150 years.

We can see, from this review of Malthus' basic thesis, that his demographic model is flexible enough to describe all of the regions of our contemporary world: If Malthus were living today, he would say that in countries with low birth and death rates and stable populations, the checks to population growth are primarily preventive, while in countries with high death rates, the positive checks are important. Finally, Malthus would describe our rapidly-growing

global population as the natural result of the introduction of improved methods of food production in the developing countries. We should notice, however, that the flexibility of Malthus' demographic model first appears in the 1803 version of his *Essay*: In the 1798 version, he maintained "..that population does invariably increase, where there are means of subsistence.." and "that the superior power (of population) cannot be checked without producing misery and vice.." This narrower model of population did not agree with Malthus' own observations in Norway in 1799, and therefore in his 1803 *Essay* he allowed more scope for preventive checks, which included late marriage and moral restraint as well as birth control (which he classified under the heading of "vice").

Today we are able to estimate the population of the world at various periods in history, and we can also make estimates of global population in prehistoric times. Looking at the data, we can see that the global population of humans has not followed an exponential curve as a function of time, but has instead followed a hyperbolic trajectory. At the time of Christ, the population of the world is believed to have been approximately 220 million. By 1500, the earth contained 450 million people, and by 1750, the global population exceeded 700 million. As the industrial and scientific revolution has accelerated, global population has responded by increasing at a break-neck speed: In 1930, the population of the world reached two billion; in 1958 three billion; in 1974 four billion; in 1988 five billion, and in 1999, six billion. Today, roughly a billion people are being added to the world's population every fourteen years.

An analysis of the global ratio of population to cropland shows that we have probably already exceeded the sustainable limit of population through our dependence on petroleum: Between 1950 and 1982, the use of cheap synthetic fertilizers increased by a factor of 8. Much of our present agricultural output depends on their use, but their production is expensive in terms of energy. Furthermore, petroleum-derived synthetic fibers have reduced the amount of cropland needed for growing natural fibers, and petroleum-driven tractors have replaced draft animals which required cropland for pasturage. Also, petroleum fuels have replaced fuelwood and other fuels derived for biomass. The reverse transition, from fossil fuels back to renewable energy sources, will require a considerable diversion of land from food production to energy production. For example, 1.1 hectares are needed to grow the sugarcane required for each alcohol-driven Brazilian automobile. This figure may be compared with the steadily falling average area of cropland available to each person in the world: .24 hectares in 1950, .16 hectares in 1982.

As population increases, the cropland per person will continue to fall, and we will be forced to make still heavier use of fertilizers to increase output per hectare. Also marginal land will be used in agriculture, with the probable re-

sult that much land will be degraded through erosion and salination. Climate change will reduce agricultural output. The Hubbert peaks for oil and natural gas will occur within one or two decades, and the fossil fuel era will be over by the end of 21st century. Thus there is a danger that just as global population reaches the unprecedented level of 10 billion or more, the agricultural base for supporting it may suddenly collapse. Ecological catastrophe, possibly compounded by war and other disorders, could produce famine and death on a scale unprecedented in history - a disaster of unimaginable proportions, involving billions rather than millions of people.

What would Malthus tell us if he were alive today? Certainly he would say that we have reached a period of human history where it is vital to stabilize the world's population if catastrophic environmental degradation and famine are to be avoided. He would applaud efforts to reduce suffering by eliminating poverty, widespread disease, and war; but he would point out that, since it is necessary to stop the rapid increase of human numbers, it follows that whenever the positive checks to population growth are removed, it is absolutely necessary to replace them by preventive checks. Malthus' point of view became more broad in the successive editions of his *Essay*; and if he were alive today, he would probably agree that family planning is the most humane of the preventive checks.

In Malthus' *Essay on the Principle of Population*, population pressure appears as one of the main causes of war; and Malthus also discusses many societies in which war is one of the the principle means by which population is reduced to the level of the food supply. Thus, his *Essay* contains another important message for our own times: If he were alive today, Malthus would also say that there is a close link between the two most urgent tasks which history has given to the 21st century - stabilization of the global population, and abolition of the institution of war.

In most of the societies which Malthus described, a clear causal link can be seen, not only between population pressure and poverty, but also between population pressure and war. As one reads his *Essay*, it becomes clear why both these terrible sources of human anguish saturate so much of history, and why efforts to eradicate them have so often met with failure: The only possible way to eliminate poverty and war is to reduce the pressure of population by preventive checks, since the increased food supply produced by occasional cultural advances can give only very temporary relief. Today, the links between population pressure, poverty, and war are even more pronounced than they were in the past, because the growth of human population has brought us to the absolute limits imposed by ecological constraints.

2.3 Biology and economics

Classical economists like Smith and Ricardo pictured the world as largely empty of human activities. According to the "empty-world" picture of economics, the limiting factors in the production of food and goods are shortages of capital and labor. The land, forests, fossil fuels, minerals, oceans filled with fish, and other natural resources upon which human labor and capital operate, are assumed to be present in such large quantities that they are not limiting factors. In this picture, there is no naturally-determined upper limit to the total size of the human economy. It can continue to grow as long as new capital is accumulated, as long as new labor is provided by population growth, and as long as new technology replaces labor by automation.

Biology, on the other hand, presents us with a very different picture. Biologists remind us that if any species, including our own, makes demands on its environment which exceed the environment's carrying capacity, the result is a catastrophic collapse both of the environment and of the population which it supports. Only demands which are within the carrying capacity are sustainable. For example, there is a limit to regenerative powers of a forest. It is possible to continue to cut trees in excess of this limit, but only at the cost of a loss of forest size, and ultimately the collapse and degradation of the forest. Similarly, cattle populations may for some time exceed the carrying capacity of grasslands, but the ultimate penalty for overgrazing will be degradation or desertification of the land. Thus, in biology, the concept of the carrying capacity of an environment is extremely important; but in economic theory this concept has not yet been given the weight that it deserves.

The terminology of economics can be applied to natural resources: For example, a forest can be thought of as natural capital, and the sustainable yield from the forest as interest. Exceeding the biological carrying capacity then corresponds, in economic terms, to spending one's capital.

If it is to be prevented from producing unacceptable contrasts of affluence and misery within a society, the free market advocated by Adam Smith needs the additional restraints of ethical principles, as well as a certain amount of governmental regulation. Furthermore, in the absence of these restraints, it will destroy the natural environment of our planet.

There is much evidence to indicate that the total size of the human economy is rapidly approaching the absolute limits imposed by the carrying capacity of the global environment. For example, a recent study by Vitousek et. al. showed that 40 percent of the net primary product of landbased photosynthesis is appropriated, directly or indirectly, for human use. (The net primary product of photosynthesis is defined as the total quantity of solar energy converted into chemical energy by plants, minus the energy used by the plants

themselves). Thus we are only a single doubling time away from 80 percent appropriation, which would imply a disastrous environmental degradation.

Another indication of our rapid approach to the absolute limits of environmental carrying capacity can be found in the present rate of loss of biodiversity. Biologists estimate that between 10,000 and 50,000 species are being driven into extinction each year as the earth's rainforests are destroyed.

The burning of fossil fuels and the burning of tropical rain forests have released so much carbon dioxide that the atmospheric concentration of this greenhouse gas has increased from a preindustrial value of 260 ppm to its present value: 380 ppm. Most scientists agree that unless steps are taken to halt the burning of rain forests and to reduce the use of fossil fuels, the earth's temperature will steadily rise during the coming centuries. This gradual long-term climate change will threaten future agricultural output by changing patterns of rainfall. Furthermore, the total melting of the Arctic and Antarctic icecaps, combined with the thermal expansion of the oceans, threatens to produce a sea level rise of up to 12 meters. Although these are slow, long-term effects, we owe it to future generations to take steps now to halt global warming.

The switch from fossil fuels to renewable energy sources is vital not only because of the need to reduce global warming, but also because the earth's supply of fossil fuels is limited. A peak in the production and consumption of conventional petroleum is predicted within one or two decades. Such a peak in the use of any non-renewable natural resource is called a "Hubbert peak" after the oil expert Dr. M. King Hubbert. It occurs when reserves of the resource are approximately half exhausted. After that point, the resource does not disappear entirely, but its price increases steadily because supply fails to meet demand, and because of rising extraction costs. It is predicted that the Hubbert peak for both oil and natural gas will also occur within a few decades. The peak for oil may occur within the present decade. Thus, halfway through the 21st Century, oil and natural gas will become very expensive - perhaps so expensive that they will not be burned but will instead be reserved as starting points for chemical synthesis.

The reserves of coal are much larger, and at the present rate of use they would last for slightly more than two centuries. However, it seems likely that as petroleum is exhausted, coal will be converted into liquid fuels, as was done in Germany during World War II, and in South Africa during the oil embargo. Thus, in predicting a date for the end of the fossil fuel era, we ought to lump oil, natural gas and coal together. If we do so, we find the total supply has an energy content of 1260 terawatt-years. (1 terawatt is equal to 1,000,000,000,000 Watts). One finds in this way that if they are used at the present rate of 13 terawatts, fossil fuels will last about 100 years.

Resolute government intervention is needed to promote energy conservation

measures and to bring about the switch from fossil fuels to renewable energy sources, such as biomass, photovoltaics, solar thermal power, wind and wave power, and hydropower. Both subsidies for renewable energy technologies, to help them get started, and taxes on fossil fuels will be needed. Changes in tax structure could also encourage smaller families, encourage resource conservation, or diminish pollution. In general, taxation should be used, not merely to raise money, but, more importantly, to guide the evolution of society towards humane and sustainable goals.

2.4 Fossil fuel use and climate change

Melting of the polar ice caps

At present the amount of carbon in the atmosphere is increasing by about 6 gigatons per year because of human activities; and projections estimate that the CO_2 concentration will reach about 600 ppm by 2050 (more than double the preindustrial concentration). In addition to CO_2, methane, CH_4, and nitrous oxide, NO_2, are also released into the atmosphere by human activities. Anthropogenic methane comes from the production and transportation of coal, natural gas and oil, decomposition of organic wastes in municipal landfills, cultivation of rice paddies, and the raising of livestock.

The greenhouse gasses (which include water vapor, carbon dioxide, methane, ozone, nitrous oxide, sulfur hexafluoride, hydroflurocarbons, perflurocarbons and many other gasses) absorb a part of the infrared radiation from the earth's surface, which otherwise would have been sent directly into outer space. Part of this energy is re-radiated into space, but a part is sent downward to the earth, where it is absorbed. The result is that the earth's surface is much warmer than it otherwise would be. The mechanism is much the same as that of a greenhouse, where the glass absorbs and re-radiates infrared radiation. A moderate greenhouse effect on earth is helpful to life, but climatologists believe that anthropogenic CO_2 and CH_4 emissions may produce a dangerous amount of global warming during the next few centuries.

According to the Intergovernmental Panel on Climate Change the percentages of greenhouse gas emissions contributed by various human activities are

as follows:

Energy use	Transportation	13.5%
	Electricity and heat	24.6%
	Other fuel combustion	9.0%
	Industry	10.4%
	Fugitive emissions	3.9%
Other sources	Industrial processes	3.4%
	Land use change (deforestation)	18.2%
	Agriculture	13.5%
	Waste	3.6%

In thinking about global warming, it is important to remember that it is a very slow and long-term phenomenon. Stephen H. Schneider and Janica Lane of Stanford University, in an article entitled *An Overview of 'Dangerous' Climate Change* include a figure that emphasizes the long-term nature of global warming. The figure presupposes that CO_2 emissions will peak within 50 years and will thereafter be reduced. According to the figure, it will still take more than a century for the level of CO_2 in the atmosphere to stabilize. The establishment of temperature equilibrium will require several centuries. Sea level rises due to thermal expansion of ocean water will not be complete before the end of the millennium, while sea level rises due to melting of the polar icecaps might not be complete for several millennia!

It is worrying to think that total melting of the Greenland ice cap, which some authors think might begin in earnest during the 22nd century, would result in a sea level rise of up to 7 meters. Of course, society would have some time to adjust to this event. But a glance at maps and elevations makes one realize the extent of such a catastrophe and the importance of preventing it.

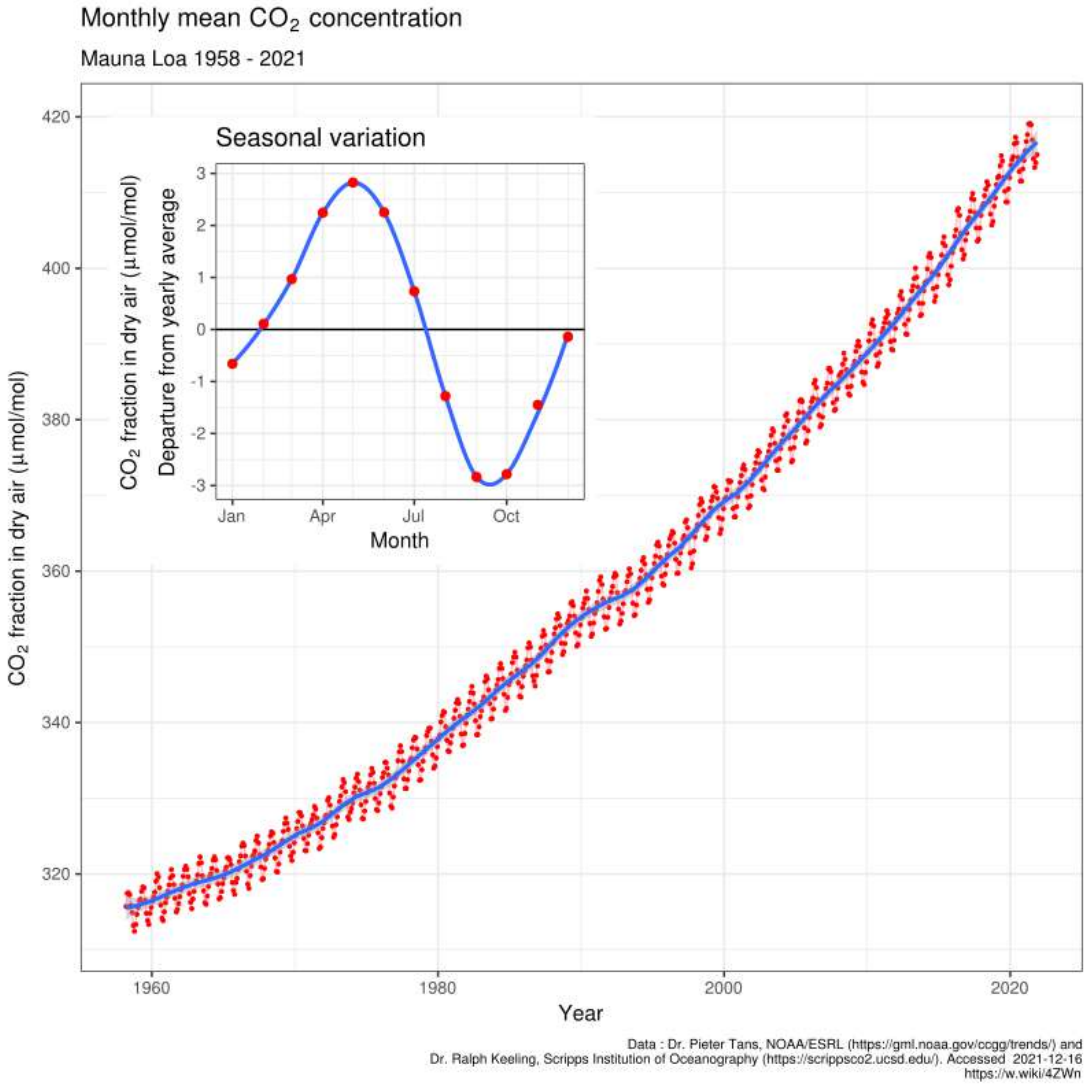

Figure 2.1: **The Keeling Curve shows atmospheric carbon dioxide (CO2) concentrations from 1958 to 2020. Today this concentration has reached 420 parts per million, and it continues to rise despite pandemic lockdowns and pledges to curb emissions.**

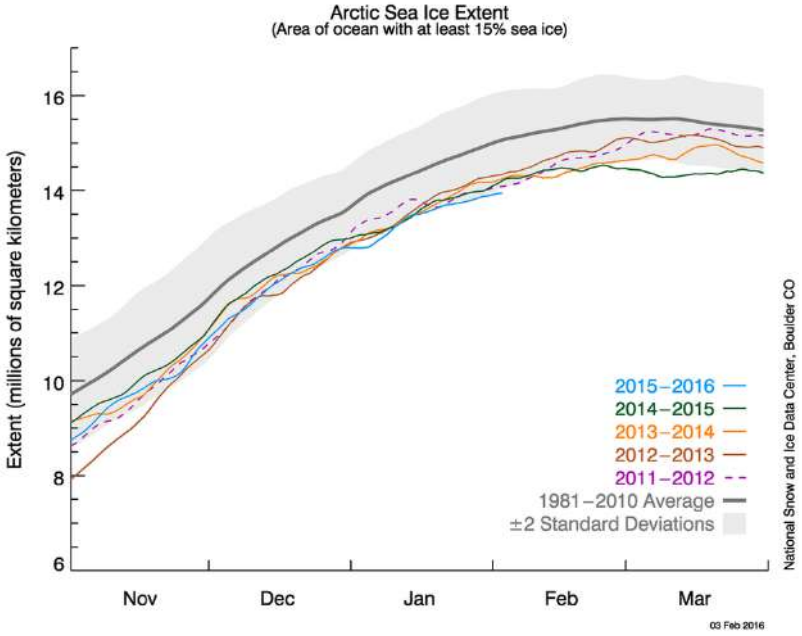

Figure 2.2: **Arctic sea ice extent as of February 3, 2016. January Arctic sea ice extent was the lowest in the satellite record. credit: NSIDC. The rapid nonlinear loss of Arctic sea ice has surprised IPCC scientists.** (Public domain)

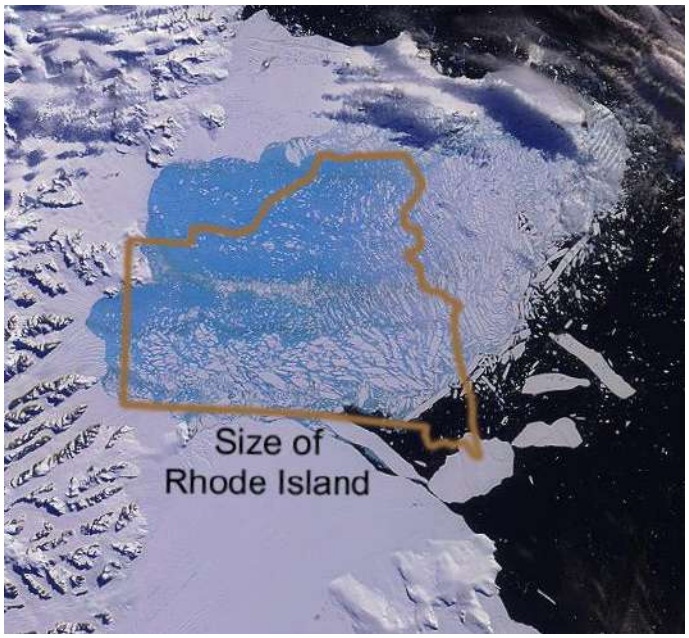

Figure 2.3: **The collapsing Larsen-B iceshelf in the Antarctic is similar in size to the US state of Rhode Island.** (Wikipedia)

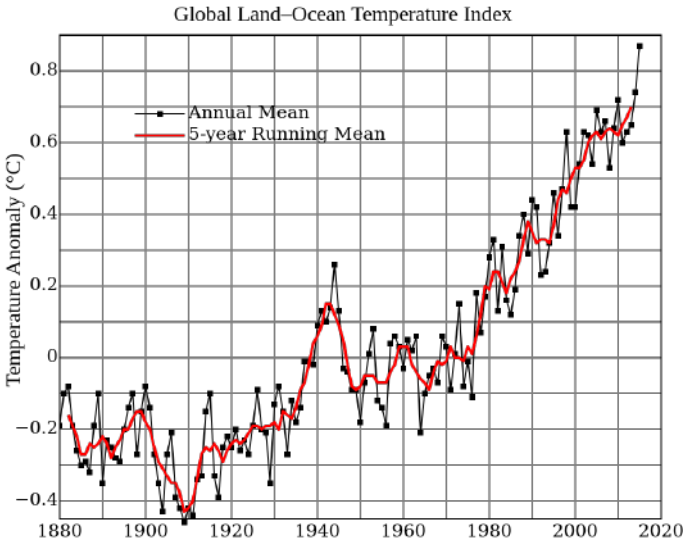

Figure 2.4: **Line plot of global mean land-ocean surface temperature index, 1880 to present, with the base period 1951-1980. The black line is the annual mean and the red line is the five-year running mean. 2016 is predicted to be the hottest year ever recorded, 1.3 °C above the 19th century baseline.** (Public domain)

The IPCC and Stern reports

Models put forward by the Intergovernmental Panel on Climate Change (IPCC, 2007 Report) suggest that if no steps are taken to reduce carbon emissions, a temperature increase of 1.4-5.6 degrees C will occur by 2100[1]. Global warming may have some desirable effects, such as increased possibilities for agriculture in Canada, Sweden and Siberia. However, most of the expected effects of global warming will be damaging. These unwanted effects include ocean level rises, extreme weather conditions (such as heat waves, hurricanes and tropical cyclones), changes in the patterns of ocean currents, melting of polar ice and glaciers, abnormal spread of diseases, extinctions of plant and animal species, together with aridity and crop failures in some areas of the world which are now able to produce and export large quantities of grain.

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.

[1] relative to 1990 temperatures.

The threat of feed-back loops

The Discussion Paper presented by Stern on January 31, 2006, also notes that "Some of the potential risks could be irreversible and accelerate the process of global warming. Melting of permafrost in the Arctic could lead to the release of huge quantities of methane. Dieback of the Amazon forest could mean that the region starts to emit rather than absorb greenhouse gases. These feedbacks could lead to warming that is at least twice as fast as current high-emissions projections, leading to temperatures higher than seen in the past 50 million years. There are still uncertainties about how much warming would be needed to trigger these abrupt changes. Nevertheless, the consequences would be catastrophic if they do occur."

The much larger (700 page) Stern Report was made public on October 30, 2006. It explores not only the scientific basis for predictions of global warming but also the possible economic consequences. Unless we act promptly to prevent it, the Stern Report states, global warming could render swaths of the planet uninhabitable, and do economic damage equal to that inflicted by the two world wars.

A large United Nations Climate Conference (COP15) took place in Copenhagen from December 7 to December 18, 2009. In order to make the latest results of researchers available to the 15,000 expected participants, a preliminary meeting of scientists was held at the University of Copenhagen in March, 2009. 2,500 delegates from 80 countries attended the meeting. Among the conclusions of this international congress of scientists were the following:

- **Climatic trends**: "Recent observations confirm that, given the high rates of observed emissions, the worst-case IPCC scenario trajectories (or even worse) are being realized. For many key parameters, the climate system is already moving beyond the patterns of natural variability within which our society and economy developed and thrived. These parameters include global mean surface temperature, sea-level rise, ocean and ice sheet dynamics, ocean acidification and extreme climate events. There is a significant risk that many of the trends will accelerate, leading to an increasing risk of abrupt or irreversible climatic shifts."

- **Social disruption**: "Recent observations show that societies are highly vulnerable to even modest levels of climate change, with poor nations and communities particularly at risk. Temperature rises above 2^o C will be very difficult for contemporary societies to cope with, and will increase the level of climate disruption through the rest of the century."

To avoid temperature increases of more than 2^o C, the scientists said that it will be necessary for the world to reduce its CO_2 emissions by 90% by 2050.

In other words if dangerous climate change is to be avoided, the fossil fuel era must essentially end by that date.

Despite these clear and unanimous warnings from the scientific community, the United Nations climate conference in Copenhagen failed to reach an agreement sufficiently strong to avoid dangerous climate change. The problem encountered by the conference was a deep disagreement between developed and developing countries. The developing countries correctly maintained that historically, they have not been to blame for emission of greenhouse gases. Meanwhile, the industrialized countries pointed to the future, saying (also correctly) that unless the developing countries accepted their future responsibilities, there would be no hope of avoiding disaster.

At the last moment, the United States, China, India, Brazil and South Africa hammered out a weak agreement, the *Copenhagen Accord*, which the other nations at the conference agreed to "take note of". The Copenhagen Accord recognizes the aim of limiting global warming to 2^o C. However, it does not provide mechanisms sufficiently strong to reach that goal.

Geological extinction events and runaway climate change

It has been observed that both the Greenland ice cap and the Antarctic ice shelfs are melting much more rapidly than was predicted by the IPCC. Complete melting of both the Greenland ice cap and the Antarctic sea ice would raise ocean levels by 14 meters. It is hard to predict how fast this will take place, but certainly within 1-3 centuries.

Most worrying, however, is the threat that without an all-out effort by both developed and developing nations to immediately curb the release of greenhouse gases, climate change will reach a tipping point where feed-back loops will have taken over, and where it will then be beyond the power of human action to prevent exponentially accelerating warming.

By far the most dangerous of these feedback loops involves methane hydrates or 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 CO2.

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 hy-

drates 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.[2]

The worst consequences of runaway climate change will not occur within our own lifetimes. However, we have a duty to all future human generations, and to the plants and animals with which we share our existence, to give them a future world in which they can survive.

Preventing a human-initiated 6th geological extinction event

Geologists studying the strata of rocks have observed 5 major extinction events. These are moments in geological time when most of the organisms then living suddenly became extinct. The largest of these was the Permian-Triassic extinction event, which occurred 252 million years ago. In this event, 96 percent of all marine species were wiped out, as well as 70 percent of all terrestrial vertebrates.

In 2012, the World Bank issued a report warning that without quick action to curb CO2 emissions, global warming is likely to reach 4 degrees C during the 21st century. This is dangerously close to the temperature which initiated the Permian-Triassic extinction event: 6 degrees C above normal.[3]

The Permian-Triasic thermal maximum seems to have been triggered by global warming and CO2 release from massive volcanic eruptions in a region of northern Russia known as the Siberian Traps. The amount of greenhouse gases produced by these eruptions is comparable to the amount emitted by human activities today.

Scientists believe that once the temperature passed 6 degrees C above normal, a feedback loop was initiated in which methane hydrate crystals on the ocean floors melted, releasing methane, a potent greenhouse gas. The more methane released the more methane hydrate crystals were destabilized, raising the temperature still further, releasing more methane gas, and so on in a vicious circle. This feedback loop raised the global temperature to 15 degrees C above normal, causing the Permian-Triassic mass extinction.[4]

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[2] https://www.youtube.com/watch?v=MVwmi7HCmSI
https://www.youtube.com/watch?v=AjZaFjXfLec
https://www.youtube.com/watch?v=m6pFDu7lLV4

[3] http://www.worldbank.org/en/news/feature/2012/11/18/Climate-change-report-warns-dramatically-warmer-world-this-century

[4] https://www.youtube.com/watch?v=sRGVTK-AAvw
https://www.youtube.com/watch?v=MVwmi7HCmSI
https://www.youtube.com/watch?v=AjZaFjXfLec
https://www.youtube.com/watch?v=m6pFDu7lLV4

No reputable doctor who diagnoses cancer would keep this knowledge from the patient. The reaction of the patient may be to reject the diagnosis and get another doctor, but no matter. It is very important that the threatened person should hear the diagnosis, because, with treatment, there is hope of a cure.

Similarly, the scientific community, when aware of a grave danger to our species and the biosphere, has a duty to bring this knowledge to the attention of as broad a public as possible, even at the risk of unpopularity. The size of the threatened catastrophe is so immense as to dwarf all other considerations. All possible efforts must be made to avoid it.

The great and complex edifice of human civilization is a treasure whose value is almost above expression; and this may be lost unless we give up many of our present enjoyments. Each living organism, each animal or plant, is product of three billion years of evolution, and a miracle of harmony and complexity; and most of these will perish if we persist in our folly and greed.

Let us, for once, look beyond present pleasures, and acknowledge our duty to preserve a future world in which all forms of life can survive.

2.5 Loss of biodiversity

Agricultural monocultures

In modern agriculture it has become common to plant large regions with a single crop variety. For example, it is common to plant large regions with a single high-yield wheat variety. Monocultures of this kind offer farmers advantages of efficiency in the timing of planting and harvesting. With regard to pest and disease control, there may be short-term advantages, but these have to be weighed against the threat of long-term disasters. In the great Irish Potato Famine of 1845-1849, the potato monoculture which had sustained Ireland's growing population was suddenly devastated by Phytophthora infestans, commonly called "potato blight". The result was a catastrophic famine that resulted in the death or emigration of much of Ireland's population.

In general, monocultures are vulnerable to plant disease. Thus the replacement of traditional varieties with the high-yield crops developed by the "Green Revolution" carries serious risks. Adjustment to climate change also requires genetic diversity. In general, a genetically diverse population is far better to adjust to environmental changes than a genetically homogeneous population. This being so, it is vital to preserve civilization's heritage of genetically diverse crops.

Deforestation and loss of biodiversity

The earth's tropical rain forests are rapidly being destroyed for the sake of new agricultural land. Tropical rain forests are thought to be the habitat of more than half of the world's species of plants, animals and insects; and their destruction is accompanied by an alarming rate of extinction of species. The Harvard biologist, E.O. Wilson, estimates that the rate of extinction resulting from deforestation in the tropics may now exceed 4,000 species per year - 10,000 times the natural background rate (*Scientific American*, September, 1989).

The enormous biological diversity of tropical rain forests has resulted from their stability. Unlike northern forests, which have been affected by glacial epochs, tropical forests have existed undisturbed for millions of years. As a result, complex and fragile ecological systems have had a chance to develop. Professor Wilson expresses this in the following words:

"Fragile superstructures of species build up when the environment remains stable enough to support their evolution during long periods of time. Biologists now know that biotas, like houses of cards, can be brought tumbling down by relatively small perturbations in the physical environment. They are not robust at all."

The number of species which we have until now domesticated or used in medicine is very small compared with the number of potentially useful species still waiting in the world's tropical rain forests. When we destroy them, we damage our future. But we ought to regard the annual loss of thousands of species as a tragedy, not only because biological diversity is potential wealth for human society , but also because every form of life deserves our respect and protection.

Paris, India and coal

The MIT Technology Review recently published an important article entitled "India's Energy Crisis".[5]

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.[6]

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

[5] http://www.technologyreview.com/featuredstory/542091/indias-energy-crisis/

[6] https://www.youtube.com/watch?v=2bRrg96UtMc
https://www.youtube.com/watch?v=MVwmi7HCmSI
https://www.youtube.com/watch?v=AjZaFjXfLec
https://www.youtube.com/watch?v=MVwmi7HCmSI

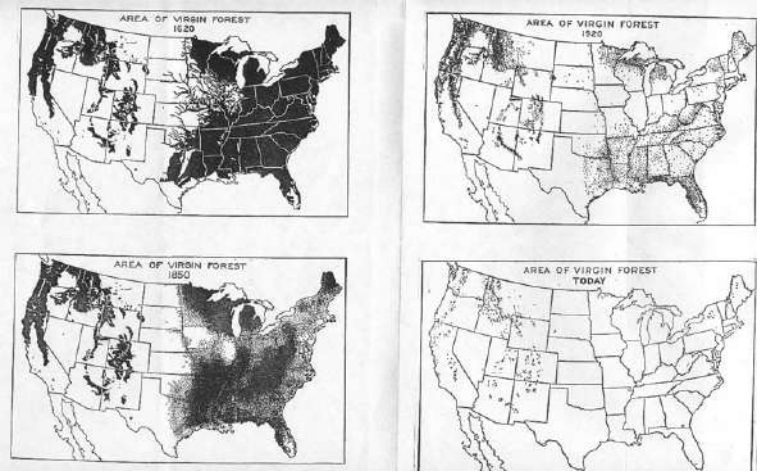

Figure 2.5: **Deforestation in the United States between 1620 and the present.** (From William B. Greeley's The Relation of Geography to Timber Supply)

Figure 2.6: **This satellite photograph illustrates slash-and-burn forest clearing along the Rio Xingu (Xingu River) in the state of Mato Grosso, Brazil.** (Public domain)

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

"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.[7]

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?

Jacob von Uexküll's speech to the World Future Council

In a recent speech to the World Future Council, the distinguished writer, philanthropist, activist and former politician Jacob von Uexküll outlined the future dangers facing our world with an accuracy and eloquence that has seldom been equaled. Here is a link to his speech:[8]

Jakob von Uexküll belongs to a brilliant family. His grandfather was a famous Baltic-German physiologist who founded the discipline of Biosemiotics. Besides being a former Member of the European Parliament and a leader of the

[7] https://www.rt.com/news/262641-india-heat-wave-killed/

[8] http://www.worldfuturecouncil.org/2016/03/15/world-future-forum-2016-opening-speech-jakob-von-uexkull/

Figure 2.7: **A logo for Coal India Limited. Although the government of India supports renewable energy, the country's use of coal is also increasing rapidly.**(Wikipedia

German Green Party, von Uexküll himself founded both the Right Livelihood Award (sometimes called the Alternative Nobel Prize) and also the World Future Council.[9]

Here are a few excerpts from his speech:

"Today we are heading for unprecedented dangers and conflicts, up to and including the end of a habitable planet in the foreseeable future, depriving all future generations of their right to life and the lives of preceding generations of meaning and purpose."

"This apocalyptic reality is the elephant in the room. Current policies threaten temperature increases triggering permafrost melting and the release of ocean methane hydrates which would make our earth unliveable, according to research presented by the British Government Met office at the Paris Climate Conference."

"The myth that climate change is conspiracy to reduce freedom is spread by a powerful and greedy elite which has largely captured governments to preserve their privileges in an increasingly unequal world. Long before that point, our prosperity, security, culture and identity will disintegrate. A Europe unable to cope with a few million war refugees will collapse under the weight of tens or even hundreds of millions of climate refugees."

Paris and the long-term future

We give our children loving care, but it makes no sense do so and at the same time to neglect to do all that is within our power to ensure that they and their descendants will inherit an earth in which they can survive. We also have a responsibility to all the other living organisms with which we share the gift of life.

Human emotional nature is such that we respond urgently to immediate temptations or dangers, while long-term considerations are pushed into the background. Thus the temptations of immediate profit or advantage motivate politicians and the executives of fossil fuel corporations; and the temptations of continued overconsumption and luxury blind the general public. Public fears of terrorism have been magnified by our perfidious mass media to such an extent that the equally perfidious French Government has been able to use this fear as an excuse to exclude democracy and proper care for the long-term future from the Paris Climate Conference.

However, our generation has an urgent duty to think of the distant future. The ultimate fate of human civilization and the biosphere is in our hands.

[9] http://www.rightlivelihood.org/
http://www.worldfuturecouncil.org/
http://www.worldfuturecouncil.org/gpact/

What we really have to fear, for the sake of our children and grandchildren and their descendants, is reaching a tipping point, beyond which uncontrollable feedback loops will make catastrophic climate change inevitable despite all human efforts to prevent it.

A feedback loop is a self-reinforcing cycle. The more it goes on, the stronger it becomes. An example of how such a feedback loop could drive climate change and make it uncontrollable is the albedo effect: When sunlight falls on sea ice in the Arctic or Antarctic, most of it is reflected by the white surface of the snow-covered ice. But when sunlight falls on dark sea water, it is almost totally absorbed. This cycle is self-reinforcing because warming the water reduces the ice cover. This is happening today, especially in the Arctic, and we have to stop it.

Another dangerous feedback loop involves the evaporation of sea water, which itself is a greenhouse gas. However, if we think of the long-term future, by far the most dangerous feedback loop is that which involves the melting of methane hydrate crystals, releasing the extremely powerful greenhouse gas methane into the atmosphere. Discussion of this highly dangerous feedback loop seems to be almost completely banned by our mass media.

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 much more potent than CO2.

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.[10]

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.

The worst consequences of runaway climate change will not occur within our own lifetimes. However, we have a duty to all future human generations, and to the plants and animals with which we share our existence, to give them a future world in which they can survive.

We can also fear a catastrophic future famine, produced by a combination

[10] https://www.youtube.com/watch?v=2bRrg96UtMc
https://www.youtube.com/watch?v=MVwmi7HCmSI
https://www.youtube.com/watch?v=AjZaFjXfLec
https://www.youtube.com/watch?v=MVwmi7HCmSI

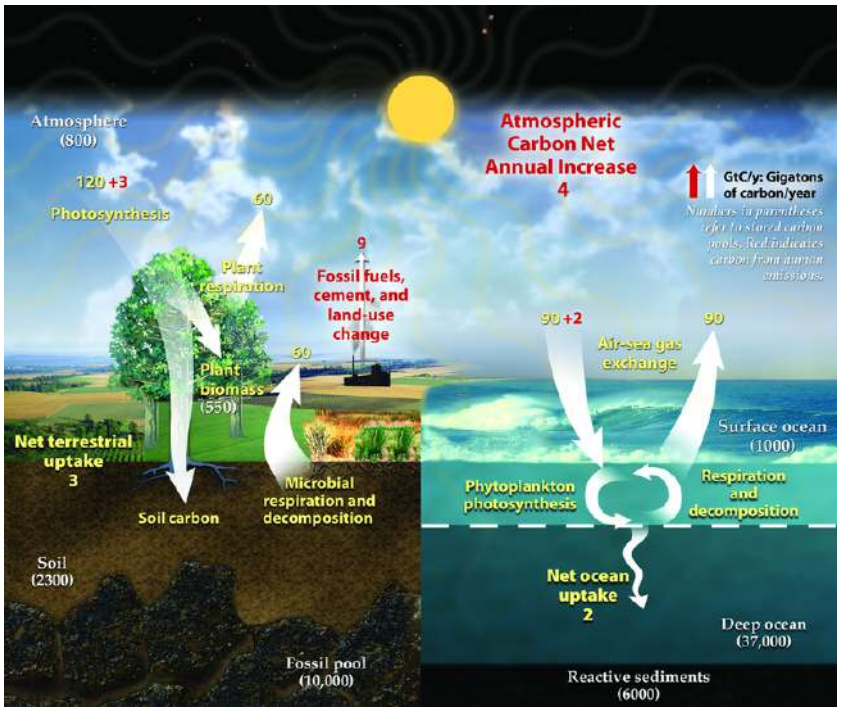

Figure 2.8: **This diagram shows a simplified representation of the contemporary global carbon cycle. Changes are measured in gigatons of carbon per year (GtC/y).** (Public domain)

of climate change, population growth and the end of fossil-fuel-dependent high-yield modern agriculture.[11]

These very real and very large long-term disasters are looming on our horizon, but small short-term considerations blind us, so that we do not take the needed action. But what is at stake is the future of everyone's children and grandchildren and their progeny, your future family tree and mine, also the families of Francois Hollande and the executives of Exxon. They should think carefully about the consequences of making our beautiful world completely uninhabitable.

OPEC oil and climate change

In an amazing display of collective schizophrenia, our media treat oil production and the global climate emergency as though they were totally disconnected. But the use of all fossil fuels, including oil, must stop almost immediately if the world is to have a chance of avoiding uncontrollable and catastrophic climate change.

The recent Doha summit meeting of the Oil Producing and Exporting Countries (OPEC) aimed at reaching an agreement on limiting the production of oil. This aim did not stem from the climate emergency but rather a from desire to raise oil prices and profits. However, the OPEC meeting failed to reach an agreement. Production continues to be extremely high and prices low.[12]

Our high-energy lifestyles continue. Our profligate use of fossil fuels continues as though the life-threatening climate emergency did not exist.

Meanwhile, early spring temperatures in 2016 have totally smashed all previous records, and this is especially pronounced in the Arctic and Antarctic regions. Polar ice caps are melting in an alarmingly rapid and non-linear way. The rate of melting of the icecaps is far greater than predicted by conventional modeling which does not include feedback loops. Many island nations and coastal cities are threatened, not in the very distant future, but by the middle of our present century. Here are a few links reporting what is happening:[13]

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[11] http://human-wrongs-watch.net/2015/08/19/the-need-for-a-new-economic-system-part-vii-glreadoval-food-crisis/

[12] http://www.cnbc.com/2016/04/17/doha-oil-producers-meeting-ends-without-an-agreement.html

[13] http://www.truth-out.org/news/item/35398-climate-disruption-in-overdrive-submerged-cities-and-melting-that-feeds-on-itself
http://www.commondreams.org/news/2016/03/14/nasa-drops-major-bomb-march-toward-ever-warmer-planet
http://www.theguardian.com/environment/2016/mar/15/record-breaking-temperatures-have-robbed-the-arctic-of-its-winter

Figure 2.9: **Iranian oil and gas facilities. An Iran-Iraq-Syria pipeline has been proposed. Catastrophic climate change threatens to destroy human civilization and much of the biosphere. The production and consumption of oil must stop almost immediately; but pipeline wars continue just as though these threats did not exist.** (Public domain)

In the long-term future, catastrophic anthropogenic climate change threatens to destroy human civilization and to drive the majority of plant and animal species into extinction. To prevent this from happening, we need to stop subsidizing and accepting fossil fuel production. We need to vigorously support the transition to a sustainable economy based on renewable energy.

2.6 Our duty to future generations

Many traditional agricultural societies have an ethical code that requires them to preserve the fertility of the land for future generations. This recognition of a duty towards the distant future is in strong contrast to the shortsightedness of modern economists. For example, John Maynard Keynes has been quoted

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http://www.truth-out.org/news/item/35283-arctic-sea-ice-volume-nears-record-low
http://dissidentvoice.org/2016/03/does-methane-threaten-life/
https://theconversation.com/meltdown-earth-the-shocking-reality-of-climate-change-kicks-in-but-who-is-listening-56255
http://www.countercurrents.org/bardi150316.htm
http://www.informationclearinghouse.info/article44427.htm
http://www.truth-out.org/news/item/35202-antarctica-on-the-brink-nasa-emeritus-scientist-warns-of-dramatic-loss-of-glaciers
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http://www.commondreams.org/news/2016/04/04/amid-climate-fueled-food-crisis-filipino-forces-open-fire-starving-farmers
http://ecowatch.com/2016/04/08/mckibben-break-free/
http://www.motherjones.com/environment/2016/04/water-scarcity-wikileaks
http://www.commondreams.org/news/2016/04/15/towards-common-good-mr-sanders-goes-vatican
http://ecowatch.com/2016/04/22/dicaprio-paris-climate-change-agreement/
http://www.informationclearinghouse.info/article44510.htm
http://www.informationclearinghouse.info/article44519.htm
http://www.truth-out.org/news/item/35796-temperatures-in-2016-are-already-near-cop21-limit
https://www.newscientist.com/article/2084835-unprecedented-global-warming-as-2016-approaches-1-5-c-mark/

Figure 2.10: **Mother Nature image, 17th century alchemical text, Atalanta Fugiens.** (Public domain)

as saying "In the long run, we will all be dead", meaning that we need not look that far ahead. By contrast, members of traditional societies recognize that their duties extend far into the distant future, since their descendants will still be alive.

Here is an ethical principle of the Native Americans: "Treat the earth well. It was not given to you by your parents. It was loaned to you by your children." They also say: "We must protect the forests for our children, grandchildren, and children yet to be born. We must protect the forests for those who cannot speak for themselves, such as the birds, animals, fish and trees."

In his book, "The Land of the Spotted Eagle", the Lakota chief Luther Standing Bear (ca. 1834-1908) wrote: "The Lakota was a true lover of Nature. He loved the earth and all things of the earth... From Waken Tanka (the Great Spirit) there came a great unifying life force that flowered in and through all things: the flowers of the plains, blowing winds, rocks, trees, birds, animals, and was the same force that had been breathed into the first man. Thus all things were kindred and were brought together by the same Great Mystery."

In some parts of Africa, a man who plans to cut down a tree offers a prayer of apology, telling the tree why necessity has forced him to harm it. This preindustrial attitude is something from which industrialized countries could learn. In industrial societies, land "belongs" to someone, and the owner has the "right" to ruin the land or to kill the communities of creatures living on it, if this happens to give some economic advantage, in much the same way that a Roman slave-owner was thought to have the "right" to kill his slaves. Preindustrial societies have a much less rapacious and much more custodial attitude towards the land and towards its non-human inhabitants.

Figure 2.11: **Aion, Gaia and four children.** (Public domain)

Figure 2.12: **Demonstrators declaring the rights of Mother Earth** (Earth Peoples)

Figure 2.13: **We are sawing off the branch on which we are sitting.** (Commentsmeme.com)

On April 22, 2010, the World People's Conference on Climate Change and the Rights of Mother Earth in Cochabamba, Bolivia, adopted a Universal Declaration of the Rights of Mother Earth. Here is a link:
http://therightsofnature.org/universal-declaration/
Contrast this expression of the deep ethical convictions of the world's people with the cynical, money-centered results of various intergovernmental conferences on climate change!

Our economic system is built on the premise that individuals act out of self-interest, and as things are today, they do so with a vengeance.There is no place in the system for thoughts about the environment and the long-term future. All that matters is the bottom line. The machine moves on relentlessly, exhausting non-renewable resources, turning fertile land into deserts, driving animal species into extinction, felling the last of the world's tropical rainforests, pumping greenhouse gasses into the atmosphere, and sponsoring TV programs that deny the reality of climate change, or other programs that extol the concept of never-ending industrial growth. But the economists, bankers, bribed politicians and corporation chiefs who destroy the earth today, are destroying the future for their own children, grandchildren and great-grandchildren. Does it make sense for them to saw off the branch on which they, like all of us, are sitting?

Recently an extremely grave danger to the long-term future of human civilization and the biosphere has become clear. The latest observations show

that Arctic sea ice is melting far faster than was predicted by the IPCC. It now seems likely that the September Arctic sea ice will vanish by as early as 2016 or 2017. It will, of course, re-freeze in the winters, but its average total mass will continue to rapidly decrease.

The rapid and non-linear vanishing of Arctic sea ice is due to a feedback loop involving albedo, i.e the high reflectivity of white ice compared with dark sea water which absorbs most of the radiation that falls onto it. As Arctic sea ice disappears more radiation is absorbed, the Arctic temperature rises still further, still more ice melts, and so on in a vicious circle.

At present Arctic temperatures are roughly 4 degrees C higher than preindustrial levels, and this has led to increasingly rapid melting of the Greenland ice cap. It is now observed that during the summers, lakes of melted water form on the surface of Greenland's inland ice. These lakes feed rivers that run for some distance along the surface of the ice cap, but which ultimately fall through fissures to the bottom of the sheet, where they lubricate its flow. Through this mechanism, the Greenland ice cap is flowing more quickly and calving into massive icebergs much more rapidly than climate scientists expected.

Complete melting of the Greenland ice cap would raise ocean levels by 7 meters. Antarctic sea ice is also breaking up much more rapidly than expected. When it is totally gone, the disappearance of Antarctic sea ice would add another 7 meters to ocean levels, making a total of 14 meters. It is hard to predict how soon this will happen, but certainly within 1-3 centuries.

However, by far the most worrying threat to our long-term future comes from the danger of an out-of-control and exponentially accelerating feedback loop involving methane hydrates. When rivers carry organic matter into the ocean, it decays, forming methane, a powerful greenhouse gas. At the temperatures and pressures currently prevailing on ocean floors, the methane combines with water molecules to form stable crystals called methane hydrates. The amount of carbon stored in methane hydrates is immense: roughly 10,000 gigatons. By comparison, the amount of carbon emitted by human activities since preindustrial times is only 337 gigatons.

Geologists have observed that life on earth has experienced 5 major extinction events, the largest of which was the Permian-Triasic event, when 96 percent of all marine species and 70 percent of all terrestrial vertebrates disappeared from the fossil record. Predictions based on current CO2 emission rates predict that early in the 22nd century, global temperature increases will have reached 6 degrees C, the temperature that is thought to have initiated the Permian-Triasic extinction event. These dangers are eloquently discussed in a short, important and clear video prepared by Thom Hartmann and his coworkers. It is available on www.lasthours.org

Must there be a human-initiated 6th geological extinction event? Is it inevitable that the long-term future will witness the disappearance of human civilization and most of the plants and animals that are alive today? No! Absolutely not! It is only inevitable if we persist in our greed and folly. It is only inevitable if we continue to value money more than nature. It is only inevitable if we are afraid to question the authority of corrupt politicians. It is only inevitable if we fail to cooperate globally, and if we fail to develop a new economic system with both a social conscience and an ecological conscience.

We are living today in a time of acute crisis. We need to act with a sense of urgency never before experienced. We need to have great courage to meet an unprecedented challenge. We need to fulfil our duty to future generations

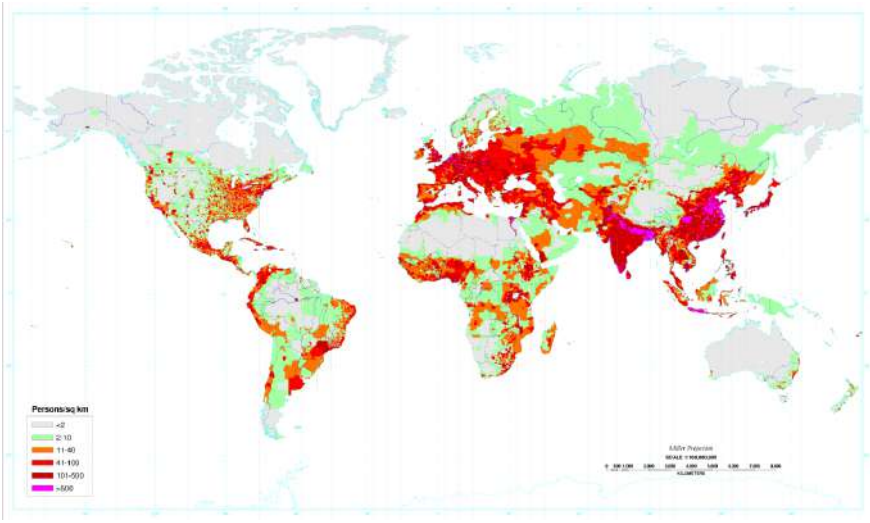

Figure 2.14: **Population density (people per km^2) map of the world in 1994. It is vitally important that all countries should pass quickly through the demographic transition from high birth and death rates to low birth and death rates.** (Public domain)

In the world as it is, population is increasing so fast that it doubles every thirty-nine years. Most of this increase is in the developing countries, and in many of these, the doubling time is less than twenty-five years. Famine is already present, and it threatens to become more severe and widespread in the future.

In the world as it could be, population would be stabilized at a level that could be sustained comfortably by the world's food and energy resources. Each country would be responsible for stabilizing its own population.

Figure 2.15: **There is a danger that a tipping point may be reached, where drying of tropical forests leads to their destruction by fires.** (World Visits)

In the world as it is, large areas of tropical rain forest are being destroyed by excessive timber cutting. The cleared land is generally unsuitable for farming.

In the world as it could be, it would be recognized that the conversion of carbon dioxide into oxygen by tropical forests is necessary for the earth's climatic stability. Tropical forests would also be highly valued because of their enormous diversity of plant and animal life, and large remaining areas of forest would be protected.

Figure 2.16: **Air pollution from a fossil fuel power station. Among the pollutants released into the atmosphere, greenhouse gases are the most dangerous. To avoid catastrophic climate change, we must very rapidly make the transition from fossil fuels to renewable energy.** (Public domain)

In the world as it is, pollutants are dumped into our rivers, oceans and atmosphere. Some progress has been made in controlling pollution, but far from enough.

In the world as it could be, a stabilized and perhaps reduced population would put less pressure on the environment. Strict international laws would prohibit the dumping of pollutants into our common rivers, oceans and atmosphere. The production of greenhouse gasses would also be limited by international laws.

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Chapter 3

THE THREAT OF LARGE-SCALE FAMINE

"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

3.1 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.

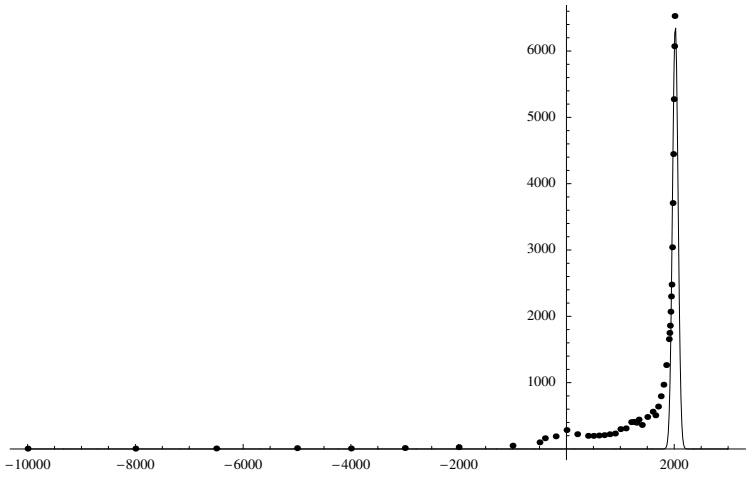

Figure 3.1: **Population growth and fossil fuel use, seen on a time-scale of several thousand years. The dots are population estimates in millions from the US Census Bureau. Fossil fuel use appears as a spike-like curve, rising from almost nothing to a high value, and then falling again to almost nothing 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)

3.2 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 of population growth, the ffect of climate change on agriculture, and because of the end of the fossil fuel era.

When the major glaciers in the Himelayas 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

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

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 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.

3.3 Population growth and the Green Revolution

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

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

Figure 3.2: **Norman Borlaug's work on developing high-yield disease-resistant plant varieties won him a Nobel Peace Prize in 1970.**

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."

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 post-fossil-fuel future.

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

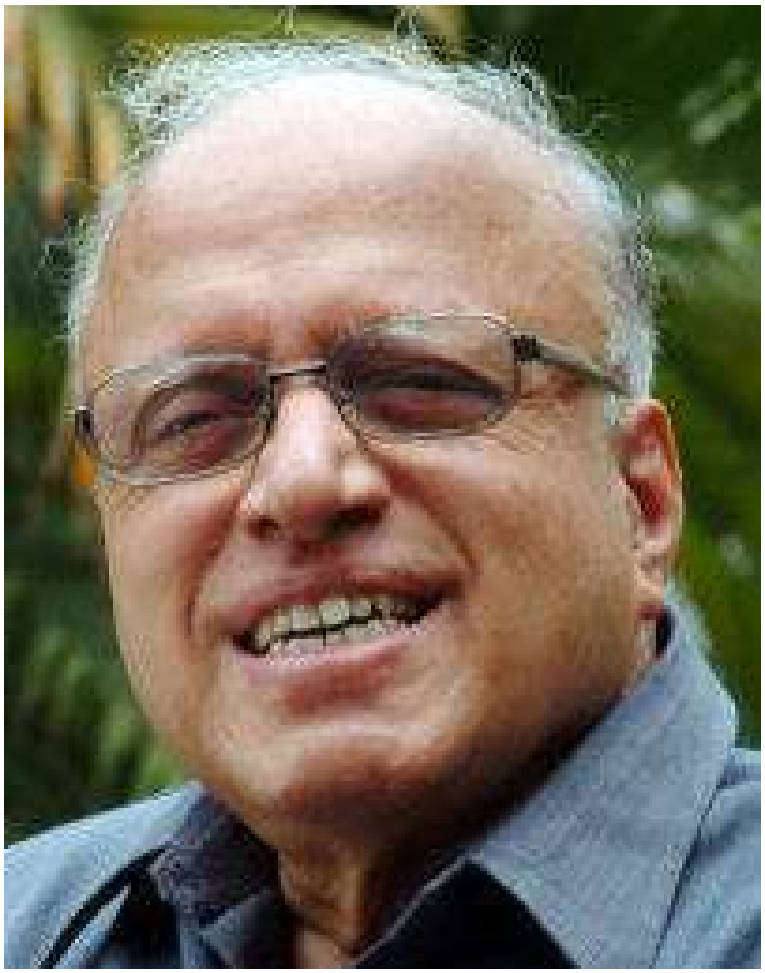

Figure 3.3: **Professor M.S. Swaminathan, father of the Green Revolution in India.** (Open and Shut7)

a billion people.

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

Figure 3.4: **Norman Borlaug and agronomist George Harrer in 1943.** (Human Wrongs Watch)

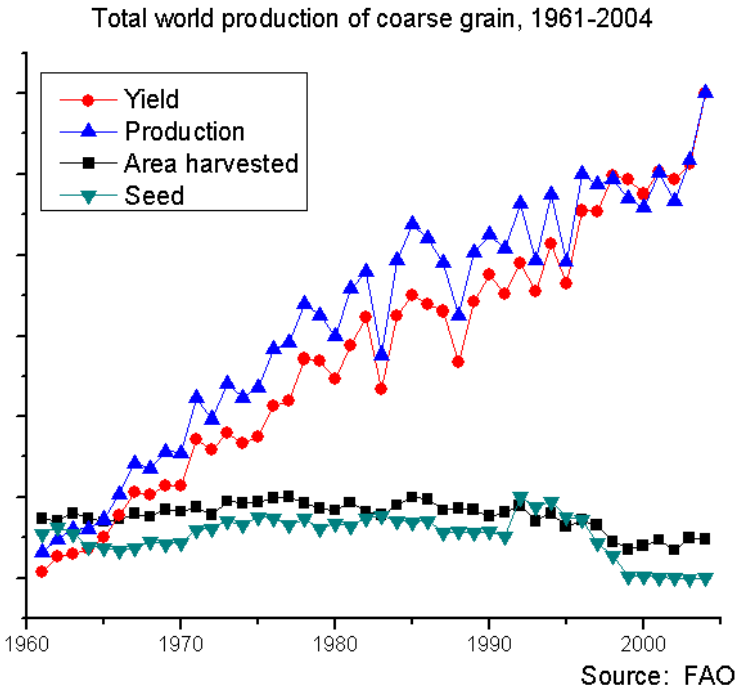

Figure 3.5: **This graph shows the total world production of coarse grain between 1960 and 2004. Because of high-yield varieties, the yield of grain increased greatly. Notice, however, that the land under cultivation remained almost constant. High-yield agriculture depends on large inputs of fossil fuel energy and irrigation, and may be difficult to maintain in the future.** (FAO)

of the Sahara and in Latin America, but 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.

3.4 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,

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

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.

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

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 or eliminated, 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] 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.

3.5 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 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.

Figure 3.6: **Whitechuck Glacier in the North Cascades National Park in 1973.** (Nicholas College)

Figure 3.7: **The same glacier in 2006** (Nicholas College)

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 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

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

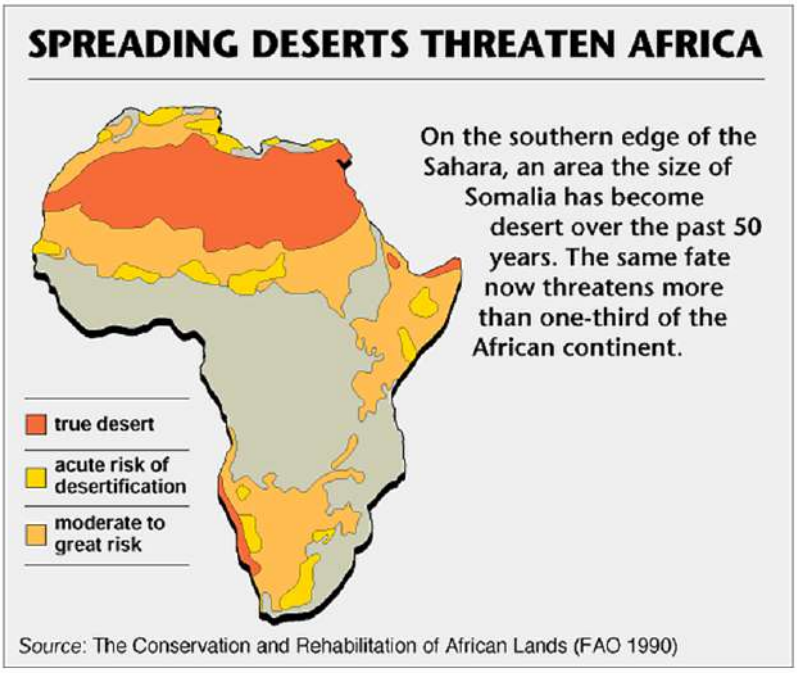

Figure 3.8: **Desert regions of the Africa that are in danger of spreading.** (FAO)

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.

3.6 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.

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.

[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/

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.

3.7 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.

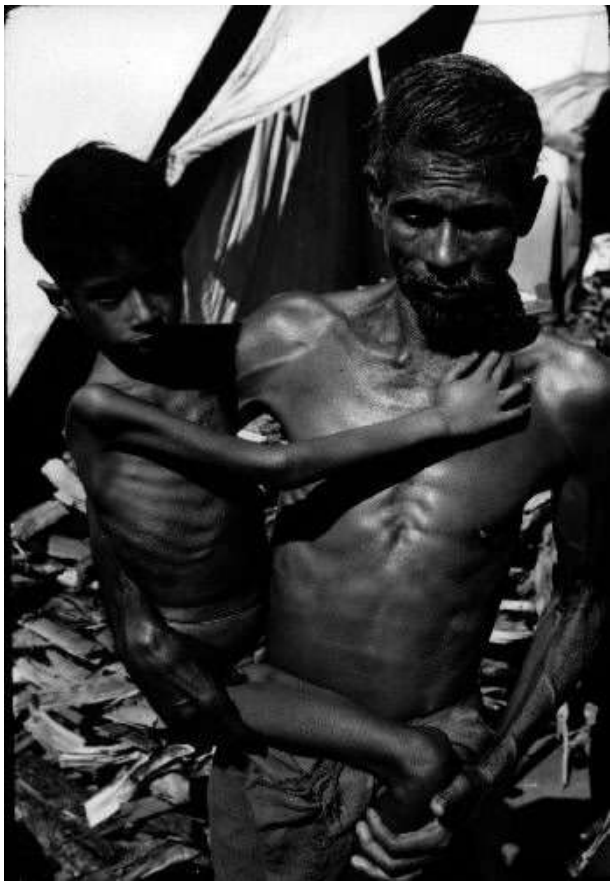

Figure 3.9: **Child suffering with the deficiency disease Marasmus in India.** (Public domain)

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 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

Figure 3.10: **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)

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".

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

"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.

3.8 Lester Brown's lecture in Copenhagen

After a lecture at the University of Copenhagen in the 1980's, Lester R. Brown of the Earth Policy Institute was asked which resource would be the first to become critically scarce. Everyone in the audience expected him to say "oil", but instead he said "fresh water". He went on to explain that falling water tables in China would soon make China unable to feed its population. This would not cause famine in China itself because of the strength of the Chinese economy, which would allow the Chinese to purchase grain on the world market. However, shortages of fresh water in China would indeed cause famine, for example in Africa, because Chinese demand for grain would raise prices on the world market beyond the ability of poor countries to pay.

Figure 3.11: **Lester R. Brown**

3.9 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.

3.10 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.

3.11 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.

3.12 Advances in desalinization technology

Scientists at the Massachusetts Institute of Technology have developed a new desalinization process, called shock electrodialysis. In this process. water flows through a porous material -in this case, made of tiny glass particles, called a frit - with membranes or electrodes sandwiching the porous material on each side. When an electric current flows through the system, the salty water divides

into regions where the salt concentration is either depleted or enriched. When that current is increased to a certain point, it generates a shockwave between these two zones, sharply dividing the streams and allowing the fresh and salty regions to be separated by a simple physical barrier at the center of the flow.

"It generates a very strong gradient," says Martin Bazant, a researcher involved with the project[8].

Even though the system can use membranes on each side of the porous material, Bazant explains, the water flows across those membranes, not through them. That means they are not as vulnerable to fouling - a buildup of filtered material - or to degradation due to water pressure, as happens with conventional membrane-based desalination, including conventional electrodialysis. "The salt doesn't have to push through something," Bazant says. "The charged salt particles, or ions, just move to one side".

3.13 Sustainable future populations

In an important and detailed study entitled *Will Limited Land, Water, and Energy Control Human Population Numbers in the Future?*, David Pimentel et al. [9] discuss the problem of agriculture and global population in the post fossil fuel era. Here are some quotations from the article:

"Nearly 60% of the world's human population is malnourished and the numbers are growing. Shortages of basic foods related to decreases in per capita cropland, water, and fossil energy resources contribute to spreading malnutrition and other diseases. The suggestion is that in the future only a smaller number of people will have access to adequate nourishment. In about 100 years, when it is reported that the planet will run out of fossil energy, we suggest that a world population of about two billion might be sustainable if it relies on renewable energy technologies and also reduces per capita use of the earth's natural resources.

"Developed and developing nations need to provide a good quality life for their people while coping with rapid population growth, but 'Population is the issue no one wants to touch' (Meadows 2000). The current world population is about 6.8 billion. Based on the present growth rate of 1.2% per year, the population is projected to double in approximately 58 years (Chiras 2006; PRB 2008). Because population growth cannot continue indefinitely, society can either voluntarily control its numbers or let natural forces such as disease, malnutrition, and other disasters limit human numbers (Bartlett 1997-98; Pimentel et al. 1999). Increasing human numbers especially in urban areas, and

[8] He was quoted in an article published in *MIT News*, November 12, 2015

[9] D. Pimentel et al., Human Ecology DOI 10.1007/s10745-010-9346-y, (2010)

increasing pollution of food, water, air, and soil by pathogenic disease organisms and chemicals, are causing a rapid increase in the prevalence of disease and human mortality (Murray and Lopez 1996; Pimentel et al. 2007). Currently, more than 3.7 billion humans are malnourished worldwide - the largest number ever (WHO 2005a, b).

"The planet's numerous environmental problems highlight the urgent need to evaluate available land, water, and energy resources and how they relate to the requirements of a rapidly growing human population (Pimentel and Pimentel 2008). In this article we assess the carrying capacity of the Earth's natural resources, and suggest that humans should voluntarily limit their population growth, rather than letting natural forces control their numbers (Ferguson 1998; Pimentel et al. 1999). In addition, we suggest appropriate policies and technologies that would improve standards of living and quality of life worldwide...

"In 1960, when the world population numbered about 3 billion, approximately 0.5 ha of cropland was available per capita worldwide. This half a hectare is needed to provide a diverse, healthy, nutritious diet of plant and animal products..."

Pimentel et al. state that worldwide, the average cropland per capita has now fallen to 0.22 hectares. This number will continue to fall because global population is increasing at the rate of almost one billion people per decade, while the global area available for cropland is not increasing. On the contrary, it is decreasing because of desertification, erosion, salination and urban sprawl. Pimentel et al.state that cropland is being degraded and lost at a rate of more than 20 million hectares per year.

The current cropland per capita in the United States is 0.56 hectares, and thus still quite large, but in China, the figure is dangerously low: only 0.1 hectares. China will soon be unable to feed its population and will have to buy grain on the world market. As Lester Brown pointed out in his Copenhagen lecture, China will be able to import grain because of its strong economy, but this will raise food prices and will cause widespread famine in other parts of the world.

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.

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."[10]

Dennis Meadows, one of the authors of *Limits to Growth*, stated recently that the optimum human population in the distant future may be about 2 billion people.

But what about the near future? 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. At present, there are only a few major food-exporting countries, notably the United States, Canada, Australia and Argentina. There is a danger that within a few decades, the United States will no longer be able to export food because of falling production and because of the demands of a growing population. We should be aware of these serious future problems if we are to have a chance of avoiding them.

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

3.14 The demographic transition

The developed industrial nations of the modern world have gone through a process known as the "demographic transition" - a shift from an equilibrium where population growth is held in check by the grim Malthusian forces of disease, starvation and war, to one where it is held in check by birth control and late marriage.

The transition begins with a fall in the death rate, caused by various factors, among which the most important is the application of scientific knowledge to the prevention of disease. Malthus gives the following list of some of the causes of high death rates: "...unwholesome occupations, severe labour and exposure to the seasons, extreme poverty, bad nursing of children, great towns, excesses of all kinds, the whole train of common diseases and epidemics, wars, plague and famine." The demographic transition begins when some of the causes of high death rates are removed.

Cultural patterns require some time to adjust to the lowered death rate, and so the birth rate continues to be high. Families continue to have six or seven children, just as they did when most of the children died before having children of their own. Therefore, at the start of the demographic transition, the population increases sharply. After a certain amount of time, however, cultural patterns usually adjust to the lowered death rate, and a new equilibrium is established, where both the birth rate and the death rate are low.

In Europe, this period of adjustment required about two hundred years. In 1750, the death rate began to fall sharply: By 1800, it had been cut in half, from 35 deaths per thousand people in 1750 to 18 in 1800; and it continued to fall. Meanwhile, the birth rate did not fall, but even increased to 40 births per thousand per year in 1800. Thus the number of children born every year was more than twice the number needed to compensate for the deaths!

By 1800, the population was increasing by more than two percent every year. In 1750, the population of Europe was 150 million; by 1800, it was roughly 220 million; by 1950 it had exceeded 540 million, and in 1970 it was 646 million.

Meanwhile the achievements of medical science and the reduction of the effects of famine and warfare had been affecting the rest of the world: In 1750, the non-European population of the world was only 585 million. By 1850 it had reached 877 million. During the century between 1850 and 1950, the population of Asia, Africa and Latin America more than doubled, reaching 1.8 billion in 1950. In the twenty years between 1950 and 1970, the population of Asia, Africa and Latin America increased still more sharply, and in 1970, this segment of the world's population reached 2.6 billion, bringing the world total to 3.6 billion. The fastest increase was in Latin America, where population

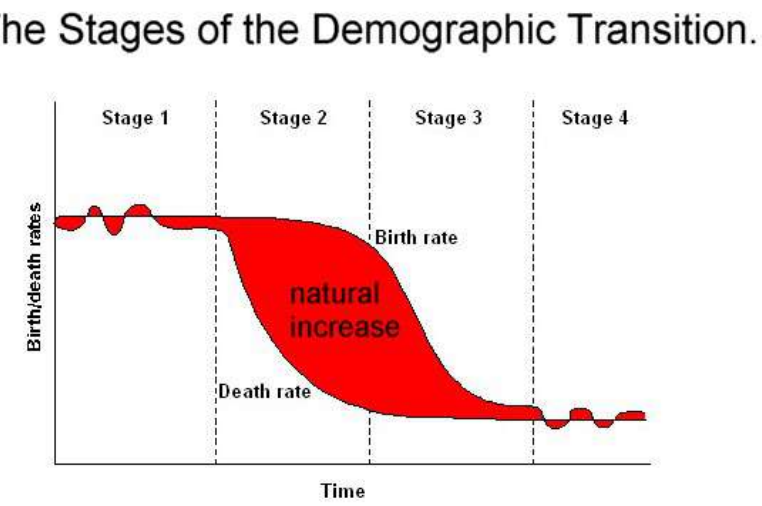

Figure 3.12: **The demographic transition.**

almost doubled during the twenty years between 1950 and 1970.

The latest figures show that population has stabilized or in some cases is even decreasing in Europe, Russia, Canada, Japan, Cuba and New Zealand. In Argentina, the United States, China, Myanmar, Thailand and Australia, the rates of population increase are moderate - 0.6%-1.0%; but even this moderate rate of increase will have a heavy ecological impact, particularly in the United States, with its high rates of consumption.

The population of the remainder of the world is increasing at breakneck speed - 2%-4% per year - and it cannot continue to expand at this rate for very much longer without producing widespread famines, since modern intensive agriculture cannot be sustained beyond the end of the fossil fuel era. The threat of catastrophic future famines makes it vital that all countries that have not completed the demographic transition should do so as rapidly as possible.

3.15 Urbanization

The global rate of population growth has slowed from 2.0 percent per year in 1972 to 1.7 percent per year in 1987; and one can hope that it will continue to fall. However, it is still very high in most developing countries. For example, in Kenya, the population growth rate is 4.0 percent per year, which means that the population of Kenya will double in seventeen years.

During the 60 years between 1920 and 1980 the urban population of the

Figure 3.13: **Because of the threat of widespread famine, it is vital that all countries should complete the demographic transition as quickly as possible.**

Figure 3.14: **Sir Partha Dasgupta of Cambridge University has pointed out that all the changes needed for population stabilization are desirable in themselves. These include education for women, higher status for women, state provision of old-age help for the poor, universal health care, and making safe drinking water available near to dwellings.**

developing countries increased by a factor of 10, from 100 million to almost a billion. In 1950, the population of Sao Paulo in Brazil was 2.7 million. By 1980, it had grown to 12.6 million; and it is expected to reach 24.0 million by the year 2000. Mexico City too has grown explosively to an unmanageable size. In 1950, the population of Mexico City was 3.05 million; in 1982 it was 16.0 million; and the population in 2000 was 17.8 million.

A similar explosive growth of cities can be seen in Africa and in Asia. In 1968, Lusaka, the capital of Zambia, and Lagos, the capital of Nigeria, were both growing at the rate of 14 percent per year, doubling in size every 5 years. In 1950, Nairobi, the capital of Kenya, had a population of 0.14 million. In a 1999 census, it was estimated to be between 3 and 4 million, having increased by a factor of 25.

In 1972, the population of Calcutta was 7.5 million. By the turn of the century in 2000, it had almost doubled in size. This rapid growth produced an increase in the poverty and pollution from which Calcutta already suffered in the 1970's. The Hooghly estuary near Calcutta is choked with untreated industrial waste and sewage, and a large percentage of Calcutta's citizens suffer from respiratory diseases related to air pollution.

Governments in the third world, struggling to provide clean water, sanitation, roads, schools, medical help and jobs for all their citizens, are defeated by rapidly growing urban populations. Often the makeshift shantytowns inhabited by new arrivals have no piped water; or when water systems exist, the pressures may be so low that sewage seeps into the system.

Many homeless children, left to fend for themselves, sleep and forage in the streets of third world cities. These conditions have tended to become worse with time rather than better. Whatever gains governments can make are immediately canceled by growing populations.

3.16 Achieving economic equality

Today's world is characterized by intolerable economic inequalities, both between nations and within nations. A group of countries including (among others) Japan, Germany, France, the United Kingdom and the United States, has only 13% of the world's population, but receives 45% of the global PPP[11] income. By contrast, a second group, including 2.1 Billion people (45% of the world's population) receives only 9% of the global PPP income. Another indicator of inequality is the fact that the 50 million richest people in the world receive as much as the 2,700 million poorest.

[11] Purchasing Power Parity

Figure 3.15: **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.**

18 million of our fellow humans die each year from poverty-related causes. Each year, 11 million children die before reaching their fifth birthday. 1.1 billion people live on less than $1 per day; 2.7 billion live on less than $2.

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 their own sake, 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.

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.

3.17 Harmful effects of industrialized farming

Pharming

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.[12]

Meat and methane

Methane is an extremely powerful greenhouse gas. and it is emitted in large quantities by ruminants, such as cattle produced for beef. A new report[13] finds that cattle are not the biggest contributor to the annual methane budget in the atmosphere, but they may be the biggest contributor to increases in methane emissions over recent years.

One must also remember that by eating less meat, and in particular less beef, we can shorten the food chain and thus help famine-threatened populations.

[12]http://ecowatch.com/2014/03/06/misuse-antibiotics-fatal-superbug-crisis/
http://ecowatch.com/2013/12/06/8-scary-facts-about-antibiotic-resistance/
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[13]J. Wolf et al., *Revised methane emissions factors and spatially distributed annual carbon fluxes for global livestock*, Carbon Balance and Management 2017, 12:16

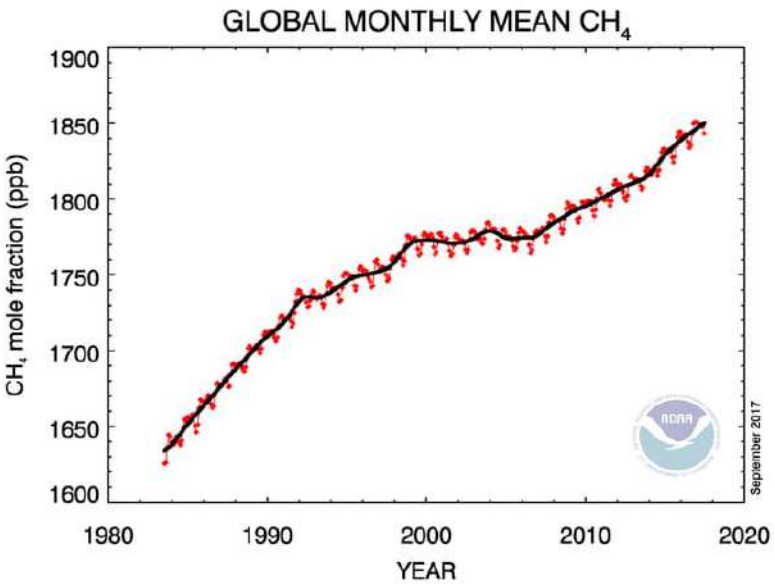

Figure 3.16: **Methane emissions are steadily increasing. A new report has shown ruminants are largely responsible for increases in rates of emission.**

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.

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Chapter 4

STABILIZING GLOBAL POPULATION

4.1 Rusting of the Iron Law

David Ricardo's Iron Law of Wages maintained that workers must necessarily live at the starvation level: Their wages are determined by the law of supply and demand, Ricardo said. If the wages should increase above the starvation level, more workers' children would survive, the supply of workers would increase, and the wages would fall again. This gloomy pronouncement was enthusiastically endorsed by members of the early 19th century Establishment, since it absolved them from responsibility for the miseries of the poor. However, the passage of time demonstrated that the Iron Law of Wages held only under the assumption of an economy totally free from governmental intervention.

Both the growth of the political power of industrial workers, and the gradual acceptance of birth control were important in eroding Ricardo's Iron Law. Birth control is especially important in countering the argument used to justify child labor under harsh conditions. The argument (still used in many parts of the world) is that child labor is necessary in order to save the children from starvation, while the harsh conditions are needed because if a business provided working conditions better than its competitors, it would go out of business. However, with a stable population and appropriate social legislation prohibiting both child labor and harsh working conditions, the Iron Law argument fails.

The Fabian Society

With the gradual acceptance of birth control in England, the growth of trade unions, the passage of laws against child labor and finally minimum wage laws, conditions of workers gradually improved, and the benefits of industrialization began to spread to the whole of society.

One of the important influences for reform was the Fabian Society, founded in London in 1884. The group advocated gradual rather than revolutionary reform (and took its name from Quintus Fabius Maximus, the Roman general who defeated Hannibal's Carthaginian army by using harassment and attrition rather than head-on battles). The Fabian Society came to include a number of famous people, including Sydney and Beatrice Webb, George Bernard Shaw, H.G. Wells, Annie Besant, Leonard Woolf, Emmeline Pankhurst, Bertrand Russell, John Maynard Keynes, Harold Laski, Ramsay MacDonald, Clement Attlee, Tony Benn and Harold Wilson. Jawaharlal Nehru, India's first Prime Minister, was greatly influenced by Fabian economic ideas.

The group was instrumental in founding the British Labour Party (1900), the London School of Economics and the New Statesman. In 1906, Fabians lobbied for a minimum wage law, and in 1911 they lobbied for the establishment of a National Health Service.

The reform movement's efforts, especially those of the Fabians, overcame the worst horrors of early 19th century industrialism, but today their hard-won achievements are being undermined and lost because of uncritical and unregulated globalization. Today, a factory owner or CEO, anxious to avoid high labor costs, and anxious to violate environmental regulations merely moves his factory to a country where laws against child labor and rape of the environment do not exist or are poorly enforced. In fact, he must do so or be fired, since the only thing that matters to the stockholders is the bottom line.

The movement of a factory from Europe or North America to a country with poorly enforced laws against environmental destruction, child labor, and slavery, puts workers into unfair competition. Unless they are willing to accept revival of the unspeakable conditions of the early Industrial Revolution, they are unable to compete.

Today, child labor accounts for 22% of the workforce in Asia, 32% in Africa, and 17% in Latin America. Large-scale slavery also exists today, although there are formal laws against it in every country. There are more slaves now than ever before. Their number is estimated to be between 12 million and 27 million. Besides outright slaves, who are bought and sold for as little as 100 dollars, there many millions of workers whose lack of options and dreadful working conditions must be described as slavelike. [1]

[1] http://www.commondreams.org/news/2015/08/04/state-dept-accused-watering-down-

Figure 4.1: **The sociologist, economist, socialist, labour historian and social reformer, Beatrice Webb (1858-1943), played an important role in the founding of the Fabian Society and the British Labour Party.**

4.2 Birth Control in England: The Utilitarians

James Mill and John Stuart Mill

John Stuart Mill (1806-1873) showed his genius at an early age, and his father, the Utilitarian philosopher and political economist James Mill, immediately began to groom him to replace Jeremy Bentham as the leader of the Utilitarian movement. From the age of 3 onwards, Mill was deliberately kept away from children of his own age and made to spend all his waking hours in study. Play was not allowed, since it would break the habit of continual diligence.

At the age of three, Mill was taught Greek. By the time he reached eight, he had read Aesop's Fables, Xenophon's Anabasis, and all the works of Herodotus. He was also acquainted with Lucian, Diogenes Laërtius, Isocrates and six dialogues of Plato, in their original language. Furthermore, he had also read a great deal of history in English and had been taught arithmetic, physics and astronomy.

When he was twelve, Mill began a thorough study of the scholastic logic, at the same time reading Aristotle's logical treatises in the original language. At thirteen, he was introduced to political economy and studied the classical economists Adam Smith and David Ricardo. In fact Ricardo, who was a close friend of his father, used to invite the young Mill to his house for a walk in order to talk about political economy.

At the age of fourteen, Mill spent a year in France, where he attended the winter courses on chemistry, zoology, logic of the Faculté des Sciences, as well as taking a course of the higher mathematics. He also met the economist Jean-Baptiste Say, a friend of his father, and the political philosopher Henri Saint-Simon.

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http://www.foodispower.org/slavery-chocolate/
https://www.wsws.org/en/articles/2014/10/01/modi-o01.html
http://www.theguardian.com/world/2007/oct/28/ethicalbusiness.retail
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https://www.dosomething.org/facts/11-facts-about-sweatshops
https://sites.google.com/site/rgssenglishmsgsweatshops/conditions-of-sweatshops-in-indonesia
http://www.greenpeace.org/eastasia/campaigns/air-pollution/problems/
http://www.wired.com/2015/04/benedikt-partenheimer-particulate-matter/

Figure 4.2: **The Utilitarian philosopher and political economist James Mill (1773-1836) was an early advocate of birth control. In his Elements of Political Economy, he wrote: "The result to be aimed at is to secure to the great body of the people all the happiness which is capable of being derived from the matrimonial union, (while) preventing the evils which the too rapid increase of their numbers would entail. The progress of legislation, the improvement of the education of the people, and the decay of superstition will, in time, it may be hoped, accomplish the difficult task of reconciling these important objects."**

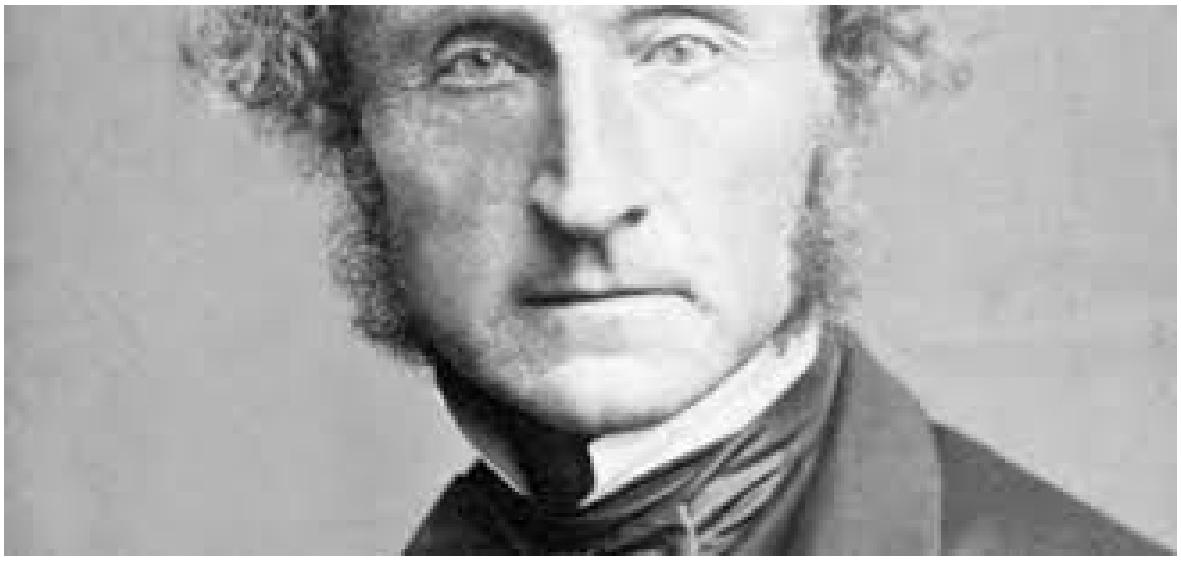

Figure 4.3: **As a Member of Parliament, John Stuart Mill (1806-1873) introduced a law, the first of its kind, to give votes to women. Unfortunately it was defeted, but it set a precedent. He also foresaw that economic growth would have to end.**

Limits to growth

John Stuart Mill pioneered the concept of a steady.state economy. He realized that on a finite earth, neither the population of humans nor the economy can continue to grow forever. In 1848 (when there were just over one billion people in the world), he 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."

Contributions to Utilitarian theory

Jeremy Bentham (1748-1832) had written that "it is the greatest happiness of the greatest number that is the measure of right and wrong". Mill refined this basic principle of Utilitarianism by pointing out the difference between higher pleasures, for example moral or intellectual pleasures, and lower ones, such as pleasures of the flesh. Mill remarked that "It is better to be a human being dissatisfied than a pig satisfied; better to be Socrates dissatisfied than a fool satisfied. And if the fool, or the pig, are of a different opinion, it is because they only know their own side of the question."

Ideas on economics and on individual liberty

According to David Ricardo's "Iron Law of Wages", laborers must always live on the exact borderline between starvation and survival. Wages, Ricardo argued, are determined by the laws of supply and demand. If wages increase above the starvation level, more children of workers survive, the supply of workers increases, and the wages fall once more.

Mill rebelled against Ricardo's dismal "Iron Law" by pointing out that although the means of production might be regulated by the necessities of economics, social conscience can determine the way in which the goods are distributed. (Later Mahatma Gandhi extended this idea by showing that social conscience can also play a role in the way that goods are produced).

John Stuart Mill also contributed importantly to the idea of individual liberty as opposed to unlimited control by the state or by social opinion. He is the author of the following influential principle: "The only purpose for which power can be rightfully exercised over any member of a civilized community, against his will, is to prevent harm to others."

Opposition to slavery

Regarding slavery, Mill wrote: "This absolutely extreme case of the law of force, condemned by those who can tolerate almost every other form of arbitrary power, and which, of all others, presents features the most revolting to the feeling of all who look at it from an impartial position, was the law of civilized and Christian England within the memory of persons now living: and in one half of Angle-Saxon America three or four years ago, not only did

slavery exist, but the slave trade, and the breeding of slaves expressly for it, was a general practice between slave states. Yet not only was there a greater strength of sentiment against it, but, in England at least, a less amount either of feeling or of interest in favour of it, than of any other of the customary abuses of force: for its motive was the love of gain, unmixed and undisguised: and those who profited by it were a very small numerical fraction of the country, while the natural feeling of all who were not personally interested in it, was unmitigated abhorrence."

Member of Parliament and advocate of for votes for women

During the years between 1865 and 1868, John Stuart Mill served simultaneously as a Member of Parliament and as Lord Rector of the University of St. Andrews. In Parliament, Mill was the first person to call for votes for women. His motion was defeated, but it set an important precedent. Mill may have been influenced by his wife, Harriet Taylor Mill, who was a brilliant person in her own right.

Together with his wife and stepdaughter, Mill composed a book entitled *The Subjugation of Women*, which was completed in 1861. It contains a passage arguing that "the legal subordination of one sex to another - is wrong in itself, and now one of the chief hindrances to human improvement; and that it ought to be replaced by a system of perfect equality, admitting no power and privilege on the one side, nor disability on the other.

Ricardo's model accurately described the condition of industrial workers at the time when he was living. However, this model did not take into account the possibility of trade unions and social legislation fixing the minimum wage; nor did Ricardo's model take into account the possibility that workers would use birth control to limit their population growth.

We have seen that Malthus himself was opposed to birth control, advocating late marriage and "moral restraint" instead as the proper means for avoiding excessive population growth. However others in England, notably the Utilitarians, while accepting Malthus' ideas concerning population pressure, advocated birth control as a means of relieving it. In 1821, the Utilitarian philosopher James Mill (the father of John Stuart Mill) wrote in his Elements of Political Economy: "The result to be aimed at is to secure to the great body of the people all the happiness which is capable of being derived from the matrimonial union, (while) preventing the evils which the too rapid increase of their numbers would entail. The progress of legislation, the improvement of the education of the people, and the decay of superstition will, in time, it may be hoped, accomplish the difficult task of reconciling these important objects."

This somewhat vague advocacy of birth control was made much more ex-

plicit by the trade union leader Francis Place (1771-1854). In 1822 Place published, at considerable risk to himself, a pamphlet entitled To the Married of Both Sexes of the Working People. Place's pamphlet contains the following passages:

"It is a great truth, often told and never denied, that when there are too many working people in any trade or manufacture, they are worse paid than they ought to be paid, and are compelled to work more hours than they ought to work. When the number of working people in any trade or manufacture has for some years been too great, wages are reduced very low, and the working people become little better than slaves." "When wages have thus been reduced to a very small sum, working people can no longer maintain their children as all good and respectable people wish to maintain their children, but are compelled to neglect them; - to send them to different employments; - to Mills and Manufactories, at a very early age."

"The miseries of these poor children cannot be described, and need not be described to you, who witness them and deplore them every day of your lives."

"The sickness of yourselves and your children, the privation and pain and premature death of those you love but cannot cherish as you wish, need only be alluded to. You know all these evils too well." "And what, you will ask, is the remedy? How are we to avoid these miseries? The answer is short and plain: the means are easy. Do as other people do, to avoid having more children than they wish to have, and can easily maintain."

Place's pamphlet then goes on to describe very explicitly the sponge method of contraception. "What is to be done is this. A piece of soft sponge is tied by a bobbin or penny ribbon, and inserted just before intercourse takes place. Many tie a sponge to each end of a ribbon, and they take care not to use the same sponge again until it has been washed. If the sponge be large enough, that is, as large as a green walnut, or a small apple, it will prevent conception.... without diminishing the pleasures of married life..."

In 1832, Dr. Charles Knowlton, a Boston physician, published a book entitled *The Fruits of Philosophy, or the Private Companion of Young Married People*. It reviewed the various methods of birth control then available, and it pointed out that in order to be reliable, the sponge method required the use of a saline douching solution. This small book was reprinted in England and sold for a number of years without opposition. However, in 1876, the book was classified as obscene under a new law, and a bookseller was sentenced to two years in prison for selling it. The feminist leader, Annie Besant, and the liberal politician, Charles Bradlaugh, then provoked a new trial by selling the book themselves. They sent a polite letter to the magistrates announcing when and where they intended to sell Knowlton's book, and asking to be arrested. The result was a a famous trial, at which the arguments of Malthus were quoted

both by the judge and by the defense. The result of trial was inconclusive, however: Annie Besant and Charles Bradlaugh were acquitted, but Knowlton's book was held to be obscene.

As the nineteenth century progressed, birth control gradually came to be accepted in England, and the average number of children per marriage fell from 6.16 in 1860 to 4.13 in 1890. By 1915 this figure had fallen to 2.43. Because of lowered population pressure, combined with the growth of trade unions and better social legislation, the condition of England's industrial workers improved; and under the new conditions, Ricardo's Iron Law of Wages fortunately no longer seemed to hold.

Trade unions and child labor laws

The battle to establish trade unions was not won easily. At the start of the 19th century, many countries had laws prohibiting organizing unions, and these invoked penalties up to and including death. In England, the Reform Act of 1832 made unions legal, but nevertheless in 1834, six men from Dorset who had formed the "Friendly Society of Agricultural Workers" were arrested and sentenced to a seven years' transportation to Australia. An obscure law from 1797 was invoked, which prohibited swearing secret oaths. This they had in fact done, but their main crime seems to have been refusing to work for less than 10 shillings a week. Despite bitter opposition, trade unions gradually developed both in England and in other industrial countries.

One of the important influences for reform was the Fabian Society, founded in London in 1884. The group advocated gradual rather than revolutionary reform (and took its name from Quintus Fabius Maximus, the Roman general who defeated Hannibal's Carthaginian army by using harassment and attrition rather than head-on battles). The Fabian Society came to include a number of famous people, including Sydney and Beatrice Webb, George Bernard Shaw, H.G. Wells, Annie Besant, Leonard Woolf, Emmeline Pankhurst, Bertrand Russell, John Maynard Keynes, Harold Laski, Ramsay MacDonald, Clement Attlee, Tony Benn and Harold Wilson. Jawaharlal Nehru, India's first Prime Minister, was greatly influenced by Fabian economic ideas.

The group was instrumental in founding the British Labour Party (1900), the London School of Economics and the New Statesman. In 1906, Fabians lobbied for a minimum wage law, and in 1911 they lobbied for the establishment of a National Health Service.

Adam Smith had praised division of labor as one of the main elements in industrial efficiency, but precisely this aspect of industrialism was criticized by Thomas Carlyle (1795-1891), John Ruskin (1819-1900) and William Morris (1834-1896). They considered the numbingly repetitive work of factory labor-

Figure 4.4: **Francis Place (1771-1854), was a trade union leader and reformer who was anxious to improve the lives of workers. His political activities brought him into contact with William Godwin, James Mill, John Stuart Mill, Robert Owen and Jeremy Bentham. He courageously advocated birth control at a time when it was dangerous to do so.**

Figure 4.5: **Annie Besant (1847-1933). She and the Liberal politician Charles Bradlaugh sent a polite letter to the magistrates announcing when and where they intended to sell Knowlton's book on birth control methods, and asking to be arrested. The result was a a famous trial, at which the arguments of Malthus were quoted both by the judge and by the defense. The result of trial was inconclusive, however: Annie Besant and Charles Bradlaugh were acquitted, but Knowlton's book was held to be obscene.**

Figure 4.6: **Marie Stopes (1880-1958). She founded the first birth control clinic in Britain, and authored the controversial sex manual *Married Love*. Stopes disapproved of abortion and believed that birth control methods should be used to make abortion unnecessary. She edited the newsletter *Birth Control News*, which gave explicit practical advice.**

ers to be degrading, and they rightly pointed out that important traditions of design were being lost and replaced by ugly mass produced artifacts. The Arts and Crafts movement founded by Ruskin and Morris advocated cooperative workshops, where creative freedom and warm human relationships would make work rewarding and pleasant. In several Scandinavian countries, whose industrialization came later than England's, efforts were made to preserve traditions of design. Hence the present artistic excellence of Scandinavian furniture and household articles.

Through the influence of reformers, the more brutal aspects of Adam Smith's economic model began to be moderated. Society was learning that free market mechanisms alone do not lead to a happy and just society. In addition, ethical and ecological considerations and some degree of governmental regulation are also needed.

The Reform Movement aimed at social goals, but left ecological problems untreated. Thus our economic system still does not reflect the true price to society of environmentally damaging activities. For example, the price of coal does not the reflect the cost of the environmental damage done by burning it. This being so, our growth-worshiping economic system of today thunders ahead towards an environmental mega-catastrophe, as we will see in the next chapter.

4.3 Birth control in the United States

The Comstock Laws

Anthony Comstock (1844-1915) was a United States Postal Inspector, which is to say that he was the head of a department of the US Postal Service that had the responsibility of preventing the mail from being used for illegal or immoral purposes. Unfortunately, in his view, this included any information or materials related to birth control.

According to the Wikipedia article about him, "In 1873, Comstock created the New York Society for the Suppression of Vice, an institution dedicated to supervising the morality of the public. Later that year, Comstock successfully influenced the United States Congress to pass the Comstock Law, which made illegal the delivery by U.S. mail, or by other modes of transportation, of 'obscene, lewd, or lascivious' material, as well as prohibiting any methods of production or publication of information pertaining to the procurement of abortion, the prevention of conception and the prevention of venereal disease.

"During his career, Comstock clashed with Emma Goldman and Margaret Sanger. In her autobiography, Goldman referred to Comstock as the leader

of America's 'moral eunuchs'. Comstock had numerous enemies, and in later years his health was affected by a severe blow to the head from an anonymous attacker. He lectured to college audiences and wrote newspaper articles to sustain his causes. Before his death, Comstock attracted the interest of a young law student, J. Edgar Hoover, who was interested in his causes and methods.

"Comstock is also known for his opposition to suffragists Victoria Woodhull and Tennessee Celeste Claflin, and those associated with them. The men's journal The Days' Doings had popularized images of the sisters for three years and was instructed by its editor (while Comstock was present) to stop producing lewd images. Comstock also took legal action against the paper for advertising contraceptives. When the sisters published an expose of an adulterous affair between Reverend Henry Ward Beecher and Elizabeth Tilton, he had the sisters arrested under laws forbidding the use of the postal service to distribute 'obscene material'

"Comstock's ideas of what might be 'obscene, lewd, or lascivious' were quite broad. During his time of greatest power, even some anatomy textbooks were prohibited from being sent to medical students by the United States Postal Service.

"Through his various campaigns, he destroyed 15 tons of books, 284,000 pounds of plates for printing 'objectionable' books, and nearly 4,000,000 pictures. Comstock boasted that he was responsible for 4,000 arrests and claimed he drove fifteen persons to suicide."

"In 1915, architect William Sanger was charged under the New York law against disseminating contraceptive information.[24] His wife Margaret Sanger was similarly charged in 1915 for her work The Woman Rebel. Sanger circulated this work through the U.S. postal service, effectively violating the Comstock Law. On appeal, her conviction was reversed on the grounds that contraceptive devices could legally be promoted for the cure and prevention of disease.

"The prohibition of devices advertised for the explicit purpose of birth control was not overturned for another eighteen years. During World War I, U.S. servicemen were the only members of the Allied forces sent overseas without condoms.

"In 1932, Sanger arranged for a shipment of diaphragms to be mailed from Japan to a sympathetic doctor in New York City. When U.S. customs confiscated the package as illegal contraceptive devices, Sanger helped file a lawsuit. In 1936, a federal appeals court ruled in United States v. One Package of Japanese Pessaries that the federal government could not interfere with doctors providing contraception to their patients.

"Griswold v. Connecticut (1965) struck down one of the remaining contra-

Figure 4.7: **Anthony Comstock (1844-1915). He boasted that he was responsible for 4,000 arrests and claimed he drove fifteen persons to suicide. Through his various campaigns, he destroyed 15 tons of books, 284,000 pounds of plates for printing 'objectionable' books, and nearly 4,000,000 pictures.**

Figure 4.8: **Emma Goldman (1869-1940). She was arrested several times for illegally distributing information on birth control. Wikipedia states that "Her writing and lectures spanned a wide variety of issues, including prisons, atheism, freedom of speech, militarism, capitalism, marriage, free love, and homosexuality."**

Figure 4.9: **Margaret Sanger (1879-1966) is considered to be the founder of the modern birth control movement. Defying threats of arrest, she founded the first birth control clinic in America as well as an organization that developed into the Planned Parenthood Federation of America. In 1925 Sanger organized the Sixth International Neo-Malthusian Birth Control Conference. From 1952 to 1959, she served as President of the International Planned Parenthood Federation.**

ception Comstock laws in Connecticut and Massachusetts. However, Griswold only applied to marital relationships. Eisenstadt v. Baird (1972) extended its holding to unmarried persons as well."

Margaret Sanger is widely regarded as the founder of the modern birth control movement. She was born in 1879 in New York State, to Irish-American parents. Margaret Sanger's mother, Anne Higgens, went through 18 pregnancies, resulting in 11 live births, before dying, exhausted, at the age of 49. Of the 11 surviving children, Margaret was the sixth, and she spent much of her youth caring for her younger siblings. Nevertheless, with the help of her two older sisters, she attended Claverack College and the Hudson River Institute. She became a nurse, and in 1902 she married William Sanger, who was both a socialist and a successful architect.

In the years 1911-1912, Margaret Sanger wrote a series of articles for the magazine The New York Call entitled *What Every Mother Should Know* and in 1912-1913 *What Every Girl Should Know*. Both of these series appeared as books in 1916. Many New York readers were outraged by the frankness of the articles, but many others praised them for their honesty. One reader stated that the articles contained "a purer morality than whole libraries full of hypocritical cant about modesty".

Margaret Sanger's work as a nurse among poor immigrant women convinced her that birth control information was urgently needed to avoid excessive family size and deaths from the consequences of back-street abortions. Throughout her career, Sanger disapproved of abortion, and believed that preventative birth control is the only practical way to avoid it.

One of her patients, Sadie Sachs, died after a self-induced abortion. Remembering this event, Margaret Sanger said later: "I threw my nursing bag in the corner and announced ... that I would never take another case until I had made it possible for working women in America to have the knowledge to control birth".

4.4 China and India

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,

Figure 4.10: **The one-child policy: A Chinese mother and her only child at a market in Jiayuguan.**

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.

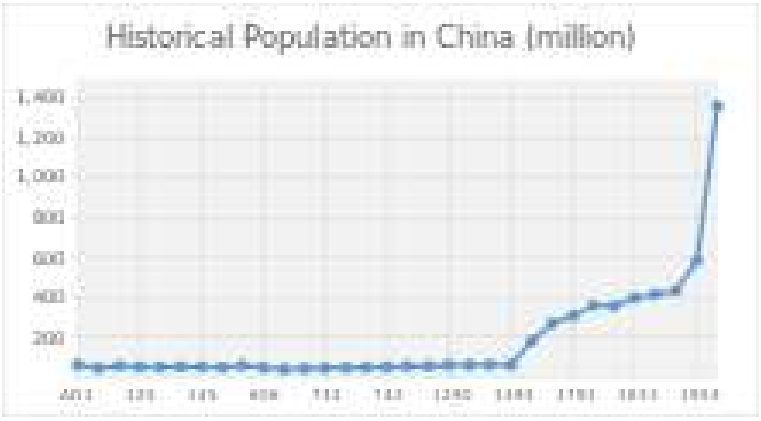

Figure 4.11: **Historical estimates of China's population, in millions, from AD 2 until the present. After Ming and earlier period of Qing dynasty founded population moved around 100 million to 150 million until 1700s. In the period between 1749 and 1851, the population doubled in a century. During 1960-2015, the population doubled to nearly 1.4 billion .**

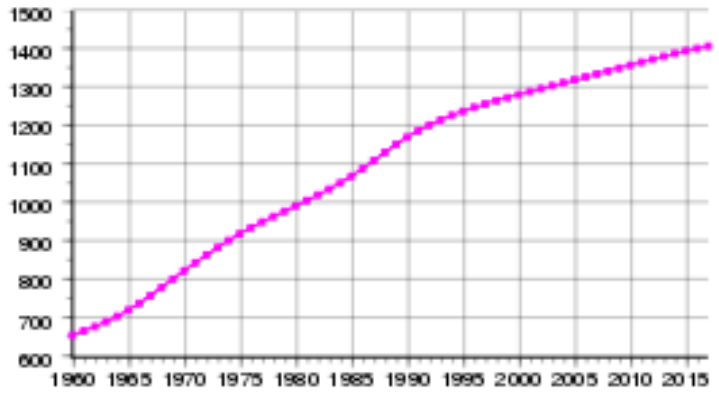

Figure 4.12: **This graph shows the population growth of China, in billions, since 1900. Despite China's one-child policy, the country's population continues to grow because of exceptions to the policy and because so many young people are now reaching reproductive age.**

Table 4.1: **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

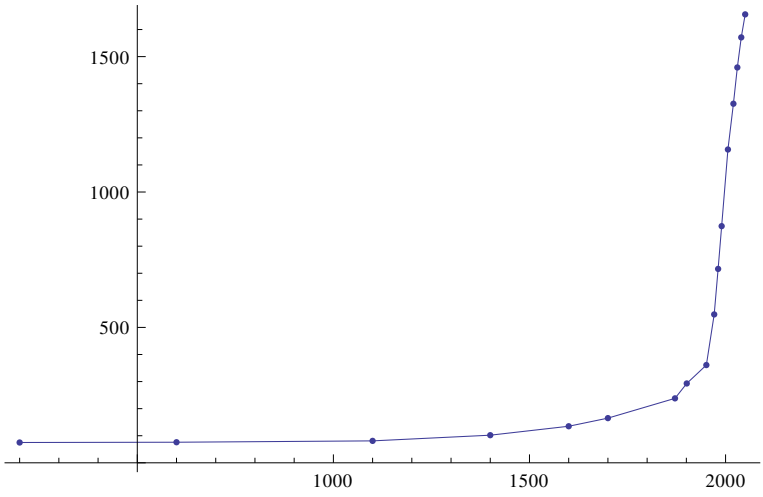

Figure 4.13: **The historical and projected population of India as a function of time, from 200 AD to 2050, based on data from the Wikipedia article on *Demographics of India*. If the projections hold, there will be 1.4 billion people in India by 2050, making it the most populous country in the world. However, there is a danger that death rates may rise sharply because of famine and because of deaths due to rising temperatures.**

Figure 4.14: **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 4.2: **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%

4.5 Population projections in Africa

Wikipedia's article on *Projections of Population Growth* states that "By 2070, the bulk of the world's population growth will take place in Africa: of the additional 2.4 billion people projected between 2015 and 2050, 1.3 billion will be added in Africa, 0.9 billion in Asia and only 0.2 billion in the rest of the world. Africa's share of global population is projected to grow from 16% in 2015 to 25% in 2050 and 39% by 2100, while the share of Asia will fall from 60% in 2015 to 54% in 2050 and 44% in 2100. The strong growth of the African population will happen regardless of the rate of decrease of fertility, because of the exceptional proportion of young people already living today. For example, the UN projects that the population of Nigeria will surpass that of the United States by 2050."

"During 2005-2050, twelve countries are expected to account for half of the world's projected population increase: India, China, United States, Indonesia, Nigeria, Pakistan, Brazil, Democratic Republic of the Congo, Ethiopia, Philippines, Mexico and Egypt, listed according to the size of their contribution to population growth."

The predictions shown in Table 2.2, especially the prediction that the population of Africa will be 2.53 billion people, raise some worrying questions. It seems likely that because of climate change, failure of the West African monsoon, desertification, and sale of African agricultural land to rich countries such China and Saudi Arabia, the food available to the people of Africa will diminish rather than increasing. Can the population of Africa really increase by 209% by 2050? Or will this be prevented by the terrible Malthusian forces of famine, disease and war? In some parts of Africa famine is already present.

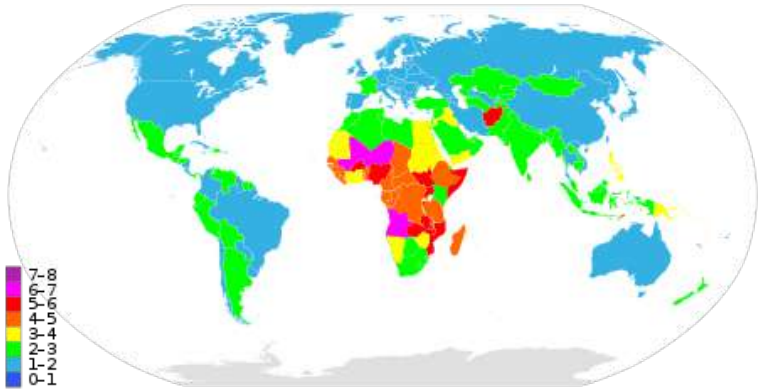

Figure 4.15: **A map from the Wikipedia article showing global fertility rates in 2015. The highest fertility rates (purple, 7-8 children per woman-life) occur in Africa.**

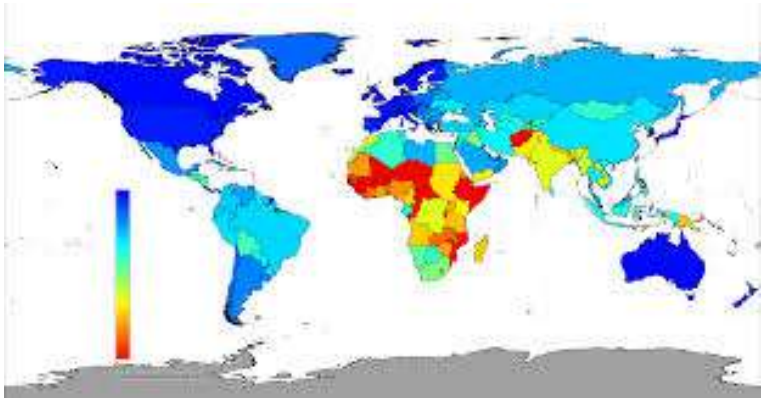

Figure 4.16: **A map showing the human development index (HDI) in various parts of the world. The index is based on educational levels, life expectancy, and GDP per capita. It can be seen that regions of high fertility generally have low HDI values.**

4.6 What is the future of megacities?

A transformation in cities is going on. Over 80% of the people on the planet today are living in cities. Over 100 new cities will be created within 25 years in China alone. Over 20 new Megacities will redefine the consumer marketplace and society. Most of these cities of over 8 million people each will be in the developing world. With the huge migration to cities of the global population, what challenges will these cities face? What are the opportunities and risks? How should global organizations prepare for the future of cities?

Transition Towns

The Transition Town Movement of today is a response to the end of the fossil fuel era and the threat of economic collapse. It can be thought of as a modern branch of the Cooperative Movement. In 2006, the Transition Town of Totnes in Devon, England was the first to use this name, which implied a transition from globalism, consumerism and growth to a sustainable, local and self-sufficient economy. The ideal was to produce locally all the necessary food for the town, and as much of other necessities as possible. In this way, the energy expenditures involved in transportation could be avoided.

Today there are more than a thousand Transition Towns and they are located in 43 countries. Many of them have local currencies which are legal tender within the town. If the pioneers of this movement are right in saying that this is the only sustainable model for the future, we may wonder whether mega-cities will be able to survive in the long-term future.[2]

Gandhi's vision of India's future

Gandhi tried to reconstruct the crafts and self-reliance of village life that he felt had been destroyed by the colonial system. "I would say that if the village perishes, India will perish too", he wrote, "India will be no more India. Her own mission in the world will get lost. The revival of the village is only possible when it is no more exploited. Industrialization on a mass scale will necessarily lead to passive or active exploitation of the villagers as problems of competition and marketing come in. Therefore we have to concentrate on the village being self-contained, manufacturing mainly for use. Provided this character of the village industry is maintained, there would be no objection to villagers using

[2]https://en.wikipedia.org/wiki/Degrowth
http://commondreams.org/views/2015/07/31/we-are-all-greece
http://www.localfutures.org/
http://www.powells.com/biblio/7-9780871566430-2

Table 4.3: **The World's Largest Cities in 2016**

Rank	Name	Country	Population
1	Tokyo	Japan	38,140,000
2	Shanghai	China	34,000,000
3	Jakarta	Indonesia	31,500,000
4	Delhi	India	27,200,000
5	Seoul	Korea	25,600,000
6	Guangzhou	China	25,000,000
7	Beijing	China	24,900,000
8	Manila	Philippines	24,100,000
9	Mumbai	India	23,900,000
10	New York City	United States	23,876,155
11	Shenzhen	China	23,300,000
12	Sao Paolo	Brazil	21,242,939

Figure 4.17: **Totnes, Devon, England: a transition town.**

even the modern machines that they can make and can afford to use. Only they should not be used as a means of exploitation by others."

"You cannot build nonviolence on a factory civilization, but it can be built on self-contained villages... Rural economy as I have conceived it, eschews exploitation altogether, and exploitation is the essence of violence... We have to make a choice between India of the villages that are as ancient as herself and India of the cities which are a creation of foreign domination..."

4.7 All the needed reforms are desirable in themselves

Experts agree that the following steps are needed if we are to avoid a catastrophic global famine and population crash:

1. Higher education and higher status for women throughout the world. Women need higher education to qualify for jobs outside their homes, and higher status within their families so they will net be forced into the role of baby-producing machines.
2. Primary health care for all. Children should be vaccinated against preventable diseases. Materials and information for family planning should be provided for all women who desire smaller families. Advice should be given on improving sanitation.
3. The provision of clean water supplies near to homes is needed in order to reduce the incidence of water-borne diseases. In some countries today,

Figure 4.18: **Professor Sir Partha Dasgupta of Cambridge University has pointed out that all of the steps that are needed for population stabilization are desirable in themselves.**

family members, including children, spend large amounts of time carrying water home from distant sources.

4. State provision of care for the elderly is a population-stabilization measure because in many countries, parents produce many children so that the children will provide for them in their old age.
5. In many countries child labor is common, and in some there is even child slavery. Parents who regard their children as a source of income are motivated to produce large families. Enforceable laws against child labor and slavery contribute to population stabilization.
6. General economic progress has been observed to contribute to population stabilization. However in some countries there is a danger of population growing so rapidly that it prevents the economic progress that would otherwise have stabilized population. This situation is known as the demographic trap.

4.8 Higher status and higher education for women

It is only recently that women have had the right to vote. In most of the industrialized countries, this right was only granted during the early part of the 20th century. In some countries, this reform was even slower. For example. in Switzerland. it was only in 1971 that women gained the right to vote in federal elections. In Lichtenstein, women's right to vote was delayed until 1981. It was only in December, 2015 that Saudi Arabia granted the right to

Figure 4.19: **Higher education and higher political representation for women are vitally needed reforms.**

vote to women. Currently, the only country in the world where this right is denied is the Vatican City.

It is important that women should have equal political representation because female representation not only advances gender equality in legal matters, such as the inheritance of property, but also promotes the rights of children.

Prior to the 20th century, women were very largely barred from higher education. In later chapters we will look at some particular cases. For example, the famous pioneer of modern educational methods, Dr. Maria Montessori, had to overcome many barriers to obtain her medical degree.

With higher education, comes the motivation and the opportunity for women to have jobs outside their homes. With lower rates of infant mortality, and the aid of machines, being a housewife and mother has become less and less a lifelong full-time occupation. Experts agree that higher education for women. and jobs for women outside their homes are vitally important measures for population stabilization; but these reforms are also very desirable for their own sake, for the sake of justice, and for the sake of the uniquely life-oriented vision that women can bring to public life.

4.9 Primary health care for all

An International Conference on Primary Health Care took place at Alma-Ata, USSR, 6-12 September, 1978. Point **VII** of the Alma-Ata Declaration defines primary health care as follows:

Primary health care

1. *reflects and evolves from the economic conditions and sociocultural and political characteristics of the country and its communities and is based on the application of the relevant results of social, biomedical and health services research and public health experience;*

2. *addresses the main health problems in the community, providing promotive, preventive, curative and rehabilitative services accordingly;*

3. *includes at least: education concerning prevailing health problems and the methods of preventing and controlling them; promotion of food supply and proper nutrition; an adequate supply of safe water and basic sanitation; maternal and child health care, including family planning; immunization against the major infectious diseases; prevention and control of locally endemic diseases; appropriate treatment of common diseases and injuries; and provision of essential drugs;*

4. *involves, in addition to the health sector, all related sectors and aspects of national and community development, in particular agriculture, animal husbandry, food, industry, education, housing, public works, communications and other sectors; and demands the coordinated efforts of all those sectors;*

5. *requires and promotes maximum community and individual self-reliance and participation in the planning, organization, operation and control of primary health care, making fullest use of local, national and other available resources; and to this end develops through appropriate education the ability of communities to participate;*

6. *should be sustained by integrated, functional and mutually supportive referral systems, leading to the progressive improvement of comprehensive health care for all, and giving priority to those most in need;*

7. *relies, at local and referral levels, on health workers, including physicians, nurses, midwives, auxiliaries and community workers as applicable, as well as traditional practitioners as needed, suitably trained socially and technically to work as a health team and to respond to the expressed health needs of the community.*

Provision of primary health care is high on the list of priorities of the World Health Organization. The Bill and Melinda Gates Foundation has also made great financial contributions to this goal.

Figure 4.20: **The provision of primary health care to all countries throughout the world should include not only measures, such as vaccination, for the prevention of diseases, but also making advice and materials for family planning available to all women who desire them.**

4.10 Clean water supplies near homes

According to the World Health Organization, 842,000 deaths per year are attributable to a lack of safe drinking water supply, sanitation and hygiene. Wikipedia states that "Waterborne diseases can have a significant impact on the economy, locally as well as internationally. People who are infected by a waterborne disease are usually confronted with related costs and not seldom with a huge financial burden. This is especially the case in less developed countries. The financial losses are mostly caused by e.g. costs for medical treatment and medication, costs for transport, special food, and by the loss of manpower. Many families must even sell their land to pay for treatment in a proper hospital. On average, a family spends about 10% of the monthly households income per person infected."

Figure 4.21: **Carrying water from distant sources to homes is a time-consuming burden. Often this task is performed by children.**

4.11 State provision of care for the elderly

In many countries, elderly parents have traditionally been cared for by their children. This is one of the motives for large family size. Parents with many children feel that they will have a secure old age. For example, in India, parents are typically cared for by their children into old age, most commonly by their sons. Thus, many parents in India continue to have children until they produce a son, and this often leads to large family sizes. State supported care for the elderly throughout the world is an important step that is needed for population stabilization.

Figure 4.22: **Government-provided care for the elderly will help to stabilize the currently-exploding global population of humans.**

4.12 Abolition of child labor and slavery

Today the hard-won achievements of reformers in the industrialized countries are being undermined and lost because of uncritical and unregulated globalization. A factory owner or CEO, anxious to avoid high labor costs, and anxious to violate environmental regulations merely moves his factory to a country where laws against child labor and rape of the environment do not exist or are poorly enforced. In fact, he must do so or be fired, since the only thing that matters to the stockholders is the bottom line. One might say (as someone has done), that Adam Smith's invisible hand is at the throat of the world's peoples and at the throat of the global environment.

The movement of a factory from Europe or North America to a country with poorly enforced laws against environmental destruction, child labor and slavery puts workers into unfair competition. Unless they are willing to accept revival of the unspeakable conditions of the early Industrial Revolution, they are unable to compete.

Today, child labor accounts for 22% of the workforce in Asia, 32% in Africa, and 17% in Latin America. Large-scale slavery also exists today, although there are formal laws against it in every country. There are more slaves now than ever before - their number is estimated to be between 12 million and 27 million. Besides outright slaves, who are bought and sold for as little as 100 dollars, there many millions of workers whose lack of options and dreadful working

Figure 4.23: **Laws prohibiting child labor are non-existent in many countries, or poorly enforced.**

conditions must be described as slave-like.

We need to reform our economic system to give it both a social conscience and an ecological conscience. Perhaps some of the things that the world produces and consumes today are not really necessary.

Figure 4.24: **More slaves exist today than ever before.**

4.13 General economic progress

It has been observed that general economic progress leads to population stabilization. However, it often happens that population growth in a country is so rapid that it prevents economic progress. This phenomenon is known as the *demographic trap*. For example, if we look at the population-age structure of Egypt in 2005. shown in Figure 2.9, we see that there are very many young people approaching reproductive age, and very few old people. Thus the birth rate will not be balanced by the death rate, and the population of any country with a similar population-age structure can be expected to grow rapidly, preventing the economic development that might have slowed population growth. In such a situation, strong state-supported birth control programs are clearly needed.

Very early marriage and forced marriage must also be discouraged. We can recall that Malthus mentions late marriage as one of the preventive checks to population growth. Forced and child marriages entrap women and young girls in relationships that deprive them of their basic human rights. Forced marriage constitutes a human rights violation in and of itself.

According to the website Stop Violence Against Women, "In 2003, the International Centre for Research on Women estimated that more than 51 million girls under 18 years were married and they expected the figure to rise to over 100 million within the next ten years. Similarly, in 2006, experts estimated that thirty-eight percent of young women aged 20 to 24 in the fifty least developed countries were married before the age of 18.

"In *Early Marriage: A Harmful Traditional Practice*, UNICEF estimates that among women aged 15 to 24, 48 percent were married before the age of 18 in South Asia. In Bangladesh, 27.3 percent of women aged 15 to19 years old were married by the age of 15, and 65.3 percent of women aged 20 to 24 were married before the age of 18.

"UNICEF estimates that in Africa 42 percent of women aged 15 to 24 were married before the age of 18. In Niger, 27.3 percent of women ages 15 to 19 were married before the age of 15, and 76.6 percent of women ages 20 to 24 were married before the age of 18. According to surveys conducted by the National Committee on Traditional Practices of Ethiopia (NCTPE), the prevalence of marriage by abduction is as high as 92 per cent in Southern Nations Nationalities and Peoples Region (SNNPR), with a national average of 69 percent."

Today's world is one in which the wealth of the richest 1% of the global population increased by 82% in 2017, while for the poorest half of humanity there was no increase at all. It is a world where an estimated 11 million children die every year from starvation or from diseases related to poverty. It is a world

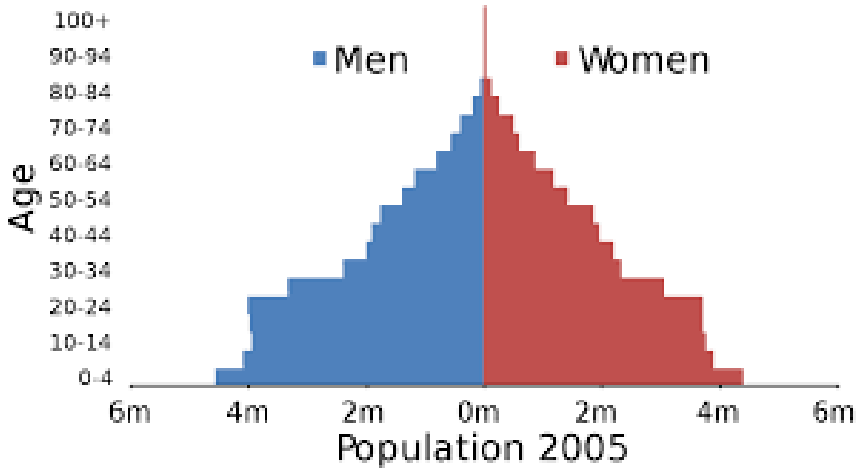

Figure 4.25: **The population pyramid of Egypt in 2005.**

where obesity is a serious public health problem in rich nations, while at the same time, children in poorer countries scavenge among toxic wastes in garbage dumps. It is a world where almost a billion people are undernourished.

Figure 4.26: **A slum in India**

Figure 4.27: **Children scavenging at a garbage dump.**

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Chapter 5

THE CLIMATE EMERGENCY

5.1 Contrasting responses to the pandemic and the climate crisis

There is a remarkable contrast in the way that governments around the world have responded to the COVID-19 pandemic and the way that they have responded to the climate emergency. The pandemic, which indeed represents an extremely grave danger to humanity, has produced a massive global response. Borders have been closed, airlines have become virtually inoperative, industries, restaurants and entertainments have been closed, sporting events have been cancelled or postponed, people have been asked to stay at home and practice social distancing, and the everyday life of citizens around the world has been drastically changed.

By contrast, let us consider the threat that if immediate action is not taken to halt the extraction and use of fossil fuels, irreversible feedback loops will be initiated which will make catastrophic climate change inevitable despite human any human efforts to prevent it.

This threat is even more serious than the COVID-19 pandemic. Climate change could make much of the earth too hot for human life. It could produce a famine involving billions of people, rather than millions.

My own belief is that catastrophic climate change would not lead do the extinction of the human species; but I think that because much of the world would become uninhabitable, the global population of humans would be very much reduced.

How have governments responded to the climate emergency? A minority, for example the Scandinavian countries, have taken appropriate action. Most governments pay lip service to the emergency, but do not take effective action; and a few countries, such as the United States under Donald Trump,

Bolsonaro's Brazil, and Saudi Arabia, deny that there is a climate emergency and actively sabotage action.

The world's net response has been totally inadequate. The Keeling Curve, which measures CO_2 concentrations in the atmosphere, continues to rise, and the rate of rising is even increasing.

What is the reason for this remarkable contrast in our response to two serious emergencies? We see clearly and respond to what is close to us, and are relatively indifferent to what is far away. We hear of people dying every day from the COVID-19 pandemic, and there is a danger that as many as 100 million people could die before it is over.

By contrast, although immediate climate action is needed today to avoid disaster, the worst consequences of climate change lie in the long-term future. Old people, like me, will not live to see massive deaths from starvation and overheating.

However, we have a responsibility to our children and grandchildren, and to all future generations. A large-scale global famine could occur by the middle of the present century, and children who are alive today could experience it.

5.2 Recovery from the pandemic offers climate action opportunities

When the COVID-19 pandemic is over, governments will be faced by the task of repairing the enormous economic damage that it has caused. The situation will be similar to the crisis that faced US President Franklin D. Roosevelt when he took office during the Great Depression of the 1930s. Roosevelt, encouraged by John Maynard Keynes, used federal funds to build much-needed infrastructure around the United States. His programs, the New Deal, ended the Great Depression in his country.

Today, the concept of a similar Green New Deal is being put forward globally. This concept visualizes government-sponsored programs aimed at simultaneously creating both jobs and urgently-needed renewable energy infrastructure. The Green New Deal programs could be administered in such a way as to correct social injustices.

5.3 Quick action is needed to save the long-term future

The worst effects of catastrophic climate change lie in the distant future, a century or even many centuries from the present; but disaster can only be

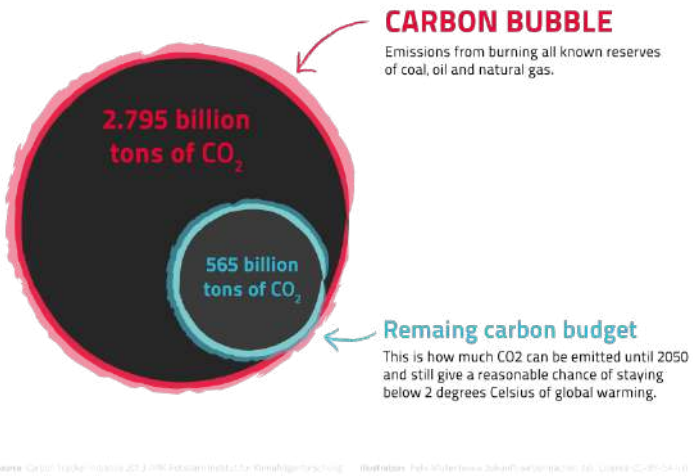

Figure 5.1: **The Carbon Bubble according to data by the Carbon Tracker Initiative 2013. In order to avoid tipping points that will make human attempts to avoid catastrophic climate change useless, we must leave most of the known fossil fuel reserves in the ground!**

avoided if quick action is taken. The nations of the world must act immediately to reduce and eventually stop the use of fossil fuels and the destruction of forests. If decisive action is not taken within the next few decades, feedback loops will make human intervention useless. These feedback loops include the albedo effect, the methane hydrate feedback loop, and the fact as tropical forests become drier, they become vulnerable to fires ignited by lightning. These fires accelerate the drying, and thus a feed-back loop is formed.

As time passes, and as the disastrous consequences of climate change become more apparent, the political will required for action will increase; but by that time it may be too late. We are rapidly approaching several crucial tipping points.

At present, the average global rate of use of primary energy is roughly 2 kW_t per person. In North America, the rate is 12 kW_t per capita, while in Europe, the figure is 6 kW_t. In Bangladesh, it is only 0.2 kW_t. This wide variation implies that considerable energy savings are possible, through changes in lifestyle, and through energy efficiency.

5.4 Is the transition to 100% renewable energy possible?

If we ask whether the transition to 100% renewable energy is possible, the answer is very simple: It is not only possible; it is inevitable! This is because the supply of fossil fuels is finite, and at the present rate of use they will be exhausted in less than a century. While the transition to 100% renewables is inevitable, the vitally important point to remember is that if we are to avoid disaster, the transition must come quickly.

	Reserves	2005 rate of use	Years remaining
Coal	780 TWy	3.5 TW	217 years
Oil	250 TWy	6.0 TW	42 years
Natural gas	250 TWy	3.7 TW	68 years
Total	1260 TWy	13.2 TW	(95 years)

Year	Demand	Population	Per Capita
1980	9.48 TW	4.45 bil.	2.13 kW
1985	10.3 TW	4.84 bil.	2.11 kW
1990	11.6 TW	5.99 bil.	2.20 kW
1995	12.3 TW	5.68 bil.	2.16 kW
2003	14.1 TW	6.30 bil.	2.23 kW
2010	17.1 TW	6.84 bil.	2.50 kW
2015	18.9 TW	7.23 bil.	2.58 kW
2020	20.5 TW	7.61 bil.	2.70 kW
2025	22.3 TW	7.91 bil.	2.82 kW
2030	24.2 TW	8.30 bil.	2.93 kW

In this book, we will use kilowatts (kW), megawatts (MW) and terawatts (TW) as the units in which we discuss the rate of use of energy. A megawatt is equal to a thousand kilowatts or a million watts. A terawatt is equal to a thousand megawatts, or a million kilowatts or a billion (1,000,000,000) watts. A citizen of the European Union uses energy at the rate of about 6 kilowatts, while in North America, the rate of energy use is double that amount. The global average rate of energy use is a little over 2 kilowatts. Since there are

now 7.5 billion people in the world, our present rate of energy use is roughly 15 terawatts,

The total available energy from fossil fuels can be measured in terawatt.years (TWy). Rough estimates of global coal reserves of coal, oil and natural gas are given by the table shown above.

The present rate of use of fossil fuels is greater than the 2005 rate shown in the table, and the remaining reserves are smaller than those shown. It is assumed that as oil becomes exhausted, coal will be converted into liquid fuels, as was done in Germany during World War II.

A second table, shown below, illustrates the historical and projected total global energy demand as a function of time between 1980 and 2030. In this slightly out-of-date table, the last year using historical data is 2003, later years being estimates based on projections.

Notice that the per capita energy use is almost constant. Our rapidly growing demand for energy is primarily the result of the world's rapidly growing population of humans. It would be wise to stabilize human populations because of the threat of human-caused ecological catastrophes and the danger of an extremely large-scale famine, involving billions of people rather than millions. Such a famine is threatened because growing populations require a growing food supply, climate changes threaten agriculture through droughts, melting glaciers and loss of agricultural land. The end of the fossil fuel era will also mean the end of high-yield petroleum.based agriculture.

The rate of growth of renewable energy

There is reason for hope that even the high energy demands show in the second table can be met by renewables. The basis of this hope can be found in the extremely high present rate of growth of renewable energy, and in the remarkable properties of exponential growth. According to figures recently released by the Earth Policy Institute, the global installed photovoltaic capacity is currently able to deliver 242,000 megawatts, and it is increasing at the rate of 27.8% per year. Wind energy can now deliver 370,000 megawatts, and it is increasing at the rate of roughly 20% per year.

Because of the astonishing properties of exponential growth, we can calculate that if these growth rates are maintained, renewable energy can give us 24.8 terawatts within only 15 years! This is far more than the world's present use of all forms of energy.

5.5 Renewables are now much cheaper than fossil fuels!

According to an article written by Megan Darby and published in *The Guardian* on 26 January, 2016, "Solar power costs are tumbling so fast the technology is likely to fast outstrip mainstream energy forecasts.

"That is the conclusion of Oxford University researchers, based on a new forecasting model published in Research Policy[1].

"Commercial prices have fallen by 58% since 2012 and by 16

"Since the 1980s, panels to generate electricity from sunshine have got 10% cheaper each year. That is likely to continue, the study said, putting solar on course to meet 20% of global energy needs by 2027.' '

Solar energy

Unlike the burning of fossil fuels, renewables like solar energy do not release pollutants into the atmosphere. In China. public opinion has shifted in favor of renewables because of air pollution in cities.

Photovoltaic cells

The price of solar photovoltaic panels has declined 99 percent over the last four decades, from $74 a watt in 1972 to less than 70 cents a watt in 2014.

Between 2009 and 2014, solar panel prices dropped by three fourths, helping global PV installations grow 50 percent per year.

Deutsche Bank notes that as of early 2014, solar PV was already competitive with average residential, commercial or industrial electricity rates in 14 countries, and in California - even without subsidies. By late 2014 there were nearly 600,000 individual PV systems in the United States, almost twice as many as in 2012. This number may well pass 1 million in 2016.

In 2013, just 12 percent of U.S homebuilders offered solar panels as an option for new single-family homes. More than half of them anticipate doing so by 2016. Four of the top five U.S. home construction firms - DR Horton, Lennar Corp, PulteGroup and KB Home - now automatically include solar panels on every new house in certain markets.

In 2007 there were only 8,000 rooftop solar installations in coal-heavy Australia; now there are over a million.

Saudi Arabia has 41,000 megawatts of solar PV operating, under construction and planned - enough to generate up to two thirds of the country's electricity.

[1]http://www.sciencedirect.com/science/article/pii/S0048733315001699

For the roughly 1.3 billion people without access to electricity, it is now often cheaper and more efficient simply to install solar panels rooftop-by-rooftop than to build a central power plant and transmission infrastructure.

Wind energy

Over the past decade, world wind power capacity grew more than 20 percent a year, its increase driven by its many attractive features, by public policies supporting its expansion, and by falling costs.

By the end of 2014, global wind generating capacity totaled 369,000 megawatts, enough to power more than 90 million U.S. homes. Wind currently has a big lead on solar PV, which has enough worldwide capacity to power roughly 30 million U.S. homes.

China is now generating more electricity from wind farms than from nuclear plants, and should have little trouble meeting its official 2020 wind power goal of 200,000 megawatts. For perspective, that would be enough to satisfy the annual electricity needs of Brazil.

In nine U.S. states, wind provides at least 12 percent of electricity. Iowa and South Dakota are each generating more than one quarter of their electricity from wind.

In the Midwestern United States, contracts for wind power are being signed at a price of 2.5 cents per kilowatt-hour (kWh), which compares with the nationwide average grid price of 10-12 cents per kWh.

Although a wind farm can cover many square miles, turbines occupy little land. Coupled with access roads and other permanent features, a wind farm's footprint typically comes to just over 1 percent of the total land area covered by the project.

Wind energy yield per acre is off the charts. For example, a farmer in northern Iowa could plant an acre in corn that would yield enough grain to produce roughly $1,000 worth of fuel-grade ethanol per year, or the farmer could put on that same acre a turbine that generates $300,000 worth of electricity per year. Farmers typically receive $3,000 to $10,000 per turbine each year in royalties. As wind farms spread across the U.S. Great Plains, wind royalties for many ranchers will exceed their earnings from cattle sales.

The problem of intermittency

Many forms of renewable energy encounter the problem of intermittency. For example, on windy days, Denmark's windmills generate more than enough electricity to meet the needs of the country, but on days when the wind is less strong, the electrical energy generated is insufficient. Denmark solves this

problem by selling surplus electrical power to Germany on windy days, and buying power from hydroelectric-rich Norway on less windy days.

The problem of intermittency can alternatively be solved by pumping water to uphill reservoirs when the wind is strong, and letting the stored water drive turbines when the wind is weak. The problem of intermittency can also be solved with lithium ion storage batteries, by splitting water into hydrogen and oxygen, or by using other types of fuel cells.

Developing countries: No need for grids

When cell phones came into general use, developing countries with no telephone networks were able to use the new technology through satellites, thus jumping over the need for country-wide telephone lines. Similarly, village solar or wind installations in the developing countries can supply power locally, bypassing the need for a grid.

5.6 An economic tipping point

Renewables are now cheaper than fossil fuels

Solar energy and wind energy have recently become cheaper than fossil fuels. Thus a tipping point has been passed. From now on, despite frantic efforts of giant fossil fuel corporations to prevent it from happening, the transition to 100% renewable energy will be driven by economic forces alone.

Subsidies to the fossil fuel industry

http://www.imf.org/en/News/Articles/2015/09/28/04/53/sonew070215a
http://priceofoil.org/fossil-fuel-subsidies/

5.7 An unprecedented investment opportunity

Investment in electric vehicles

On July 5, 2017, the Volvo Car Group made the following announcement: [2]

"Volvo Cars, the premium car maker, has announced that every Volvo it launches from 2019 will have an electric motor, marking the historic end of cars

[2] https://www.media.volvocars.com/global/en-gb/media/pressreleases/210058/volvo-cars-to-go-all-electric


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FUEL


THE CLIMATE IS
CHANGING
WHY AREN'T WE?


WE CAN build a better tomorrow, today
It's time for a Green New Deal
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that only have an internal combustion engine (ICE) and placing electrification at the core of its future business.

"The announcement represents one of the most significant moves by any car maker to embrace electrification and highlights how over a century after the invention of the internal combustion engine electrification is paving the way for a new chapter in automotive history.

"'This is about the customer,' said Håkan Samuelsson, president and chief executive. 'People increasingly demand electrified cars and we want to respond to our customers' current and future needs. You can now pick and choose whichever electrified Volvo you wish.'

"Volvo Cars will introduce a portfolio of electrified cars across its model range, embracing fully electric cars, plug in hybrid cars and mild hybrid cars.

"It will launch five fully electric cars between 2019 and 2021, three of which will be Volvo models and two of which will be high performance electrified cars from Polestar, Volvo Cars' performance car arm. Full details of these models will be announced at a later date."

The electric vehicle investment opportunity was also illustrated by the 2017 vote of Germany's Bundesrat to ban the manufacture of internal combustion engines after 2030 [3].

The article announcing the vote adds that "It's a strong statement in a nation where the auto industry is one of the largest sectors of the economy; Germany produces more automobiles than any other country in Europe and is the third largest in the world. The resolution passed by the Bundesrat calls on the European Commission (the executive arm of the European Union) to 'evaluate the recent tax and contribution practices of Member States on their effectiveness in promoting zero-emission mobility,' which many are taking to mean an end to the lower levels of tax currently levied on diesel fuel across Europe."

France plans to end the sale of vehicles powered by gasoline and diesel by 2040, environment minister Nicolas Hulot announced recently.

Hulot made the announcement on Thursday, June 13, 2017, in Paris as he launched the country's new Climate Plan to accelerate the transition to clean energy and to meet its targets under the Paris climate agreement.

To ease the transition, Hulot said the French government will offer tax incentives to replace fossil-fuel burning cars with clean alternatives.

Furthermore, the government of India has recently announced its intention to only nave electric vehicles by 2030[4]. This hugely ambitious plan was

[3]https://arstechnica.com/cars/2016/10/germanys-bundesrat-votes-to-ban-the-internal-combustion-engine-by-2030/

[4]https://www.greentechmedia.com/articles/read/what-country-will-become-the-first-to-ban-internal-combustion-cars

announced during the 2017 Confederation of Indian Industry Annual Session. Besides the avoidance of climate change, which might make many regions of India uninhabitable, the motive for replacing 28 million combustion engine vehicles by electric ones was the severe air pollution from which India suffers. Severe air pollution also motivates efforts by the government of China to promote the transition to electric vehicles.

The governments of Norway and the Netherlands have taken steps towards banning the internal combustion engine[5]. Both the upper and lower houses of the Netherlands' government voted to ban cars driven by internal combustion engines by 2025, the same year in which Norway plans to sell nothing but zero-emission vehicles.

In a report commissioned by the investment bankers Cowan & Co, managing director and senior research analyst Jeffrey Osborne, predicted that electric vehicles will cost less than gasoline-powered cars by the early- to mid-2020s due to falling battery prices as well as the costs that traditional carmakers will incur as they comply to new fuel-efficiency standards. Osbourne pointed out that a number of major car brands are hopping onto the electric bandwagon to compete in a space carved out by industry disrupter, Tesla.

"We see the competitive tides shifting in 2019 and beyond as European [car makers] roiled by the diesel scandal and loss of share to Tesla in the high margin luxury segment step on the gas and accelerate the pace of EV introductions", he wrote.

Bloomberg New Energy Finance reported similar predictions: "Falling battery costs will mean electric vehicles will also be cheaper to buy in the U.S. and Europe as soon as 2025," the report said. "Batteries currently account for about half the cost of EVs, and their prices will fall by about 77 percent between 2016 and 2030."

In October, 2017, General Motors unveiled plans to roll out 20 new entirely electric car models by 2023, with two of the new EVs coming out in the next 18 months. Meanwhile, Ford announced the creation of "Team Edison," intended to accelerate the company's EV development and partnership work. The name, is "seemingly in direct response to Elon Musk's Tesla, which recently surpassed Ford's market capitalization."

Tesla's Chairman, highly successful inventor and entrepreneur Elon Musk, has made massive investments in factories manufacturing electric vehicles, improved lithium ion storage cells, and photovoltaic panels, as will be discussed in Chapter 2.

[5]http://www.prnewswire.com/news-releases/the-dutch-revolution-in-smart-charging-of-electric-vehicles-597268791.html

Investment in wind turbine energy

In Denmark, the wind turbine industry contributes substantially to the country's positive balance of payments. According to Wikipedia, "The Danish wind turbine industry is the world's largest. Around 90% of the national output is exported, and Danish companies accounted for 38% of the world turbine market in 2003, when the industry employed some 20,000 people and had a turnover of around 3 billion euro."

Denmark's two largest wind turbine manufacturers are Vestas and Simiens Wind Power. Vestas employs more that 21000 people globally. In February 2016, Vestas got its largest order of 1,000 MW (278 x 3.6 MW) for the Fosen project near Trondheim in Norway. It costs DKK 11 billion, and should deliver 3.4 TWh per year.

In 2015 Siemens Wind had a combined market share of 63% of European offshore wind turbines (nearly 75% in 2009 by capacity and number). In 2011, Siemens Wind Power had 6.3% share of the world wind turbine market, and was the second largest in 2014.

In many countries, including Australia, Canada, Denmark, Germany, India, The Netherlands, United Kingdom, and United States, wind turbine cooperatives have sprung up. In these cooperatives, communities share the costs and profits of wind turbine projects. For example, the Hepburn Wind Project in Victoria, Australia, owns two 2MW wind turbines which produce enough power for 2,300 households.

Investment in solar energy

Global retinues from solar photovoltaic installations are expected to reach $1.2 trillion between the present and 2024 according to a recent article[6]

Another article[7] states that "The global electric power industry is evolving into a model that offers more diversity, both in terms of generation and in the ownership of generation assets, and solar PV is one technology at the head of this change. Following years of unsustainable pricing and oversupply, demand for solar PV systems has finally caught up, with 2015 expected to be the year when the global solar PV market shifts and starts to compete with other technologies. According to a recent report from Navigant Research, global revenue from solar PV installations is expected to total more than $1.2 trillion from 2015 to 2024."

[6]https://cleantechnica.com/2016/01/25/global-revenue-solar-pv-installations-expected-reach-1-2-trillion/

[7]http://www.navigantresearch.com/newsroom/global-revenue-from-solar-pv-installations-is-expected-to-total-more-than-1-2-trillion-from-2015-to-2024

5.8 For creating jobs, renewables beat fossil fuels

Here are some excerpts from a 2016 report issued by the Solar Foundation:

- One out of every 50 new jobs added in the United States in 2016 was created by the solar industry, representing 2 percent of all new jobs.
- Solar jobs in the United States have increased at least 20 percent per year for the past four years, and jobs have nearly tripled since the first Solar Jobs Census was released in 2010.
- Over the next 12 months, employers surveyed expect one out of every 50 new jobs added in the United States in 2016 was created by the solar industry, representing 2 percent of all new jobs.
- In 2016, the five states with the most solar jobs were California, Massachusetts, Texas, Nevada, and Florida.
- The solar industry added $84 billion to the US GDP in 201t to see total solar industry employment increase by 10 percent to 286,335 solar workers.
- The solar industry added $84 billion to the US GDP in 2016.

5.9 The Stern Review

Background of the Stern Review

The Stern Review on the Economics of Climate Change is a 700 page document commissioned by the government of the United Kingdom and released on 30 October, 2006. The research behind this report was conducted by a team led by Nicolas Stern (Baron Stern of Brentford), chair of the Grantham Research Institute on Climate Change and the Environment.

The Stern Review discusses the catastrophic climate change which will result if prompt action is not taken, and it proposes that 1% of global GDP be used annually to prevent such disasters. In 2014, the global GDP was estimated to be 77.9 trillion dollars, so that the 1% investment in renewable energy recommended by Lord Stern and his research team would have amounted to nearly a trillion dollars.

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.

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%[8]. 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.

India

The MIT Technology Review recently published an important article entitled *India's Energy Crisis*[9].

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 "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

[8]https://tradingeconomics.com/china/gdp-growth-annual

[9]http://www.technologyreview.com/featuredstory/542091/indias-energy-crisis/

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, a recent heat wave killed over 1,400 people and melted asphalt streets.[10]

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?

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.

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.

[10] https://www.rt.com/news/262641-india-heat-wave-killed/

The position of the Canadian government has been strongly criticized by leading climate scientist Professor James Hansen. A recent article in *The Guardian*[11], 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,

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.

[11]https://www.theguardian.com/environment/2013/may/19/tar-sands-exploitation-climate-scientist

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[12].

Extraction of oil in Brazil

According to a recent article in *The Guardian*[13] "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?"

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.

[12]https://en.wikipedia.org/wiki/PDVSA

[13]https://www.theguardian.com/environment/ng-interactive/2015/jun/25/brazils-gamble-on-deep-water-oil-guanabara-bay

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).

5.10 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

5.11 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.[14]

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!

[14]See https://www.theguardian.com/commentisfree/2017/sep/18/enough-tiptoeing-around-lets-make-this-clear-coal-kills-people

5.12 Greta Thunberg's TED talk

While political leaders and the older generation have been slow to react to the climate crisis, young people, whose future is at stake, are wide awake and are warning the world that action must be taken immediately if disaster is to be avoided. Massive global demonstrations have been initiated by the teenage activist, Greta Thunberg, who has succeeded where others have failed by speaking with extraordinary clarity, honesty and forcefulness.

Greta 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.[15]. 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 basically means, I only speak, when I think it is necessary.

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

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 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.

5.13 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

Figure 5.2: **Greta Thunberg speaking to a meeting of the European Union.**

"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."

5.14 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[16]:

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 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.

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

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...

5.15 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.[17]:

"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 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

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

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."

5.16 The leaked 2022 IPCC report

A 4,000-page report by the International Panel on Climate Change (IPCC) was not due to be released until February, 2022, but a copy was leaked to Agence

France-Presse. The report calls for a total transformation of our way of life if we wish to avoid catastrophe. The window of opportunity is closing rapidly. Urgent action must be taken within less than a decade. The Report states that **"We need transformational change operat- ing on processes and behavior at all levels: individual, communi- ties, business, institutions and governments. We must redefine our way of life and consuntion"**

Here are some quotations from an article entitled **"Crushing climate impacts to hit sooner than feared: draft UN report"**, published by Agence France-Presse on 23/06/2021:

"Climate change will fundamentally reshape life on Earth in the coming decades, even if humans can tame planet-warming greenhouse gas emissions, according to a landmark draft report from the UN's climate science advisors obtained by AFP.

"Species extinction, more widespread disease, unliveable heat, ecosystem collapse, cities menaced by rising seas – these and other devastating climate impacts are accelerating and bound to become painfully obvious before a child born today turns 30.

"The choices societies make now will determine whether our species thrives or simply survives as the 21st century unfolds, the Intergovernmental Panel on Climate Change (IPCC) says in a draft report seen exclusively by AFP.

"But dangerous thresholds are closer than once thought, and dire consequences stemming from decades of unbridled carbon pollution are unavoidable in the short term.

" 'The worst is yet to come, affecting our children's and grandchildren's lives much more than our own,' the report says.

"By far the most comprehensive catalogue ever assembled of how climate change is upending our world, the report reads like a 4,000-page indictment of humanity's stewardship of the planet.

"But the document, designed to influence critical policy decisions, is not scheduled for release until February 2022 – too late for crunch UN summits this year on climate, biodiversity and food systems, some scientists say.

"The draft report comes at a time of global 'eco-awakening' and serves as a reality check against a slew of ill-defined net-zero promises by governments and corporations worldwide.

"The challenges it highlights are systemic, woven into the very fabric of daily life.

"They are also deeply unfair: those least responsible for global warming will suffer disproportionately, the report makes clear.

"And it shows that even as we spew record amounts of greenhouse gases into the atmosphere, we are undermining the capacity of forests and oceans to absorb them, turning our greatest natural allies in the fight against warming into enemies.

"It warns that previous major climate shocks dramatically altered the environment and wiped out most species, raising the question of whether humanity is sowing the seeds of its own demise...."

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.

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. [18]

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. [19]

History has given to our generation an enormous responsibility towards future generations. We must achieve a new kind of economy, a steady-state

[18] http://eruditio.worldacademy.org/issue-5/article/urgent-need-renewable-energy
[19] http://steadystate.org/category/herman-daly/

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

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Chapter 6

THE ECOLOGICAL IMPACT OF MILITARISM

6.1 The training of soldiers

Within individual countries, murder is rightly considered to be the worst of crimes. But the institution of war tries to convince us that if a soldier murders someone from another country, whom the politicians have designated as an "enemy", it is no longer a crime, no longer a violation of the common bonds of humanity. It is "heroic".

In their hearts, soldiers know that this is nonsense. Murder is always murder. The men, women and children who are supposed to be the "enemy", are just ordinary people, with whom the soldier really has no quarrel. Therefore when the training of soldiers wears off a little, so that they realize what they have done, they have to see themselves as murderers, and many commit suicide.

A recent article in the journal "Epidemiology" pointed out a startling statistic: for every American soldier killed in combat this year, 25 will commit suicide. The article also quotes the Department of Veterans Affairs, which says that 18 veterans commit suicide every day.

Obviously, the training of soldiers must overwrite fundamental ethical principles. This training must make a soldier abandon his or her individual conscience and sense of responsibility. It must turn the soldier from a compassionate human being into an automaton, a killing machine. How is this accomplished? Through erosion of of the soldier's self-respect. Through the endless repetition of senseless rituals where obedience is paramount and from which rational thought and conscience are banished.

In his book on fanaticism, The True Believer (1951), the American author Eric Hoffer gives the following description of the factors promoting self-

sacrifice:

"To ripen a person for self-sacrifice, he must be stripped of his individual identity. He must cease to be George, Hans, Ivan or Tado - a human atom with an existence bounded by birth and death. The most drastic way to achieve this end is by the complete assimilation of the individual into a collective body. The fully assimilated individual does not see himself and others as human beings. When asked who he is, his automatic response is that he is a German, a Russian, a Japanese, a Christian, a Muslim, a member of a certain tribe or family. He has no purpose, worth or destiny apart from his collective body, and as long as that body lives, he cannot really die. ..."

"The effacement of individual separateness must be thorough. In every act, however trivial, the individual must, by some ritual, associate himself with the congregation, the tribe, the party, etcetera. His joys and sorrows, his pride and confidence must spring from the fortunes and capacities of the group, rather than from his individual prospects or abilities. Above all, he must never feel alone. Though stranded on a desert island, he must feel that he is under the eyes of the group. To be cast out from the group must be equivalent to being cut off from life."

"This is undoubtedly a primitive state of being, and its most perfect examples are found among primitive tribes. Mass movements strive to approximate this primitive perfection, and we are not imagining things when the anti-individualist bias of contemporary mass movements strikes us as being a throwback to the primitive."

The conditioning of a soldier in a modern army follows the pattern described in Eric Hoffer's book. The soldier's training aims at abolishing his sense of individual separateness, individual responsibility, and moral judgment. It is filled with rituals, such as saluting, by which the soldier identifies with his tribe-like army group. His uniform also helps to strip him of his individual identity and to assimilate him into the group. The result of this psychological conditioning is that the soldier's mind reverts to a primitive state. He surrenders his moral responsibility, and when the politicians tell him to kill, he kills.

6.2 Killing civilians

Between 2 September and 5 September, 1807, the civilian population of Copenhagen was subjected to a bombardment by British military forces, without any declaration of war. The purpose of the bombardment was to induce terror in the population, and to thereby force the surrender of the Danish fleet, which the British feared might otherwise fall into the hands of Napoleon. It was

one of the first occasions on which civilians were deliberately targeted in this manner.

Copenhagen was almost undefended, since the Danish army was positioned at the southern boundary of the country, ready to repel a possible attack by Napoleon's army. British troops and artillery were thus easily able to surround the city, while the British fleet occupied the harbor. On the first night of the bombardment, 5000 rounds were fired into the city, on the second night 2000, and on the third night 7000. New incendiary rockets developed by William Congreve were also used. More than 2000 civilians were killed by the bombardment, and about 30 percent of Copenhagen's buildings were destroyed. The bicentenary of this barbaric event might be an appropriate time to think about state-sponsored terror, in which innocent civilians are deliberately targeted.

The erosion of ethical principles during World War II

When Hitler invaded Poland in September, 1939, US President Franklin Delano Roosevelt appealed to Great Britain, France, and Germany to spare innocent civilians from terror bombing. "The ruthless bombing from the air of civilians in unfortified centers of population during the course of the hostilities", Roosevelt said (referring to the use of air bombardment during World War I) "...has sickened the hearts of every civilized man and woman, and has profoundly shocked the conscience of humanity." He urged "every Government which may be engaged in hostilities publicly to affirm its determination that its armed forces shall in no event, and under no circumstances, undertake the bombardment from the air of civilian populations or of unfortified cities."

Two weeks later, British Prime Minister Neville Chamberlain responded to Roosevelt's appeal with the words: "Whatever the lengths to which others may go, His Majesty's Government will never resort to the deliberate attack on women and children and other civilians for purposes of mere terrorism."

Much was destroyed during World War II, and among the casualties of the war were the ethical principles that Roosevelt and Chamberlain announced at its outset. At the time of Roosevelt and Chamberlain's declarations, terror bombing of civilians had already begun in the Far East. On 22 and 23 September, 1937, Japanese bombers attacked civilian populations in Nanjing and Canton. The attacks provoked widespread protests. The British Under Secretary of State for Foreign Affairs, Lord Cranborne, wrote: "Words cannot express the feelings of profound horror with which the news of these raids has been received by the whole civilized world. They are often directed against places far from the actual area of hostilities. The military objective, where it exists, seems to take a completely second place. The main object seems to be

to inspire terror by the indiscriminate slaughter of civilians..."

On the 25th of September, 1939, Hitler's air force began a series of intense attacks on Warsaw. Civilian areas of the city, hospitals marked with the Red Cross symbol, and fleeing refugees all were targeted in a effort to force the surrender of the city through terror. On the 14th of May, 1940, Rotterdam was also devastated. Between the 7th of September 1940 and the 10th of May 1941, the German Luftwaffe carried out massive air attacks on targets in Britain. By May, 1941, 43,000 British civilians were killed and more than a million houses destroyed.

Although they were not the first to start it, by the end of the war the United States and Great Britain were bombing of civilians on a far greater scale than Japan and Germany had ever done. For example, on July 24-28, 1943, British and American bombers attacked Hamburg with an enormous incendiary raid whose official intention "the total destruction" of the city.

The result was a firestorm that did, if fact, lead to the total destruction of the city. One airman recalled, that "As far as I could see was one mass of fire. 'A sea of flame' has been the description, and that's an understatement. It was so bright that I could read the target maps and adjust the bomb-sight." Another pilot was "...amazed at the awe-inspiring sight of the target area. It seemed as though the whole of Hamburg was on fire from one end to the other and a huge column of smoke was towering well above us - and we were on 20,000 feet! It all seemed almost incredible and, when I realized that I was looking at a city with a population of two millions, or about that, it became almost frightening to think of what must be going on down there in Hamburg."

Below, in the burning city, temperatures reached 1400 degrees Fahrenheit, a temperature at which lead and aluminum have long since liquefied. Powerful winds sucked new air into the firestorm. There were reports of babies being

torn by the high winds from their mothers' arms and sucked into the flames. Of the 45,000 people killed, it has been estimated that 50 percent were women and children and many of the men killed were elderly, above military age. For weeks after the raids, survivors were plagued by "...droves of vicious rats, grown strong by feeding on the corpses that were left unburied within the rubble as well as the potatoes and other food supplies lost beneath the broken buildings."

The German cities Kassel, Pforzheim, Mainz, Dresden and Berlin were similarly destroyed, and in Japan, US bombing created firestorms in many cities, for example Tokyo, Kobe and Yokohama. In Tokyo alone, incendiary bombing caused more than 100,000 civilian casualties.

Hiroshima and Nagasaki

On August 6, 1945, at 8.15 in the morning, a nuclear fission bomb was exploded in the air over the civilian population of Hiroshima in an already virtually defeated Japan. The force of the explosion was equivalent to fifteen thousand tons of TNT. Out of a city of two hundred and fifty thousand, one hundred thousand were killed immediately, and another hundred thousand were hurt. Many of the injured died later from radiation sickness. A few days later, Nagasaki was similarly destroyed.

The tragic destruction of the two Japanese cities was horrible enough in itself, but it also marked the start of a nuclear arms race that continues to cast a very dark shadow over the future of civilization. Not long afterwards, the Soviet Union exploded its own atomic bomb, creating feelings of panic in the United States. President Truman authorized an all-out effort to build superbombs based on thermonuclear reactions, the reactions that heat the sun and stars.

In March, 1954, the US tested a thermonuclear bomb at Bikini Atoll in the Pacific Ocean. It was 1000 times more powerful than the Hiroshima bomb. The Japanese fishing boat, Lucky Dragon, was 135 kilometers from the Bikini explosion, but radioactive fallout from the explosion killed one crew member and made all the others seriously ill. The distance to the Marshall Islands was equally large, but even today, islanders continue to suffer from the effects of fallout from the test, for example frequent birth defects.

Driven by the paranoia of the Cold War, the number of nuclear weapons on both sides reached truly insane heights. At the worst point, there were 50,000 nuclear weapons in the world, with a total explosive power roughly a million times the power of the Hiroshima bomb. This was equivalent to 4 tons of TNT for every person on the planet - enough to destroy human civilization


GROUND ZERO
12
20

many times over - enough to threaten the existence of all life on earth.

At the end of the Cold War, most people heaved a sigh of relief and pushed the problem of nuclear weapons away from their minds. It was a threat to life too horrible to think about. People felt that they could do nothing in any case, and they hoped that the problem had finally disappeared.

Today, however, many thoughtful people realize that the problem of nuclear weapons has by no means disappeared, and in some ways it is even more serious now than it was during the Cold War. There are still over 15,000 nuclear weapons in the world, many of them hydrogen bombs, many on hair-trigger alert, ready to be fired with only a few minutes warning. The world has frequently come extremely close to accidental nuclear war. If nuclear weapons are allowed to exist for a long period of time, the probability for such a catastrophic accident to happen will grow into a certainty.

Current dangers also come from proliferation. Recently, more and more nations have come to possess nuclear weapons, and thus the danger that they will be used increases. For example, if Pakistan's less-than-stable government should fall, its nuclear weapons might find their way into the hands of terrorists, and against terrorism deterrence has no effect.

Thus we live at a special time in history - a time of crisis for civilization. We did not ask to be born at a moment of crisis, but such is our fate. Every person now alive has a special responsibility: We owe it, both to our ancestors and to future generations, to build a stable and cooperative future world. It must be a war-free world, from which nuclear weapons have been completely abolished. No person can achieve these changes alone, but together we can build the world that we desire. This will not happen through inaction, but it can happen through the dedicated work of large numbers of citizens.

Civilians have for too long played the role of passive targets, hostages in the power struggles of politicians. It is time for civil society to make its will felt. If our leaders continue to enthusiastically support the institution of war, if they will not abolish nuclear weapons, then let us have new leaders.

6.3 The direct and indirect costs of war

The costs of war, both direct and indirect, are so enormous that they are almost beyond comprehension. We face a direct threat because a thermonuclear war may destroy human civilization and much of the biosphere, and an indirect threat because the institution of war interferes seriously with the use of tax money for constructive and peaceful purposes.

Today, despite the end of the Cold War, the world spends roughly 2 trillion (i.e. 2 million million) US dollars each year on armaments. This colossal flood

of money could have been used instead for education, famine relief, development of infrastructure, or on urgently needed public health measures.

The World Health Organization lacks funds to carry through an antimalarial program on as large a scale as would be desirable, but the entire program could be financed for less than our military establishments spend in a single day. Five hours of world arms spending is equivalent to the total cost of the 20-year WHO campaign that resulted in the eradication of smallpox. For every 100,000 people in the world, there are 556 soldiers, but only 85 doctors. Every soldier costs an average of $20,000 per year, while the average spent on education is only $380 per school-aged child. With a diversion of funds consumed by three weeks of military spending, the world could create a sanitary water supply for all its people, thus eliminating the cause of almost half of all human illness.

A new drug-resistant form of tuberculosis has recently become widespread in Asia and in the former Soviet Union. In order to combat this new and highly dangerous form of tuberculosis and to prevent its spread, WHO needs $500 million, an amount equivalent to 1.2 hours of world arms spending.

Today's world is one in which roughly ten million children die every year from starvation or from diseases related to poverty. Besides this enormous waste of young lives through malnutrition and preventable disease, there is a huge waste of opportunities through inadequate education. The rate of illiteracy in the 25 least developed countries is 80%, and the total number of illiterates in the world is estimated to be 800 million. Meanwhile every 60 seconds the world spends $6.5 million on armaments.

It is plain that if the almost unbelievable sums now wasted on the institution of war were used constructively, most of the pressing problems of humanity could be solved, but today the world spends more than 20 times as much on war as it does on development.

6.4 Medical and psychological consequences; loss of life

While in earlier epochs it may have been possible to confine the effects of war mainly to combatants, in the 20th century the victims of war were increasingly civilians, and especially children. For example, according to Quincy Wright's statistics, the First and Second World Wars cost the lives of 26 million soldiers, but the toll in civilian lives was much larger: 64 million.

Since the Second World War, despite the best efforts of the UN, there have been over 150 armed conflicts; and, if civil wars are included, there are on any given day an average of 12 wars somewhere in the world. In the conflicts

in Indo-China, the proportion of civilian victims was between 80% and 90%, while in the Lebanese civil war some sources state that the proportion of civilian casualties was as high as 97%.

Civilian casualties often occur through malnutrition and through diseases that would be preventable in normal circumstances. Because of the social disruption caused by war, normal supplies of food, safe water and medicine are interrupted, so that populations become vulnerable to famine and epidemics.[1]

6.5 Effects of war on children

According to UNICEF figures, 90% of the casualties of recent wars have been civilians, and 50% children. The organization estimates that in recent years, violent conflicts have driven 20 million children from their homes. They have become refugees or internally displaced persons within their own countries.

During the last decade 2 million children have been killed and 6 million seriously injured or permanently disabled as the result of armed conflicts, while 1 million children have been orphaned or separated from their families. Of the ten countries with the highest rates of death of children under five years of age, seven are affected by armed conflicts. UNICEF estimates that 300,000 child soldiers are currently forced to fight in 30 armed conflicts throughout the world. Many of these have been forcibly recruited or abducted.

Even when they are not killed or wounded by conflicts, children often experience painful psychological traumas: the violent death of parents or close relatives, separation from their families, seeing family members tortured, displacement from home, disruption of ordinary life, exposure to shelling and other forms of combat, starvation and anxiety about the future.[2]

6.6 Refugees

Human Rights Watch estimates that in 2001 there were 15 million refugees in the world, forced from their countries by war, civil and political conflict, or by gross violations of human rights. In addition, there were an estimated 22 million internally displaced persons, violently forced from their homes but still within the borders of their countries.

In 2001, 78% of all refugees came from ten areas: Afghanistan, Angola, Burma, Burundi, Congo-Kinshasa, Eritrea, Iraq, the Palestinian territories, Somalia and Sudan. A quarter of all refugees are Palestinians, who make up

[1] http://www.cadmusjournal.org/article/volume-2/issue-2-part-3/lessons-world-war-i http://www.truth-out.org/opinion/item/27201-the-leading-terrorist-state

[2] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2080482/

the world's oldest and largest refugee population. 45% of the world's refugees have found sanctuaries in Asia, 30% in Africa, 19% in Europe and 5% in North America.

Refugees who have crossed an international border are in principle protected by Article 14 of the Universal Declaration of Human Rights, which affirms their right "to seek and to enjoy in other countries asylum from persecution". In 1950 the Office of the High Commissioner for Refugees was created to implement Article 14, and in 1951 the Convention Relating to the Status of Refugees was adopted by the UN. By 2002 this legally binding treaty had been signed by 140 nations. However the industrialized countries have recently adopted a very hostile and restrictive attitude towards refugees, subjecting them to arbitrary arrests, denial of social and economic rights, and even forcible return to countries in which they face persecution.

The status of internally displaced persons is even worse than that of refugees who have crossed international borders. In many cases the international community simply ignores their suffering, reluctant to interfere in the internal affairs of sovereign states. In fact, the United Nations Charter is self-contradictory in this respect, since on the one hand it calls for non-interference in the internal affairs of sovereign states, but on the other hand, people everywhere are guaranteed freedom from persecution by the Charter's Universal Declaration of Human Rights.[3]

6.7 Damage to infrastructure

Most insurance policies have clauses written in fine print exempting companies from payment of damage caused by war. The reason for this is simple. The damage caused by war is so enormous that insurance companies could never come near to paying for it without going bankrupt.

We mentioned above that the world spends 2 trillion dollars each year on preparations for war. A similarly colossal amount is needed to repair the damage to infrastructure caused by war. Sometimes this damage is unintended, but sometimes it is intentional.

During World War II, one of the main aims of air attacks by both sides was to destroy the industrial infrastructure of the opponent. This made some sense in a war expected to last several years, because the aim was to prevent the enemy from producing more munitions. However, during the Gulf War of 1990, the infrastructure of Iraq was attacked, even though the war was expected to be short. Electrical generating plants and water purification facilities were

[3]https://www.hrw.org/topic/refugees

deliberately destroyed with the apparent aim of obtaining leverage over Iraq after the war.

In general, because war has such a catastrophic effect on infrastructure, it can be thought of as the opposite of development. War is the greatest generator of poverty.[4]

6.8 Ecological damage

Warfare during the 20th century has not only caused the loss of 175 million lives (primarily civilians) - it has also caused the greatest ecological catastrophes in human history. The damage takes place even in times of peace. Studies by Joni Seager, a geographer at the University of Vermont, conclude that "a military presence anywhere in the world is the single most reliable predictor of ecological damage".

Modern warfare destroys environments to such a degree that it has been described as an "environmental holocaust." For example, herbicides use in the Vietnam War killed an estimated 6.2 billion board-feet of hardwood trees in the forests north and west of Saigon, according to the American Association for the Advancement of Science. Herbicides such as Agent Orange also made enormous areas of previously fertile land unsuitable for agriculture for many years to come. In Vietnam and elsewhere in the world, valuable agricultural land has also been lost because land mines or the remains of cluster bombs make it too dangerous for farming.

During the Gulf War of 1990, the oil spills amounted to 150 million barrels, 650 times the amount released into the environment by the notorious Exxon Valdez disaster. During the Gulf War an enormous number of shells made of depleted uranium were fired. When the dust produced by exploded shells is inhaled it often produces cancer, and it will remain in the environment of Iraq for decades.

Radioactive fallout from nuclear tests pollutes the global environment and causes many thousands of cases of cancer, as well as birth abnormalities. Most nuclear tests have been carried out on lands belonging to indigenous peoples. Agent Orange also produced cancer, birth abnormalities and other serious forms of illness both in the Vietnamese population and among the foreign soldiers fighting in Vietnam[5]

[4]https://www.wsws.org/en/articles/2002/11/iraq-n04.html
http://www.globalresearch.ca/crimes-against-humanity-the-destruction-of-iraqs-electricity-infrastructure-the-social-economic-and-environmental-impacts/5355665
http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/00157630-EN-ERP-48.PDF

[5]http://www.dailymail.co.uk/news/article-2401378/Agent-Orange-Vietnamese-children-

6.9 Links between poverty and war

There are several relationships between intolerable economic inequality and war. Today 2.7 billion people live on less than 2 dollars a day - 1.1 billion on less than 1 dollar per day. 18 million of our fellow humans die each year from poverty-related causes. In 2006, 1.1 billion people lacked safe drinking water, and waterborne diseases killed an estimated 1.8 million people. The developing countries are also the scene of a resurgence of other infectious diseases, such as malaria, drug-resistant tuberculosis and HIV/AIDS.

Meanwhile, in 2011, world military budgets reached 1,700,000,000,000 dollars (i.e. 1.7 million million dollars). This amount of money is almost too large to be imagined. The fact that it is being spent means that many people are making a living from the institution of war. Wealthy and powerful lobbies from the military-industrial complex are able to influence mass media and governments. Thus the institution of war persists, although we know very well that it is a threat to civilization and that it responsible for much of the suffering that humans experience.

Today's military spending of roughly two trillion US dollars per year would be more than enough to finance safe drinking water for the entire world, and to bring primary health care and family planning advice to all. If used constructively, the money now wasted (or worse than wasted) on the institution of war could also help the world to make the transition from fossil fuel use to renewable energy systems.

Military might is used by powerful industrialized nations to maintain economic hegemony over less developed countries. This is true today, even though the colonial era is supposed to be over (as has been amply documented by Professor Michael Klare in his books on "Resource Wars").

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.

Another important poverty-generating factor in the developing countries

suffering-effects-herbicide-sprayed-US-Army-40-years-ago.html

is war - often civil war. The five permanent members of the U.N. Security Council are, ironically, the five largest exporters of small arms. Small arms have a long life. The weapons poured into Africa by both sides during the Cold War are still there, and they contribute to political chaos and civil wars that block development and cause enormous human suffering.

The United Nations website on Peace and Security through Disarmament states that "Small arms and light weapons destabilize regions; spark, fuel and prolong conflicts; obstruct relief programmes; undermine peace initiatives; exacerbate human rights abuses; hamper development; and foster a 'culture of violence'."

An estimated 639 million small arms and light weapons are in circulation worldwide, one for every ten people. Approximately 300,000 people are killed every year by these weapons, many of them women and children.

There is also another, less obvious, link between intolerable economic inequality and war: Abolition of the institution of war will require the replacement of "might makes right" by the rule international law. It will require development of effective global governance. But reform and strengthening of the United Nations is blocked by wealthy countries because they are afraid of loosing their privileged positions. If global economic inequality were less enormous, the problem of unifying the world would be simplified.

Let us work to break the links between poverty and war! To do that, we must work for laws that will restrict the international sale of small arms; we must work for a fair relationship between developing countries and multinational corporations; and above all, we must question the need for colossal military budgets. By following this path we can free the world from the intolerable suffering caused by poverty and from the equally intolerable suffering caused by war.

6.10 McNamara's Evil Lives On

Here are some quotations from an article by Robert Sheer entitled *McNamara's Evil Lives On*, published in The Nation on July 8, 2008.[6]

Why not speak ill of the dead?

Robert McNamara, who died this week, was a complex man - charming even, in a blustery way, and someone I found quite thoughtful when I interviewed him. In the third act of his life he was often an advocate for enlightened positions on world poverty and the dangers of the nuclear arms race. But whatever his better

[6]https://www.thenation.com/article/archive/mcnamaras-evil-lives/

nature, it was the stark evil he perpetrated as secretary of defense that must indelibly frame our memory of him.

To not speak out fully because of respect for the deceased would be to mock the memory of the millions of innocent people McNamara caused to be maimed and killed in a war that he later freely admitted never made any sense. Much has been made of the fact that he recanted his support for the war, but that came 20 years after the holocaust he visited upon Vietnam was over.

Is holocaust too emotionally charged a word? How many millions of dead innocent civilians does it take to qualify labels like holocaust, genocide or terrorism? How many of the limbless victims of his fragmentation bombs and land mines whom I saw in Vietnam during and after the war? Or are America's leaders always to be exempted from such questions? Perhaps if McNamara had been held legally accountable for his actions, the architects of the Iraq debacle might have paused.

Instead, McNamara was honored with the Medal of Freedom by President Lyndon Johnson, to whom he had written a private memo nine months earlier offering this assessment of their Vietnam carnage: 'The picture of the world's greatest superpower killing or seriously injuring 1,000 noncombatants a week, while trying to pound a tiny backward nation into submission on an issue whose merits are hotly disputed, is not a pretty one.'

He knew it then, and, give him this, the dimensions of that horror never left him. When I interviewed him for the Los Angeles Times in 1995, after the publication of his confessional memoir, his assessment of the madness he had unleashed was all too clear:

'Look, we dropped three to four times the tonnage on that tiny little area as were dropped by the Allies in all of the theaters in World War II over a period of five years. It was unbelievable. We killed - there were killed - 3,200,000 Vietnamese, excluding the South Vietnamese military. My God! The killing, the tonnage - it was fantastic. The problem was that we were trying to do something that was militarily impossible - we were trying to break the will; I don't think we can break the will by bombing short of genocide.'

We - no, he - couldn't break their will because their fight was for national independence. They had defeated the French and would defeat the Americans who took over when French colonialists gave up the ghost. The war was a lie from the first. It never had anything to do with the freedom of the Vietnamese (we installed one tyrant after another in power), but instead had to do with our irrational

cold war obsession with 'international communism.' Irrational, as President Richard Nixon acknowledged when he embraced detente with the Soviet communists, toasted China's fierce communist Mao Tse-tung and then escalated the war against 'communist' Vietnam and neutral Cambodia.

It was always a lie and our leaders knew it, but that did not give them pause. Both Johnson and Nixon make it quite clear on their White House tapes that the mindless killing, McNamara's infamous body count, was about domestic politics and never security.

The lies are clearly revealed in the Pentagon Papers study that McNamara commissioned, but they were made public only through the bravery of Daniel Ellsberg. Yet when Ellsberg, a former Marine who had worked for McNamara in the Pentagon, was in the docket facing the full wrath of Nixon's Justice Department, McNamara would lift not a finger in his defense. Worse, as Ellsberg reminded me this week, McNamara threatened that if subpoenaed to testify at the trial by Ellsberg's defense team, 'I would hurt your client badly.'

Not as badly as those he killed or severely wounded. Not as badly as the almost 59,000 American soldiers killed and the many more horribly hurt. One of them was the writer and activist Ron Kovic, who as a kid from Long Island was seduced by McNamara's lies into volunteering for two tours in Vietnam. Eventually, struggling with his mostly paralyzed body, he spoke out against the war in the hope that others would not have to suffer as he did (and still does). Meanwhile, McNamara maintained his golden silence, even as Richard Nixon managed to kill and maim millions more. What McNamara did was evil - deeply so.

6.11 The Pentagon Papers

Wikipedia states that:

The Pentagon Papers, officially titled *Report of the Office of the Secretary of Defense Vietnam Task Force*, is a United States Department of Defense history of the United States' political and military involvement in Vietnam from 1945 to 1967. The papers were released by Daniel Ellsberg, who had worked on the study; they were first brought to the attention of the public on the front page of The New York Times in 1971.A 1996 article in The New

York Times said that the Pentagon Papers had demonstrated, among other things, that the Johnson Administration 'systematically lied, not only to the public but also to Congress.'

More specifically, the papers revealed that the U.S. had secretly enlarged the scope of its actions in the Vietnam War with the bombings of nearby Cambodia and Laos, coastal raids on North Vietnam, as well as Marine Corps attacks, none of which were reported in the mainstream media. For his disclosure of the Pentagon Papers, Ellsberg was initially charged with conspiracy, espionage, and theft of government property, but the charges were later dismissed after prosecutors investigating the Watergate scandal discovered that the staff members in the Nixon White House had ordered the so-called White House Plumbers to engage in unlawful efforts to discredit Ellsberg...

To ensure the possibility of public debate about the papers' content, on June 29, US Senator Mike Gravel, an Alaska Democrat, entered 4,100 pages of the papers into the record of his Subcommittee on Public Buildings and Grounds. These portions of the papers, which were edited for Gravel by Howard Zinn and Noam Chomsky, were subsequently published by Beacon Press, the publishing arm of the Unitarian Universalist Association of Congregations. A federal grand jury was subsequently empaneled to investigate possible violations of federal law in the release of the report. Leonard Rodberg, a Gravel aide, was subpoenaed to testify about his role in obtaining and arranging for publication of the Pentagon Papers. Gravel asked the court (in Gravel v. United States) to quash the subpoena on the basis of the Speech or Debate Clause in Article I, Section 6 of the United States Constitution.

Daniel Ellesberg believed that when U.S. citizens discovered that the Vietnam War was based on lies, the war would end. However, it continued for many more years.

Figure 6.1: **Victems of the Mai Lai Massacre.**

Figure 6.2: **Napalm burn victims during the war being treated at the 67th Combat Support Hospital. 1967-1968 Innocent children become burn victims in the Vietnam War.**

Figure 6.3: **Frightened children flee from an air attack in Vietnam.**

6.12 Effects of Agent Orange

Wikipedia states that:

"Up to four million people in Vietnam were exposed to the defoliant. The government of Vietnam says as many as three million people have suffered illness because of Agent Orange,[4] and the Red Cross of Vietnam estimates that up to one million people are disabled or have health problems as a result of Agent Orange contamination.The United States government has described these figures as unreliable, while documenting higher cases of leukemia, Hodgkin's lymphoma, and various kinds of cancer in exposed US military veterans. An epidemiological study done by the Centers for Disease Control and Prevention showed that there was an increase in the rate of birth defects of the children of military personnel as a result of Agent Orange. Agent Orange has also caused enormous environmental damage in Vietnam. Over 3,100,000 hectares (31,000 km2 or 11,969 mi2) of forest were defoliated. Defoliants eroded tree cover and seedling forest stock, making reforestation difficult in numerous areas. Animal species diversity sharply reduced in contrast with unsprayed areas."

Figure 6.4: **Nguyen Xuan Minh lies in a crib at the Tu Du Hospital May 2, 2005 in Ho Chi Minh City, Vietnam.**

Figure 6.5: **A disabled and malformed victim of foliant Agent Orange, begs on the streets of Saigon to make a living, 1996.**

6.13 Bombing of Cambodia and Laos

According to an article by Jessica Pearce Rotondi entitled *Why Laos Has Been Bombed More Than Any Other Country*[7],

"The U.S. bombing of Laos (1964-1973) was part of a covert attempt by the CIA to wrest power from the communist Pathet Lao, a group allied with North Vietnam and the Soviet Union during the Vietnam War.

"The officially neutral country became a battleground in the Cold War between the United States and Soviet Union, with American bombers dropping over two million tons of cluster bombs over Laos - more than all the bombs dropped during WWII combined. Today, Laos is the most heavily bombed nation in history. Here are facts about the so-called secret war in Laos.

"Laos is a landlocked country bordered by China and Myanmar to the North, Vietnam to the East, Cambodia to the South and Thailand and the Mekong River to the West.

"Its proximity to Mao Zedong's China made it critical to Dwight D. Eisenhower's Domino Theory of keeping communism at bay. 'If Laos were lost, the rest of Southeast Asia would follow,' Eisenhower told his National Security Council. On the day of his farewell address in 1961, President Eisenhower approved the CIA's training of anti-communist forces in the mountains of Laos. Their mission: To disrupt communist supply routes across the Ho Chi Minh Trail to Vietnam.

"Eisenhower's successors in the White House: John F. Kennedy, Lyndon B. Johnson and Richard Nixon, all approved escalating air support for the guerrilla fighters, but not publicly. The 1962 International Agreement on the Neutrality of Laos, signed by China, the Soviet Union, Vietnam, the United States and 10 other countries, forbid signees from directly invading Laos or establishing military bases there. The secret war in Laos had begun...

"In Laos, the legacy of U.S. bombs continues to wreak havoc. Since 1964, more than 50,000 Lao have been killed or injured by U.S. bombs, 98 percent of them civilians. An estimated 30 percent of the bombs dropped on Laos failed to explode upon impact, and in the years since the bombing ended, 20,000 people have been killed or maimed by the estimated 80 million bombs left behind."

[7] https://www.history.com/news/laos-most-bombed-country-vietnam-war

By 1975, one tenth of the population of Laos had been killed by the bombs, and a quarter of the population were refugees.

Cambodia

Here are some quotations from an article by Maximillian Wechsler entitled *America's 'Secret War' and the Bombing of Southeast Asia*[8]:

"On March 18, 1969, USAF Strategic Air Command (SAC) B-52 bombers began carpet bombing Cambodia on the order of President Nixon. The overall covert operation was code-named 'Operation Menu', with various phases named 'Breakfast', 'Lunch', 'Dinner', 'Snack', 'Supper' and 'Dessert'.

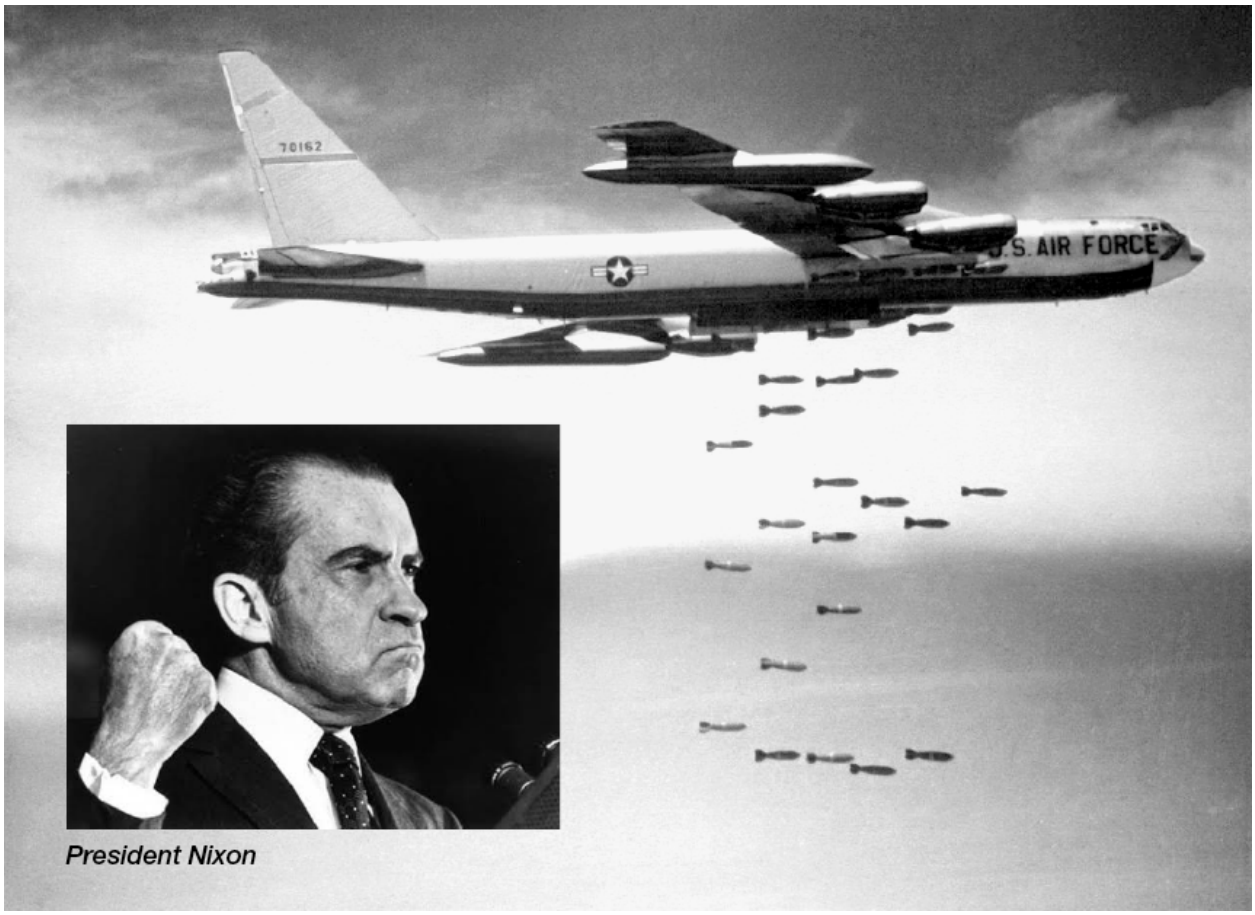
"President Nixon ordered the campaign without consulting Congress and even kept it secret from top military officials. Five members of Congress were informed several months after the start of Operation Menu, but it was kept secret from the American people until The New York Times broke the story in May 1969. Henry Kissinger, President Nixon's National Security Adviser, was reportedly outraged over the leaked information in the story and ordered the FBI to wiretap the phones of top White House aides and reporters to find the source.

"More reports of the secret bombing campaign surfaced in the press and records of Congressional proceedings, but it was not until 2000 that official the USAF records of US bombing activity over Indochina from 1964 to 1973 were declassified by President Bill Clinton.

"Some sources say that during the first phase of the bombings lasting until April 1970, 'Operation Breakfast', the SAC conducted 3,630 sorties and dropped 110,000 tons of bombs and that in the entire four-year campaign the US dropped about 540,000 tons of bombs. In the book Bombs Over Cambodia, historians Ben Kiernan and Taylor Owen state that, based on their analysis of the declassified documents, 2,756,941 tons of ordnance was dropped during Operation Menu, more than the US dropped on Japan during World War II.

"The authors also say that US planes flew 230,516 sorties over 113,716 sites. Estimates of casualties vary widely as well, but it is believed that somewhere between 100,000 and 600,000 civilians died

[8]https://www.thebigchilli.com/feature-stories/americas-secret-war-and-the-bombing-of-southeast-asia



in the bombing and two million became homeless. Some sources say that hundreds of thousands more Cambodians died from the effects of displacement, illness or starvation as a direct result of the bombings.

"The carpet bombing of Cambodia lasted until August 1973. It devastated the countryside and the chaos and upheaval it unleashed played a big part in the installation of the genocidal Khmer Rouge regime led by Pol Pot. The Khmer Rouge was responsible for the deaths of up to two million Cambodians through executions, forced labour and starvation."

6.14 The threat of nuclear war

As bad as conventional arms and conventional weapons may be, it is the possibility of a catastrophic nuclear war that poses the greatest threat to humanity. There are today roughly 16,000 nuclear warheads in the world. The total explosive power of the warheads that exist or that could be made on short notice is approximately equal to 500,000 Hiroshima bombs.

To multiply the tragedy of Hiroshima by a factor of half a million makes an enormous difference, not only quantitatively, but also qualitatively. Those who have studied the question believe that a nuclear catastrophe today would inflict irreversible damage on our civilization, genetic pool and environment.

Thermonuclear weapons consist of an inner core where the fission of uranium-235 or plutonium takes place. The fission reaction in the core is able to start a fusion reaction in the next layer, which contains isotopes of hydrogen. It is possible to add a casing of ordinary uranium outside the hydrogen layer, and under the extreme conditions produced by the fusion reaction, this ordinary uranium can undergo fission. In this way, a fission-fusion-fission bomb of almost limitless power can be produced.

For a victim of severe radiation exposure, the symptoms during the first week are nausea, vomiting, fever, apathy, delirium, diarrhoea, oropharyngeal lesions and leukopenia. Death occurs during the first or second week.

We can perhaps be helped to imagine what a nuclear catastrophe means in human terms by reading the words of a young university professor, who was 2,500 meters from the hypocenter at the time of the bombing of Hiroshima: "Everything I saw made a deep impression: a park nearby covered with dead bodies... very badly injured people evacuated in my direction... Perhaps most impressive were girls, very young girls, not only with their clothes torn off, but their skin peeled off as well. ... My immediate thought was that this was

like the hell I had always read about. ... I had never seen anything which resembled it before, but I thought that should there be a hell, this was it."

One argument that has been used in favor of nuclear weapons is that no sane political leader would employ them. However, the concept of deterrence ignores the possibility of war by accident or miscalculation, a danger that has been increased by nuclear proliferation and by the use of computers with very quick reaction times to control weapons systems.

Recent nuclear power plant accidents remind us that accidents frequently happen through human and technical failure, even for systems which are considered to be very "safe." We must also remember the time scale of the problem. To assure the future of humanity, nuclear catastrophe must be avoided year after year and decade after decade. In the long run, the safety of civilization cannot be achieved except by the abolition of nuclear weapons, and ultimately the abolition of the institution of war.

In 1985, International Physicians for the Prevention of Nuclear War received the Nobel Peace Prize. IPPNW had been founded in 1980 by six physicians, three from the Soviet Union and three from the United States. Today, the organization has wide membership among the world's physicians. Professor Bernard Lowen of the Harvard School of Public Health, one of the founders of IPPNW, said in a recent speech:

"...No public health hazard ever faced by humankind equals the threat of nuclear war. Never before has man possessed the destructive resources to make this planet uninhabitable... Modern medicine has nothing to offer, not even a token benefit, in the event of nuclear war..."

"We are but transient passengers on this planet Earth. It does not belong to us. We are not free to doom generations yet unborn. We are not at liberty to erase humanity's past or dim its future. Social systems do not endure for eternity. Only life can lay claim to uninterrupted continuity. This continuity is sacred."

The danger of a catastrophic nuclear war casts a dark shadow over the future of our species. It also casts a very black shadow over the future of the global environment. The environmental consequences of a massive exchange of nuclear weapons have been treated in a number of studies by meteorologists and other experts from both East and West. They predict that a large-scale use of nuclear weapons would result in fire storms with very high winds and high temperatures, which would burn a large proportion of the wild land fuels in the affected nations. The resulting smoke and dust would block out sunlight for a period of many months, at first only in the northern hemisphere but later also in the southern hemisphere.

Temperatures in many places would fall far below freezing, and much of the earth's plant life would be killed. Animals and humans would then die

of starvation. The nuclear winter effect was first discovered as a result of the Mariner 9 spacecraft exploration of Mars in 1971. The spacecraft arrived in the middle of an enormous dust-storm on Mars, and measured a large temperature drop at the surface of the planet, accompanied by a heating of the upper atmosphere. These measurements allowed scientists to check their theoretical models for predicting the effect of dust and other pollutants distributed in planetary atmospheres.

Using experience gained from the studies of Mars, R.P. Turco, O.B. Toon, T. Ackerman, J.B. Pollack and C. Sagan made a computer study of the climatic effects of the smoke and dust that would result from a large-scale nuclear war. This early research project is sometimes called the TTAPS Study, after the initials of the authors.

In April 1983, a special meeting was held in Cambridge, Massachusetts, where the results of the TTAPS Study and other independent studies of the nuclear winter effect were discussed by more than 100 experts. Their conclusions were presented at a forum in Washington, D.C., the following December, under the chairmanship of U.S. Senators Kennedy and Hatfield. The numerous independent studies of the nuclear winter effect all agreed of the following main predictions:

High-yield nuclear weapons exploded near the earth's surface would put large amounts of dust into the upper atmosphere. Nuclear weapons exploded over cities, forests, oilfields and refineries would produce fire storms of the type experienced in Dresden and Hamburg after incendiary bombings during the Second World War. The combination of high-altitude dust and lower altitude soot would prevent sunlight from reaching the earth's surface, and the degree of obscuration would be extremely high for a wide range of scenarios.

A baseline scenario used by the TTAPS study assumes a 5,000-megaton nuclear exchange, but the threshold for triggering the nuclear winter effect is believed to be much lower than that. After such an exchange, the screening effect of pollutants in the atmosphere might be so great that, in the northern and middle latitudes, the sunlight reaching the earth would be only 1% of ordinary sunlight on a clear day, and this effect would persist for many months. As a result, the upper layers in the atmosphere might rise in temperature by as much as 100 °C, while the surface temperatures would fall, perhaps by as much a 50 °C.

The temperature inversion produced in this way would lead to superstability, a condition in which the normal mixing of atmospheric layers is suppressed. The hydrological cycle (which normally takes moist air from the oceans to a higher and cooler level, where the moisture condenses as rain) would be strongly suppressed. Severe droughts would thus take place over continental land masses. The normal cleansing action of rain would be absent in the

atmosphere, an effect which would prolong the nuclear winter.

In the northern hemisphere, forests would die because of lack of sunlight, extreme cold, and drought. Although the temperature drop in the southern hemisphere would be less severe, it might still be sufficient to kill a large portion of the tropical forests, which normally help to renew the earth's oxygen.

The oxygen content of the atmosphere would then fall dangerously, while the concentration of carbon dioxide and oxides of nitrogen produced by firestorms would remain high. The oxides of nitrogen would ultimately diffuse to the upper atmosphere, where they would destroy the ozone layer.

Thus, even when the sunlight returned after an absence of many months, it would be sunlight containing a large proportion of the ultraviolet frequencies which are normally absorbed by the ozone in the stratosphere, and therefore a type of light dangerous to life. Finally, after being so severely disturbed, there is no guarantee that the global climate would return to its normal equilibrium.

Even a nuclear war below the threshold of nuclear winter might have climatic effects very damaging to human life. Professor Paul Ehrlich, of Stanford University, has expressed this in the following words:

"...A smaller war, which set off fewer fires and put less dust into the atmosphere, could easily depress temperatures enough to essentially cancel grain production in the northern hemisphere. That in itself would be the greatest catastrophe ever delivered upon Homo Sapiens, just that one thing, not worrying about prompt effects. Thus even below the threshold, one cannot think of survival of a nuclear war as just being able to stand up after the bomb has gone off."[9]

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[9]http://www.voanews.com/content/pope-francis-calls-for-nuclear-weapons-ban/2909357.html
http://www.cadmusjournal.org/article/issue-4/flaws-concept-nuclear-deterrance
http://www.countercurrents.org/avery300713.htm
https://www.wagingpeace.org/author/john-avery/
http://www.commondreams.org/news/2015/08/06/70-years-after-bombing-hiroshima-calls-abolish-nuclear-weapons
http://www.informationclearinghouse.info/article42488.htm
http://www.informationclearinghouse.info/article42492.htm
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http://human-wrongs-watch.net/2015/05/24/the-path-to-zero-dialogues-on-nuclear-dangers-by-richard-falk-and-david-krieger/
http://human-wrongs-watch.net/2015/03/30/europe-must-not-be-forced-into-a-nuclear-war-with-russia/
http://www.truth-out.org/opinion/item/32073-the-us-should-eliminate-its-nuclear-arsenal-not-modernize-it

Figure 6.6: **U.N. Secretary General Antonio Guterres addressed the Human Rights Council at the United Nations in Geneva, Switzerland February 26, 2018.**

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Speaking to the Conference on Disarmament at the U.N. complex in Geneva, Guterres said many states still wrongly thought that nuclear weapons made the world safer.

"There is great and justified anxiety around the world about the threat of nuclear war," he said.

"Countries persist in clinging to the fallacious idea that nuclear arms make the world safer ... At the global level, we must work towards forging a new momentum on eliminating nuclear weapons."

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http://www.cadmusjournal.org/article/issue-4/flaws-concept-nuclear-deterrance
http://www.cadmusjournal.org/article/issue-6/arms-trade-treaty-opens-new-possibilities-u
http://eruditio.worldacademy.org/issue-6/article/remember-your-humanity
http://www.informationclearinghouse.info/article42568.htm
https://firstlook.org/theintercept/2014/09/23/nobel-peace-prize-fact-day-syria-7th-country-bombed-obama/
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http://www.informationclearinghouse.info/article42580.htm
http://human-wrongs-watch.net/2015/08/06/us-unleashing-of-atomic-weapons-against-civilian-populations-was-a-criminal-act-of-the-first-order/
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http://human-wrongs-watch.net/2015/08/04/atomic-bombing-hear-the-story-setsuko-thurlow/
http://human-wrongs-watch.net/2015/08/04/atomic-bombing-hear-the-story-yasuaki-yamashita/
http://human-wrongs-watch.net/2015/08/03/why-nuclear-weapons/

Two World War I poems by Wilfred Owen

Wilfred Owen and his mentor, Siegfried Sassoon were two poets who eloquently described the horrors of World War I. They met in a military hospital, after both had been wounded in the war. Owen had been writing poetry since the age of 11, but not about war. When he became friends with Sassoon during their hospital stay, Owen was inspired by Sassoon's example and realized that the horrors of trenches and gas warfare deserved to be described realistically in poetry. Against the strong advice of Sassoon, Owen insisted on returning to active duty in France, where he wrote the eloquent and bitter war poems for which he is remembered.

Owen was killed in action exactly one week before the end of the war. His mother received the telegram informing her of his death on Armistice Day, as the church bells were ringing out in celebration. Here are two of Owen's poems:

Dulce et decorum Est

Bent double, like old beggars under sacks,
Knock-kneed, coughing like hags, we cursed through sludge,
Till on the haunting flares we turned out backs,
And towards our distant rest began to trudge.
Men marched asleep. Many had lost their boots,
But limped on, blood-shod. All went lame, all blind;
Drunk with fatigue; deaf even to the hoots
Of gas-shells dropping softly behind.

Gas! GAS! Quick, boys! - An ecstasy of fumbling
Fitting the clumsy helmets just in time,
But someone still was yelling out and stumbling
And flound'ring like a man in fire or lime.
Dim through the misty panes and thick green light,
As under a green sea, I saw him drowning.
In all my dreams before my helpless sight
He plunges at me, guttering, choking, drowning.

If in some smothering dreams, you too could pace
Behind the wagon that we flung him in,
And watch the white eyes writhing in his face,
His hanging face, like a devil's sick of sin,
If you could hear, at every jolt, the blood
Come gargling from the froth-corrupted lungs

Obscene as cancer, bitter as the cud
Of vile, incurable sores on innocent tongues,
My friend, you would not tell with such high zest
To children ardent for some desperate glory,
The old Lie: Dulce et decorum est
Pro patria mori.

The parable of the old man and the young

So Abram rose, and clave the wood, and went,
And took the fire with him, and a knife.
And as they sojourned both of them together,
Isaac the first-born spake and said, My Father,
Behold the preparations, fire and iron,
But where the lamb for this burnt-offering?
Then Abram bound the youth with belts and straps,
and builded parapets and trenches there,
And stretchèd forth the knife to slay his son.
When lo! an angel called him out of heaven,
Saying, Lay not thy hand upon the lad,
Neither do anything to him. Behold,
A ram, caught in a thicket by its horns;
Offer the Ram of Pride instead of him.

But the old man would not so, but slew his son,
And half the seed of Europe, one by one.

We condemn human sacrifice in primitive cultures, but does not our modern industrial society also practice this abominable custom? We sacrifice countless young men and women in endless and unnecessary wars.

The planned attack on Iran

Do Benjamin Netanyahu and Ehud Barak, who are contemplating starting what might develop into World War III, have any imaginative concept of what it would be like? Netanyahu has told the Israeli people that only 500 of their citizens would be killed, and that the conflict would be over in a month. One is reminded of the Austrian leaders in 1914, who started a what they thought would be a small action to punish the Serbian nationalists for their Pan-Slavic ambitions. When the result was a world-destroying war, they said "That is not what we intended." Of course it is not what they intended, but nobody can control the escalation of conflicts. The astonishing unrealism of the

Netanyahu-Barak statements also reminds one of Kaiser Wilhelm's monumentally unrealistic words to his departing troops: "You will be home before the leaves are off the trees."

The planned attack on Iran would not only violate international law, but would also violate common sense and the wishes of the people of Israel. The probable result would be a massive Iranian missile attack on Tel Aviv, and Iran would probably also close the Straits of Hormuz. If the United States responded by bombing Iranian targets, Iran would probably use missiles to sink one or more of the US ships in the Persian Gulf. One can easily imagine other steps in the escalation of the conflict: a revolution in Pakistan; the entry of nuclear-armed Pakistan into the war on the side of Iran; a preemptive nuclear strike by Israel against Pakistan's nuclear weapons; and Chinese-Russian support of Iran. In the tense atmosphere of such a war, the danger of a major nuclear exchange, due to accident or miscalculation, would be very great.

6.15 Atoms for peace?

"Atoms for Peace", the title of U.S. President Dwight D. Eisenhower's 1953 speech to the U.N. General Assembly, may be regarded by future generations as being tragically self-contradictory. Nuclear power generation has led not only to dangerous proliferation of nuclear weapons, but also to disasters which have made large areas of the world permanently uninhabitable because of long-lived radioactive contamination.

According to Wikipedia, "...Under Atoms for Peace related programs, the US exported 25 tons of highly enriched uranium to 30 countries, mostly to fuel research reactors....The Soviet Union also exported 11 tons of HEU under a similar program." This enormous quantity of loose weapons-usable highly enriched uranium, is now regarded as very worrying because of proliferation and terrorism risks.

A recent article in "The Examiner" (http://www.examiner.com/article/nuclear-security-u-s-fails-to-protect-its-nuclear-materials-overseas) pointed out that "...NRC and DOE could not account for the current location and disposition of U.S. HEW overseas in response to a 1992 congressional mandate. U.S. agencies, in a 1993 report produced in response to the mandate, were able to verify the location of only 1.160 kilograms out of 17,500 kilograms of U.S. HEW estimated to have been exported."

The dangers of nuclear power generation are exemplified by the Chernobyl disaster: On the 26th of April, 1986, during the small hours of the morning, the staff of the Chernobyl nuclear reactor in Ukraine turned off several safety systems in order to perform a test. The result was a core meltdown in Reactor

4, causing a chemical explosion that blew off the reactor's 1,000-ton steel and concrete lid. 190 tons of highly radioactive uranium and graphite were hurled into the atmosphere.

The resulting radioactive fallout was 200 times greater than that caused by the nuclear bombs that destroyed Hiroshima and Nagasaki. The radioactive cloud spread over Belarus, Ukraine, Russia, Finland, Sweden and Eastern Europe, exposing the populations of these regions to levels of radiation 100 times the normal background. Ultimately, the radioactive cloud reached as far as Greenland and parts of Asia.

The exact number of casualties resulting from the Chernobyl meltdown is a matter of controversy, but according to a United Nations report, as many as 9 million people have been adversely affected by the disaster. Since 1986, the rate of thyroid cancer in affected areas has increased ten-fold. An area of 155,000 square kilometers (almost half the size of Italy) in Belarus, Ukraine and Russia is still severely contaminated. Even as far away as Wales, hundreds of farms are still under restrictions because of sheep eating radioactive grass.

The more recent disaster of 11 March, 2011, may prove to be very much worse than Chernobyl. According to an article by Harvey Wasserman (http://www.commondreams.org/view/2014/02/03-3),
the ongoing fallout from the Fukushima catastrophe is already far in excess of that from Chernobyl. Ecosystems of the entire Pacific ocean are being contaminated by the 300 tons of radioactive water from Fukushima.that continue to pour into the Pacific every day.

Meanwhile, the increasingly militaristic government of Japan's Prime Minister Shinzo Abe has passed a State Secrets Act that makes it an offense punishable by 5 year's imprisonment for journalists to report on the situation. Under this cloak of secrecy, attempts are being made to remove highly radioactive used fuel rods balanced precariously in a partially destroyed container hanging in the air above the stricken Unit Four. If an accident should occur, the released radioactivity could dwarf previous disasters.

Public opinion turned against nuclear power generation as a result of the Chernobyl and Fukushima catastrophes. Nevertheless, many governments insist on pushing forward their plans for opening new nuclear power plants, despite popular opposition. Nuclear power could never compete in price with solar energy or wind energy if it were not heavily subsidized by governments. Furthermore, if a careful accounting is made of the CO2 released in the construction of nuclear power plants, the mining, refining and transportation of uranium ore, and the final decommissioning of the plants, the amount of CO2 released is seen to be similar to that of coal-fired plants.

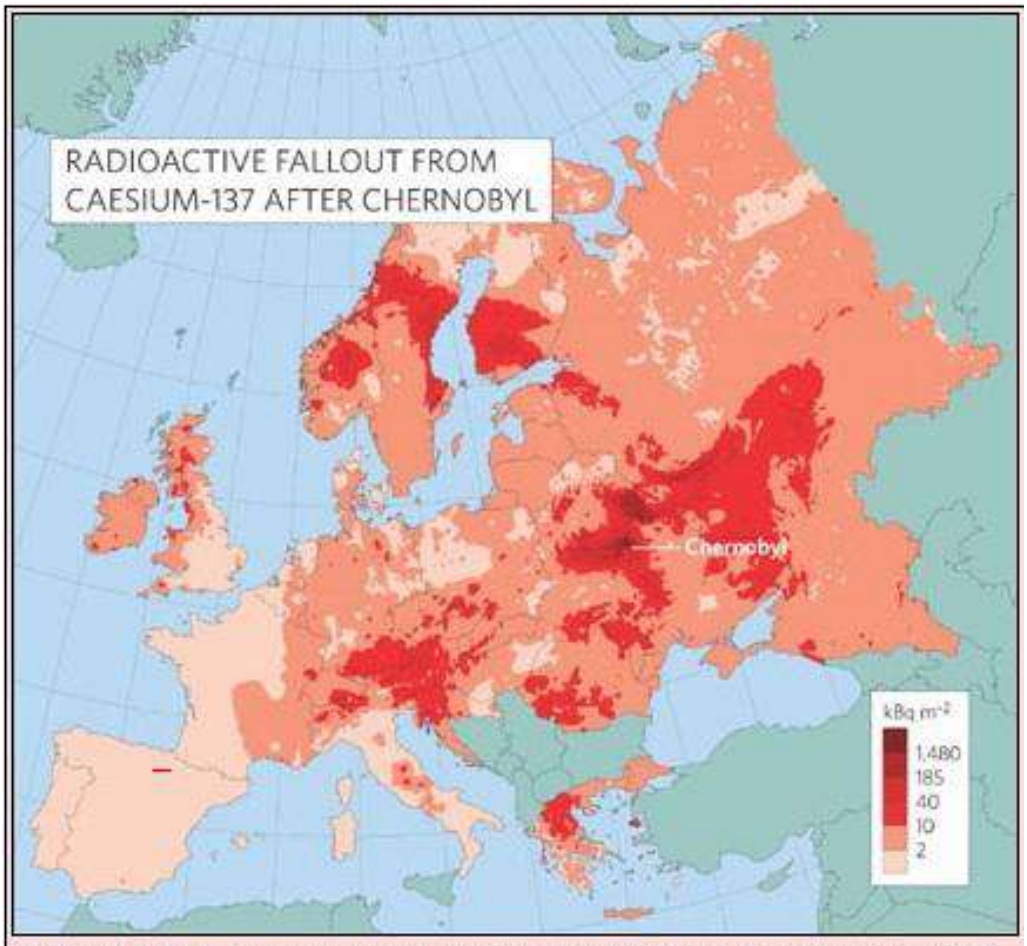
There are three basic reasons why nuclear power generation is is one of the worst ideas ever conceived: First is the danger of proliferation of nuclear

weapons, which will be discussed in detail below. Secondly, there is the danger of catastrophic accidents, such as the ones that occurred at Chernobyl and Fukushima. Finally, the problem of how to safely dispose of or store used fuel rods has not been solved.

In thinking about the dangers posed by radioactive waste, we should remember that many of the dangerous radioisotopes involved have half-lives of hundreds of thousands of years. Thus, it is not sufficient to seal them in containers that will last for a century, or even a millennium. We must find containers that will last for a hundred thousand years or more, longer than any human structure has ever lasted.

Of the two bombs that destroyed Hiroshima and Nagasaki, one made use of the rare isotope of uranium, U-235, while the other used plutonium. Both of these materials can be made by a nation with a nuclear power generation program.

Uranium has atomic number 92, i.e., a neutral uranium atom has a nucleus containing 92 positively-charged protons, around which 92 negatively-charged electrons circle. All of the isotopes of uranium have the same number of protons and electrons, and hence the same chemical properties, but they differ in the number of neutrons in their nuclei. For example, the nucleus of U-235 has 143 neutrons, while that of U-238 has 146. Notice that 92+143=235, while 92+146=238. The number written after the name of an element to specify a particular isotope is the number of neutrons plus the number of protons. This is called the "nucleon number", and the weight of an isotope is roughly



J. SMITH & N. A. BERESFORD CHERNOBYL: CATASTROPHE AND CONSEQUENCES (PRAXIS, CHICHESTER, 2005)

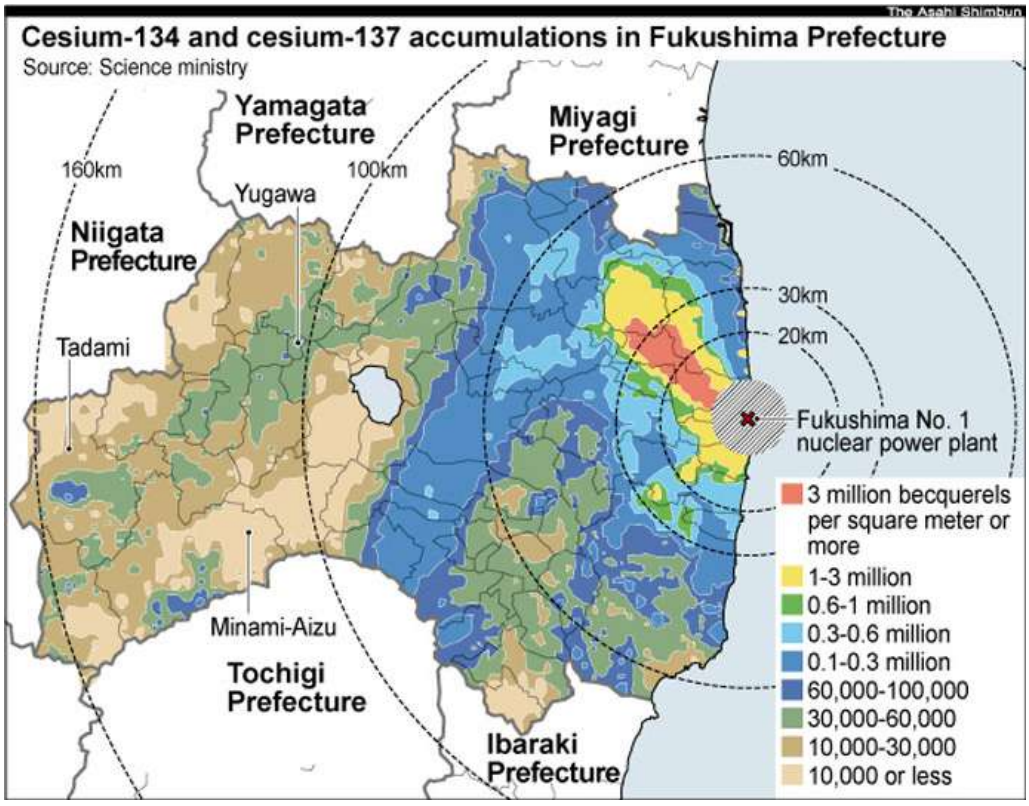


Figure 6.7: **People evacuated from the region near to Fukushima wonder when they will be able to return to their homes. The honest answer is "never".**

proportional to it. This means that U-238 is slightly heavier than U-235. If the two isotopes are to be separated, difficult physical methods dependent on mass must be used, since their chemical properties are identical. In natural uranium, the amount of the rare isotope U-235 is only 0.7 percent.

A paper published in 1939 by Niels Bohr and John A. Wheeler indicated that it was the rare isotope of uranium, U-235, that undergoes fission. A bomb could be constructed, they pointed out, if enough highly enriched U-235 could be isolated from the more common isotope, U-238 Calculations later performed in England by Otto Frisch and Rudolf Peierls showed that the "critical mass" of highly enriched uranium needed is quite small: only a few kilograms.

The Bohr-Wheeler theory also predicted that an isotope of plutonium, Pu-239, should be just as fissionable as U-235. Both U-235 and Pu-239 have odd nucleon numbers. When U-235 absorbs a neutron, it becomes U-236, while when Pu-239 absorbs a neutron it becomes Pu-240. In other words, absorption of a neutron converts both these species to nuclei with even nucleon numbers.

According to the Bohr-Wheeler theory, nuclei with even nucleon numbers are especially tightly-bound. Thus absorption of a neutron converts U-235 to a highly-excited state of U-236, while Pu-239 is similarly converted to a highly excited state of Pu-240. The excitation energy distorts the nuclei to such an extent that fission becomes possible. Instead of trying to separate the rare isotope, U-235, from the common isotope, U-238, physicists could just operate a nuclear reactor until a sufficient amount of Pu-239 accumulated, and then separate it out by ordinary chemical means.

Thus in 1942, when Enrico Fermi and his coworkers at the University of Chicago produced the world's first controlled chain reaction within a pile of cans containing ordinary (nonenriched) uranium powder, separated by blocks of very pure graphite, the chain-reacting pile had a double significance: It represented a new source of energy, but it also had a sinister meaning. It represented an easy path to nuclear weapons, since one of the by-products of the reaction was a fissionable isotope of plutonium, Pu-239. The bomb dropped on Hiroshima in 1945 used U-235, while the Nagasaki bomb used Pu-239.

By reprocessing spent nuclear fuel rods, using ordinary chemical means, a nation with a power reactor can obtain weapons-usable Pu-239. Even when such reprocessing is performed under international control, the uncertainty as to the amount of Pu-239 obtained is large enough so that the operation might superficially seem to conform to regulations while still supplying enough Pu-239 to make many bombs.

The enrichment of uranium, i.e. production of uranium with a higher percentage of U-235 than is found in natural uranium is also linked to reactor

use. Many reactors of modern design make use of low enriched uranium (LEU) as a fuel. Nations operating such a reactor may claim that they need a program for uranium enrichment in order to produce LEU for fuel rods. However, by operating their ultracentrifuges a little longer, they can easily produce highly enriched uranium (HEU), i.e. uranium containing a high percentage of the rare isotope U-235, and therefore usable in weapons.

Nuclear power generation is not a solution to the problem of obtaining energy without producing dangerous climate change: Known reserves of uranium are only sufficient for the generation of about 25 terawatt-years of electrical energy (Craig, J.R., Vaugn, D.J. and Skinner, B.J., "Resources of the Earth: Origin, Use and Environmental Impact, Third Edition", page 210). This can be compared with the world's current rate of energy use of over 14 terrawatts. Thus, if all of our energy were obtained from nuclear power, existing reserves of uranium would only be sufficient for about 2 years.

It is sometimes argued that a larger amount of electricity could be obtained from the same amount of uranium through the use of fast breeder reactors, but this would involve totally unacceptable proliferation risks. In fast breeder reactors, the fuel rods consist of highly enriched uranium. Around the core, is an envelope of natural uranium. The flux of fast neutrons from the core is sufficient to convert a part of the U-238 in the envelope into Pu-239, a fissionable isotope of plutonium.

Fast breeder reactors are prohibitively dangerous from the standpoint of nuclear proliferation because both the highly enriched uranium from the fuel rods and the Pu-239 from the envelope are directly weapons-usable. It would be impossible, from the standpoint of equity, to maintain that some nations have the right to use fast breeder reactors, while others do not. If all nations used fast breeder reactors, the number of nuclear weapons states would increase drastically.

It is interesting to review the way in which Israel, South Africa, Pakistan, India and North Korea obtained their nuclear weapons, since in all these cases the weapons were constructed under the guise of "atoms for peace", a phrase that future generations may someday regard as being tragically self-contradictory.

Israel began producing nuclear weapons in the late 1960's (with the help of a "peaceful" nuclear reactor provided by France, and with the tacit approval of the United States) and the country is now believed to possess 100-150 of them, including neutron bombs. Israel's policy is one of visibly possessing nuclear weapons while denying their existence.

South Africa, with the help of Israel and France, also weaponized its civil nuclear program, and it tested nuclear weapons in the Indian Ocean in 1979. In 1991 however, South Africa destroyed its nuclear weapons and signed the

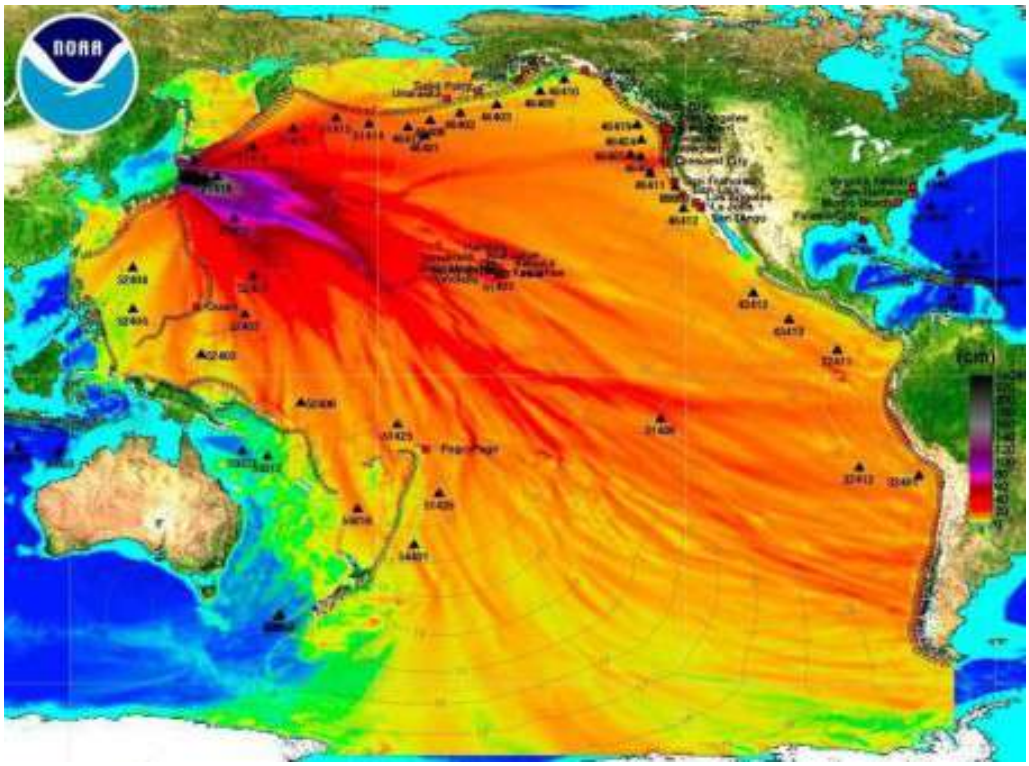


Figure 6.8: **Radioactive contamination from the Fukushima disaster is spreading through the food chain of marine life throughout the Pacific region.**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Revealed: the secrets of Israel's nuclear arsenal

Figure 6.9: **The Israeli nuclear technician and whistleblower Mordechai Vanunu called public attention to Israel's nuclear weapons while on a trip to England. He was lured to Italy by a Mossad "honey trap", where he was drugged, kidnapped and transported to Israel by Mossad.**

Figure 6.10: **Vanunu was imprisoned for 18 years, during 11 of which he was held in solitary confinement and subjected to psychological torture, such as not being allowed to sleep for long periods.**

Nuclear Non-Proliferation Treaty.

India produced what it described as a "peaceful nuclear explosion" in 1974. By 1989 Indian scientists were making efforts to purify the lithium-6 isotope, a key component of the much more powerful thermonuclear bombs. In 1998, India conducted underground tests of nuclear weapons, and is now believed to have roughly 60 warheads, constructed from Pu-239 produced in "peaceful" reactors.

Pakistan's efforts to obtain nuclear weapons were spurred by India's 1974 "peaceful nuclear explosion". As early as 1970, the laboratory of Dr. Abdul Qadeer Khan, (a metallurgist who was to become Pakistan's leading nuclear bomb maker) had been able to obtain from a Dutch firm the high-speed ultracentrifuges needed for uranium enrichment. With unlimited financial support and freedom from auditing requirements, Dr. Khan purchased restricted items needed for nuclear weapon construction from companies in Europe and the United States. In the process, Dr. Khan became an extremely wealthy man. With additional help from China, Pakistan was ready to test five nuclear weapons in 1998.

The Indian and Pakistani nuclear bomb tests, conducted in rapid succession, presented the world with the danger that these devastating weapons would be used in the conflict over Kashmir. Indeed, Pakistan announced that if a war broke out using conventional weapons, Pakistan's nuclear weapons would be used "at an early stage".

In Pakistan, Dr. A.Q. Khan became a great national hero. He was presented as the person who had saved Pakistan from attack by India by creating Pakistan's own nuclear weapons. In a Washington Post article (1 February, 2004) Pervez Hoodbhoy wrote: "Nuclear nationalism was the order of the day as governments vigorously promoted the bomb as the symbol of Pakistan's high scientific achievement and self- respect..." Similar manifestations of nuclear nationalism could also be seen in India after India's 1998 bomb tests.

Early in 2004, it was revealed that Dr. Khan had for years been selling nuclear secrets and equipment to Libya, Iran and North Korea, and that he had contacts with Al Qaeda. However, observers considered that it was unlikely that Khan would be tried, since a trial might implicate Pakistan's army as well as two of its former prime ministers.

There is a danger that Pakistan's unpopular government may be overthrown, and that the revolutionists might give Pakistan's nuclear weapons to a subnational organization. This type of danger is a general one associated with nuclear proliferation. As more and more countries obtain nuclear weapons, it becomes increasingly likely that one of them will undergo a revolution, during the course of which nuclear weapons will fall into the hands of criminals or

terrorists.

There is also a possibility that poorly-guarded fissionable material could fall into the hands of subnational groups, who would then succeed in constructing their own nuclear weapons. Given a critical mass of highly-enriched uranium, a terrorist group, or an organized criminal (Mafia) group, could easily construct a crude gun-type nuclear explosive device. Pu-239 is more difficult to use since it is highly radioactive, but the physicist Frank Barnaby believes that a subnational group could nevertheless construct a crude nuclear bomb (of the Nagasaki type) from this material.

We must remember the remark of U.N. Secretary General Kofi Annan after the 9/11/2001 attacks on the World Trade Center. He said, "This time it was not a nuclear explosion". The meaning of his remark is clear: If the world does not take strong steps to eliminate fissionable materials and nuclear weapons, it will only be a matter of time before they will be used in terrorist attacks on major cities, or by organized criminals for the purpose of extortion. Neither terrorists nor organized criminals can be deterred by the threat of nuclear retaliation, since they have no territory against which such retaliation could be directed. They blend invisibly into the general population. Nor can a "missile defense system" prevent criminals or terrorists from using nuclear weapons, since the weapons can be brought into a port in any one of the hundreds of thousands of containers that enter on ships each year, a number far too large to be checked exhaustively.

Finally we must remember that if the number of nations possessing nuclear weapons becomes very large, there will be a greatly increased chance that these weapons will be used in conflicts between nations, either by accident or through irresponsible political decisions.

The slogan "Atoms for Peace" has proved to be such a misnomer that it would be laughable if it were not so tragic. Nuclear power generation has been a terrible mistake. We must stop before we turn our beautiful earth into a radioactive wasteland.

6.16 Cancer threat from radioactive leaks at Hanford

On August 9, 1945, a nuclear bomb was dropped on the Japanese city of Nagasaki. Within a radius of one mile, destruction was total. People were vaporized so that the only shadows on concrete pavements were left to show where they had been. Many people outside the radius of total destruction were trapped in their collapsed houses, and were burned alive by the fire that followed. By the end of 1945, an estimated 80,000 men, women, young children,

babies and old people had died as a result of the bombing. As the years passed more people continued to die from radiation sickness.

Plutonium for the bomb that destroyed Nagasaki had been made at an enormous nuclear reactor station located at Hanford in the state of Washington. During the Cold War, the reactors at Hanford produced enough weapons-usable plutonium for 60,000 nuclear weapons. The continued existence of plutonium and highly-enriched uranium-235 in the stockpiles of nuclear weapons states hangs like a dark cloud over the future of humanity. A full scale thermonuclear war would be the ultimate ecological catastrophe, threatening to make the world permanently uninhabitable.

Besides playing a large role in the tragedy of Nagasaki, the reactor complex at Hanford has damaged the health of many thousands of Americans. The prospects for the future are even worse. Many millions of gallons of radioactive waste are held in Hanford's aging storage tanks, the majority of which have exceeded their planned lifetimes. The following quotations are taken from a Wikipedia article on Hanford, especially the section devoted to ecological concerns:

"A huge volume of water from the Columbia River was required to dissipate the heat produced by Hanford's nuclear reactors. From 1944 to 1971, pump systems drew cooling water from the river and, after treating this water for use by the reactors, returned it to the river. Before being released back into the river, the used water was held in large tanks known as retention basins for up to six hours. Longer-lived isotopes were not affected by this retention, and several tetrabecquerels entered the river every day. These releases were kept secret by the federal government. Radiation was later measured downstream as far west as the Washington and Oregon coasts."

"The plutonium separation process also resulted in the release of radioactive isotopes into the air, which were carried by the wind throughout southeastern Washington and into parts of Idaho, Montana, Oregon and British Colombia. Downwinders were exposed to radionuclide's, particularly Iodine 131... These radionuclide's filtered into the food chain via contaminated fields where dairy cows grazed; hazardous fallout was ingested by communities who consumed the radioactive food and drank the milk. Most of these airborne releases were a part of Hanford's routine operations, while a few of the larger releases occurred in isolated incidents."

"In response to an article in the Spokane Spokesman Review in September 1985, the Department of Energy announced its intent to declassify environmental records and in February, 1986 released to the public 19,000 pages of previously unavailable historical documents about Hanford's operations. The Washington State Department of Health collaborated with the citizen-led Hanford Health Information Network (HHIN) to publicize data about the health

effects of Hanford's operations. HHIN reports concluded that residents who lived downwind from Hanford or who used the Columbia River downstream were exposed to elevated doses of radiation that placed them at increased risk for various cancers and other diseases."

"The most significant challenge at Hanford is stabilizing the 53 million U.S. Gallons (204,000 m3) of high-level radioactive waste stored in 177 underground tanks. About a third of these tanks have leaked waste into the soil and groundwater. As of 2008, most of the liquid waste has been transferred to more secure double-shelled tanks; however, 2.8 million U.S. Gallons (10,600 m3) of liquid waste, together with 27 million U.S. gallons (100,000 m3) of salt cake and sludge, remains in the single-shelled tanks.That waste was originally scheduled to be removed by 2018. The revised deadline is 2040. Nearby aquifers contain an estimated 270 billion U.S. Gallons (1 billion m3) of contaminated groundwater as a result of the leaks. As of 2008, 1 million U.S. Gallons (4,000 m3) of highly radioactive waste is traveling through the groundwater toward the Columbia River."

The documents made public in 1986 revealed that radiation was intentionally and secretly released by the plant and that people living near to it acted as unknowing guinea pigs in experiments testing radiation dangers. Thousands of people who live in the vicinity of the Hanford Site have suffered an array of health problems including thyroid cancers, autoimmune diseases and reproductive disorders that they feel are the direct result of these releases and experiments.

In thinking about the dangers posed by leakage of radioactive waste, we should remember that many of the dangerous radioisotopes involved have half-lives of hundreds of thousands of years. Thus, it is not sufficient to seal them into containers that will last for a century or even a millennium. We must find containers that will last for a hundred thousand years or more, longer than any human structure has ever lasted. This logic has lead Finland to deposit its radioactive waste in a complex of underground tunnels carved out of solid rock. But looking ahead for a hundred thousand years involves other problems: If humans survive for that long, what language will they speak? Certainly not the languages of today. How can we warn them that the complex of tunnels containing radioactive waste is a death trap? The reader is urged to see a film exploring these problems, "Into Eternity", by the young Danish film-maker Michael Madsen. Here is the link: http://dotsub.com/view/8e40ebda-5966-4212-9b96-6abbce3c6577.

We have already gone a long way towards turning our beautiful planet earth into a nuclear wasteland. In the future, let us be more careful, as guardians of a precious heritage, the natural world and the lives of all future generations.

6.17 An accident waiting to happen

In Stanley Kubrick's film, "Dr. Strangelove", a paranoid ultra-nationalist brigadier general, Jack D. Ripper, orders a nuclear attack on the Soviet Union because he believes that the Soviets are using water fluoridation as a means to rob Americans of their "precious bodily fluids". Efforts are made to recall the US bombers, but this proves to be impossible, and the attack triggers the Soviet "Doomsday Machine". The world is destroyed.

Kubrick's film is a black comedy, and we all laugh at it, especially because of the brilliant performance of Peter Sellers in multiple roles. Unfortunately, however, the film comes uncomfortably close to reality. An all-destroying nuclear war could very easily be started by an insane or incompetent person whose hand happens to be on the red button.

This possibility (or probability) has recently come to public attention through newspaper articles revealing that 11 of the officers responsible for launching US nuclear missiles have been fired because of drug addiction. Furthermore, a larger number of missile launch officers were found to be cheating on competence examinations. Three dozen officers were involved in the cheating ring, and some reports state that an equal number of others may have known about it., and remained silent. Finally, it was shown that safety rules were being deliberately ignored. The men involved, were said to be "burned out".

According to an article in The Guardian (Wednesday, 15 January, 2014), "Revelations of misconduct and incompetence in the nuclear missile program go back at least to 2007, when six nuclear-tipped cruise missiles were accidentally loaded onto a B-52 bomber in Minot, North Dakota, and flown to a base in Louisiana."

"Last March, military inspectors gave officers at the ICBM base in Minot the equivalent of a 'D' grade for launch mastery. A month later, 17 officers were stripped of their authority to launch the missiles."

"In October, a senior air force officer in charge of 450 ICBM's, major general Michael Carey, was fired after accusations of drunken misconduct during a summer trip to Moscow. An internal investigation Â found that Carey drank heavily, cavorted with two foreign women and visited a nightclub called La Cantina, where Maj. Gen. Carey had alcohol and kept trying to get the band to let him play with them."

The possibility that a catastrophic nuclear war could be triggered by a madman gains force from the recent statements of Benjamin Netanyahu, who has said repeatedly that, with or without US help, Israel intends to attack Iran. Such an attack, besides being a war crime, would be literally insane.

If Netanyahu believes that a war with Iran would be short or limited, he is ignoring several very obvious dangers. Such a war would most probably

Figure 6.11: **Peter Sellers (left) listens while Brigadier General Jack D. Ripper tells him about the Soviet conspiracy to steal his "precious bodily fluids".**

escalate into a widespread general war in the Middle East. It could cause a revolution in Pakistan, and the new revolutionary government of Pakistan would be likely to enter the war on the side of Iran, bringing with it Pakistan's nuclear weapons. Russia and China, both staunch allies of Iran, might be drawn into the conflict. There is a danger that the conflict could escalate into a Third World War, where nuclear weapons might easily be used, either by accident or intentionally. .

China could do grave economic damage to the United States through its large dollar holdings. Much of the world's supply of petroleum passes through the Straits of Hormuz, and a war in the region could greatly raise the price of oil, triggering a depression that might rival or surpass the Great Depression of the 1920's and 1930's. Â

The probability of a catastrophic nuclear war occurring by accident is made greater by the fact that several thousand nuclear weapons are kept on "hair-trigger alert" with a quasi-automatic reaction time measured in minutes. There is a constant danger that a nuclear war will be triggered by an error in evaluating a signal on a radar screen.

Figure 6.12: **Peter Sellers as Dr. Strangelove. He has to restrain his black-gloved crippled hand, which keeps trying to give a Nazi salute.**

Figure 6.13: **General Buck Turgidson (George C. Scott) struggles with the Russian Ambassador. Peter Sellers (right) playing the US President, rebukes them for fighting in the War Room.**

Figure 6.14: **Major T. "King" Kong rides a nuclear bomb on its way down, where it will trigger the Soviet Doomsday Machine and ultimately destroy the world.**

Figure 6.15: **Benjamin Netanyahu has stated repeatedly that, with or without US support, Israel will attack Iran, an action that could escalate uncontrollably into World War III.**

6.18 Nuclear weapons are criminal! Every war is a crime!

War was always madness, always immoral, always the cause of unspeakable suffering, economic waste and widespread destruction, and always a source of poverty, hate, barbarism and endless cycles of revenge and counter-revenge. It has always been a crime for soldiers to kill people, just as it is a crime for murderers in civil society to kill people. No flag has ever been wide enough to cover up atrocities.

But today, the development of all-destroying modern weapons has put war completely beyond the bounds of sanity and elementary humanity.

Nuclear weapons are not only insane, immoral and potentially omnicidal, but also criminal under international law.

Can we not rid ourselves of both nuclear weapons and the institution of war itself? We must act quickly and resolutely before our beautiful world and everything that we love are reduced to radioactive ashes.

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Chapter 7

OUR WAR AGAINST NATURE

7.1 Antonio Guterres' *State of the Planet* broadcast

Here are some quotations from a December 2, 2020 article by Justin Rowlatt entitled *Humans waging 'suicidal war' on nature - UN chief Antonio Guterres*:

"Humanity is waging what he describes as a 'suicidal' war on the natural world.

"'Nature always strikes back, and is doing so with gathering force and fury,' he told a BBC special event on the environment.

"Mr Guterres wants to put tackling climate change at the heart of the UN's global mission.

"In a speech entitled State of the Planet, he announced that its 'central objective' next year will be to build a global coalition around the need to reduce emissions to net zero.

"Net zero refers to cutting greenhouse gas emissions as far as possible and balancing any further releases by removing an equivalent amount from the atmosphere.

"Mr Guterres said that every country, city, financial institution and company 'should adopt plans for a transition to net zero emissions

by 2050'. In his view, they will also need to take decisive action now to put themselves on the path towards achieving this vision.

"The objective, said the UN secretary general, will be to cut global emissions by 45% by 2030 compared with 2010 levels.

"Here's what Mr Guterres demanded the nations of the world do:

- **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**

Apocalyptic fires and floods

"It is an ambitious agenda, as Mr Guterres acknowledged, but he said that radical action is needed now.

" 'The science is clear,' Mr Guterres told the BBC, 'unless the world cuts fossil fuel production by 6% every year between now and 2030, things will get worse. Much worse.'

"Climate policies have yet to rise to the challenge, the UN chief said, adding that 'without concerted action, we may be headed for a catastrophic three to five-degree temperature rise this century'.

"The impact is already being felt around the world.

" 'Apocalyptic fires and floods, cyclones and hurricanes are the new normal," he warned.

" 'Biodiversity is collapsing. Deserts are spreading. Oceans are choking with plastic waste.'

Moment of truth

"Mr Guterres said the nations of the world must bring ambitious commitments to cut emissions to the international climate conference the UK and Italy are hosting in Glasgow in November next year.

"As well as pressing for action on the climate crisis, he urged nations to tackle the extinction crisis that is destroying biodiversity and to step up efforts to reduce pollution.

"We face, he said, a "moment of truth".

"But he does discern some glimmers of hope.

"He acknowledged that the European Union, the US, China, Japan, South Korea and more than 110 other countries have committed to become carbon neutral by the middle of this century.

"He said he wants to see this momentum turned into a movement.

"Technology will help us to reach these targets, Mr Guterres said he believes.

" 'The coal business is going up in smoke,' because it costs more to run most of today's coal plants than it does to build new renewable plants from scratch, he told the BBC.

" 'We must forge a safer, more sustainable and equitable path', the UN chief concluded.

"He said it is time for this war against the planet to end, adding: 'We must declare a permanent ceasefire and reconcile with nature.'"

7.2 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]:

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

Figure 7.1: **United Nations Secretary General Antonio Guterres addressing the UN General Assembly on September24, 2019.**

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.

Figure 7.2: **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 7.3: **Germany's Chancellor Angela Merkel addresses the Climate Action Summit in the United Nations General Assembly, at U.N. headquarters, Sept. 23, 2019.**

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 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 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

"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.

7.3 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.[2]

[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

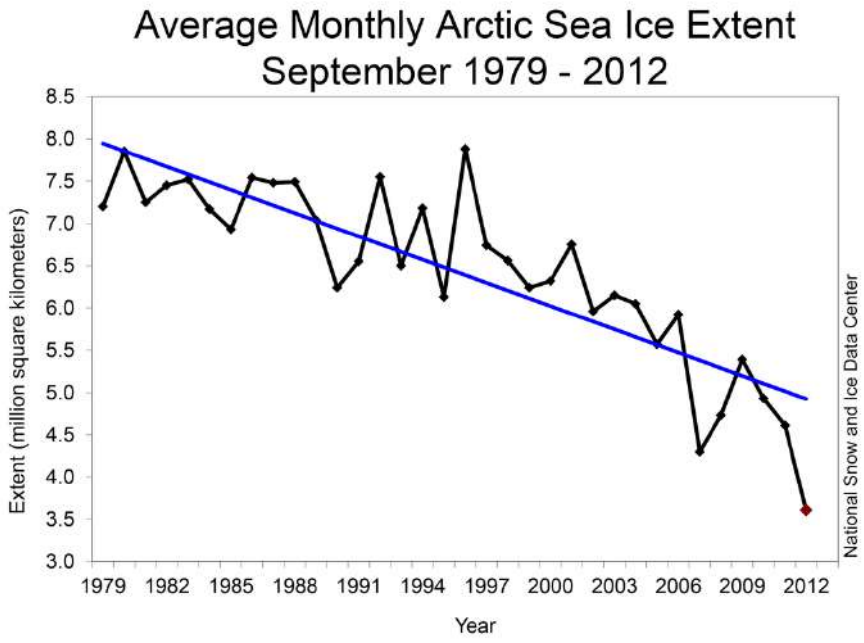

Figure 7.4: **Monthly September ice extent for 1979 to 2012 shows a decline of 13.0% per decade. One can also see that the straight line does not really fit the data, which more nearly resemble a downward curve will that reach zero in the period 2016-2019. Source: National Snow and Ice Data Center. Wikimedia Commons**

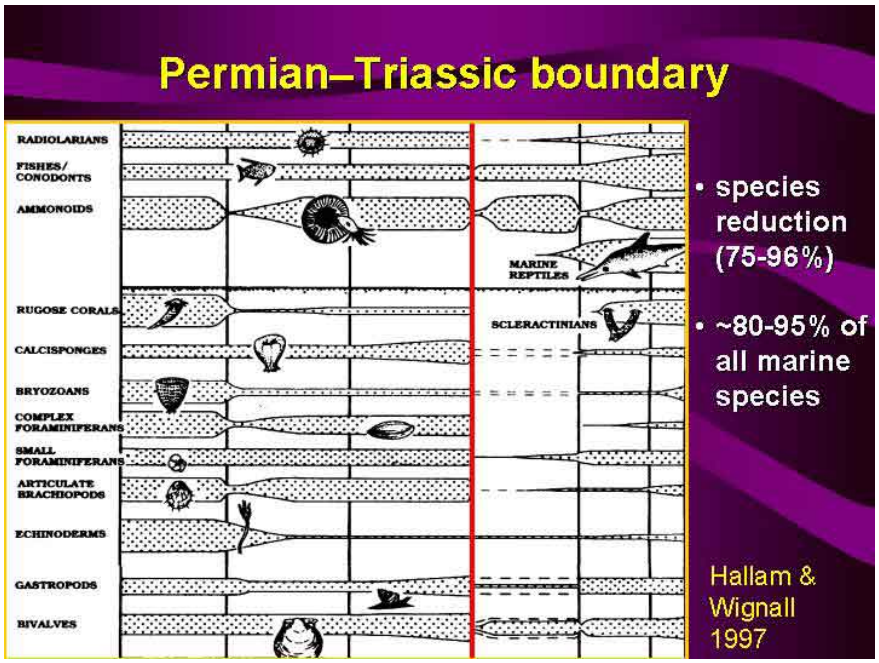

Figure 7.5: **Loss of species caused by the Permian-Triassic extinction event. Unless quick steps are taken to lower our greenhouse gas emissions, we may cause a similar extinction event, which will threaten the survival of our own species. Source: Australian Frontiers of Science, www.sciencearchive.org.au**

7.4 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.[3]

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

[3]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

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 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.

7.5 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.[4] In the Permian-Triassic extinction, 96% of all marine species and 76% of all terrestrial vertebrates disappeared forever. The cause of this extremely severe 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.

7.6 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

[4] 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/

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,"[5]

"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."

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*[6] "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[7] 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

[5]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

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

[7]International Union for the Conservation of Nature

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."

7.7 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."

7.8 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.

7.9 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.

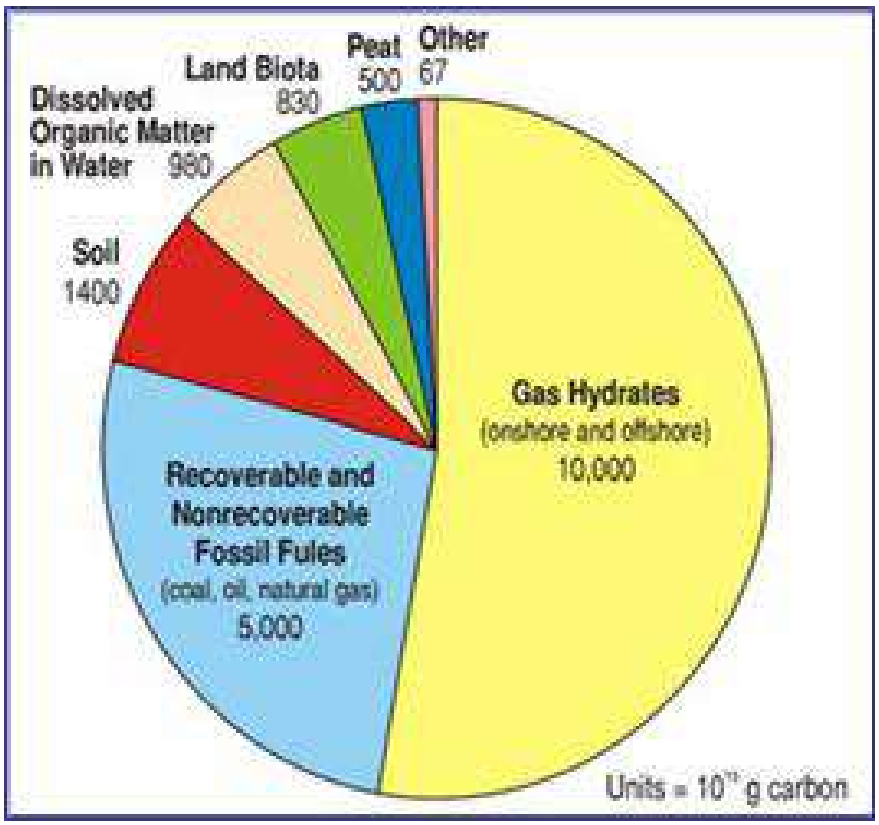

Figure 7.6: **The worrying thing about the methane/hydrate feedback loop is the enormous amount of carbon in the form of hydrate crystals, 10,000 gigatons most of it on the continental shelves of oceans. This greater than the amount of carbon in all other forms that might potentially enter the earth's atmosphere.**

Figure 7.7: **When ocean temperatures rise, methane hydrate crystals become unstable, and methane gas bubbles up to ocean surfaces.**

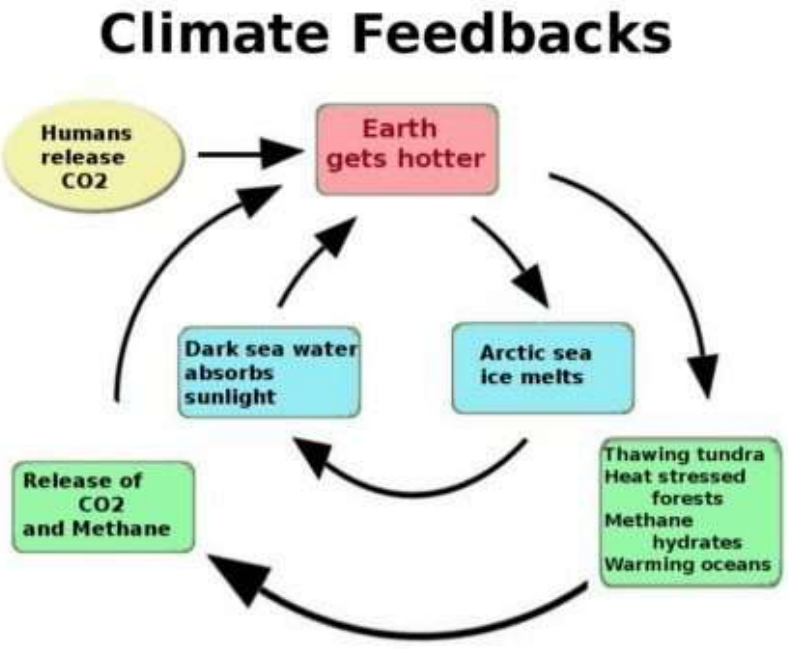

Figure 7.8: **This diagram shows two important feedback loops, one involving the albedo effect, and the other involving methane hydrates.**

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.

7.10 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*[8]. 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.

7.11 Drying of forests and forest fires

According to a recent article in *Nature*[9],"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.'

[8]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).

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

"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."

7.12 Tipping points and feedback loops

A tipping point is usually defined as the threshold for an abrupt and irreversible change[10]. 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

[10]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.

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.

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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.

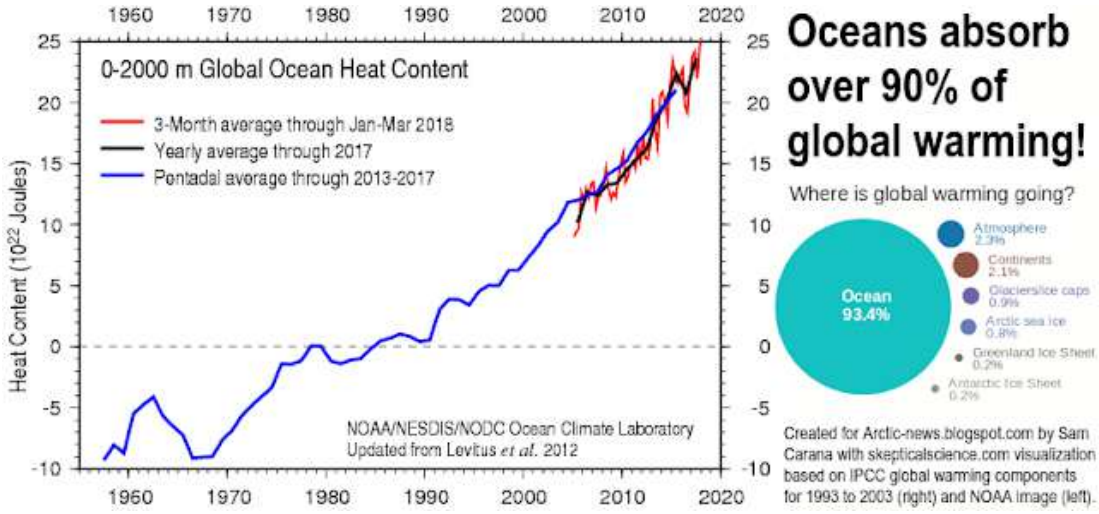

Figure 8.1: **The heat content of the oceans is rapidly increasing.**

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

[1] http://www.abc.net.au/science/articles/2015/02/13/4178113.htm

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.

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 megacatastrophe that may result if humans continue to overexploit 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

[2]University of Melbourne
http://www.abc.net.au/news/science/2017-02-27/plastic-and-plastic-waste-explained/8301316

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 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."

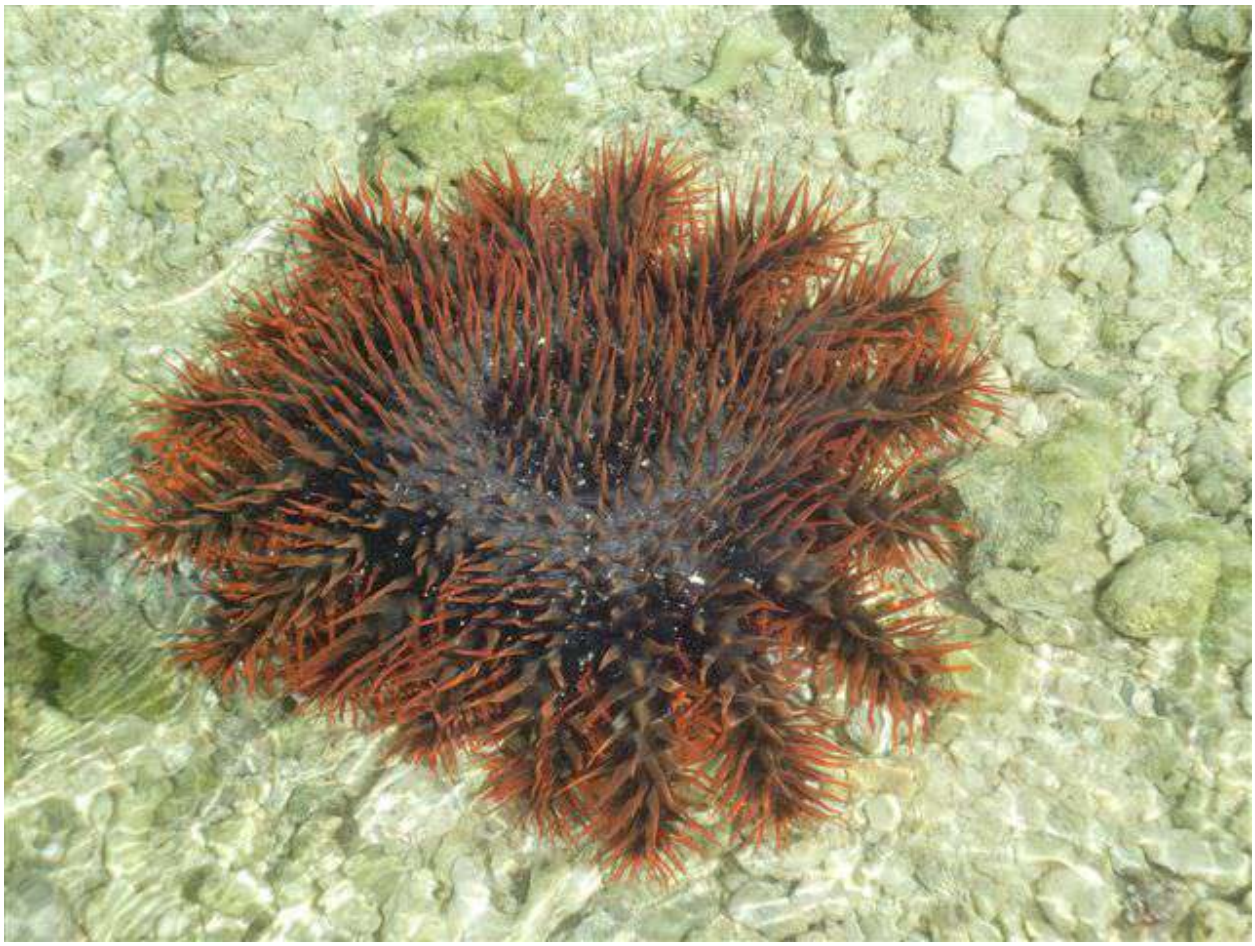

Figure 8.2: **The crown-of-thorns starfish eats coral.**

Figure 8.3: **The overfished giant triton eats the crown-of-thorns starfish.**

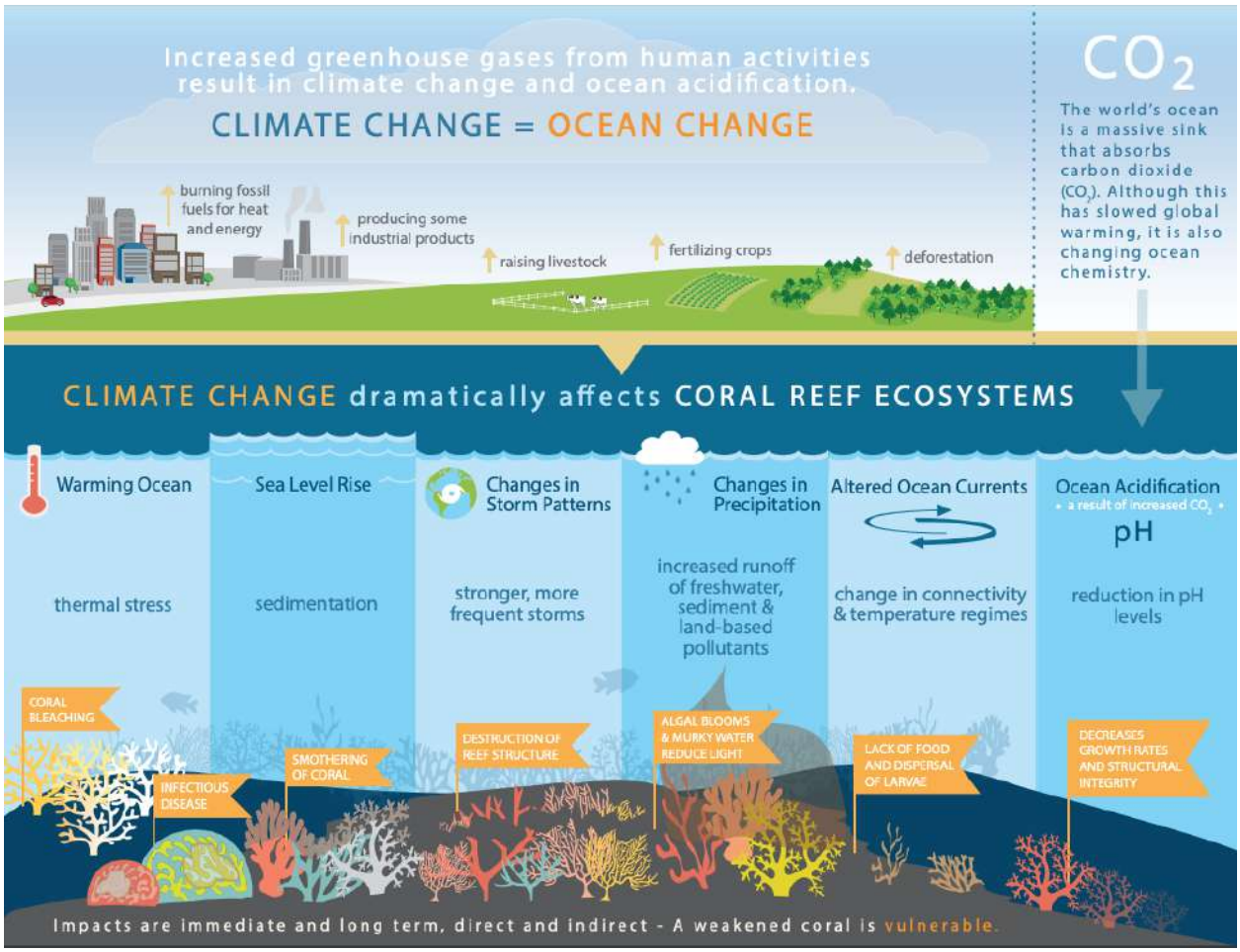

Figure 8.4: **Climate change threats to coral reefs.**

Figure 8.5: **Higher levels of carbon dioxide in the water harms the ability of young clown and damsel fishes to smell and hear.**

8.6 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.

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.

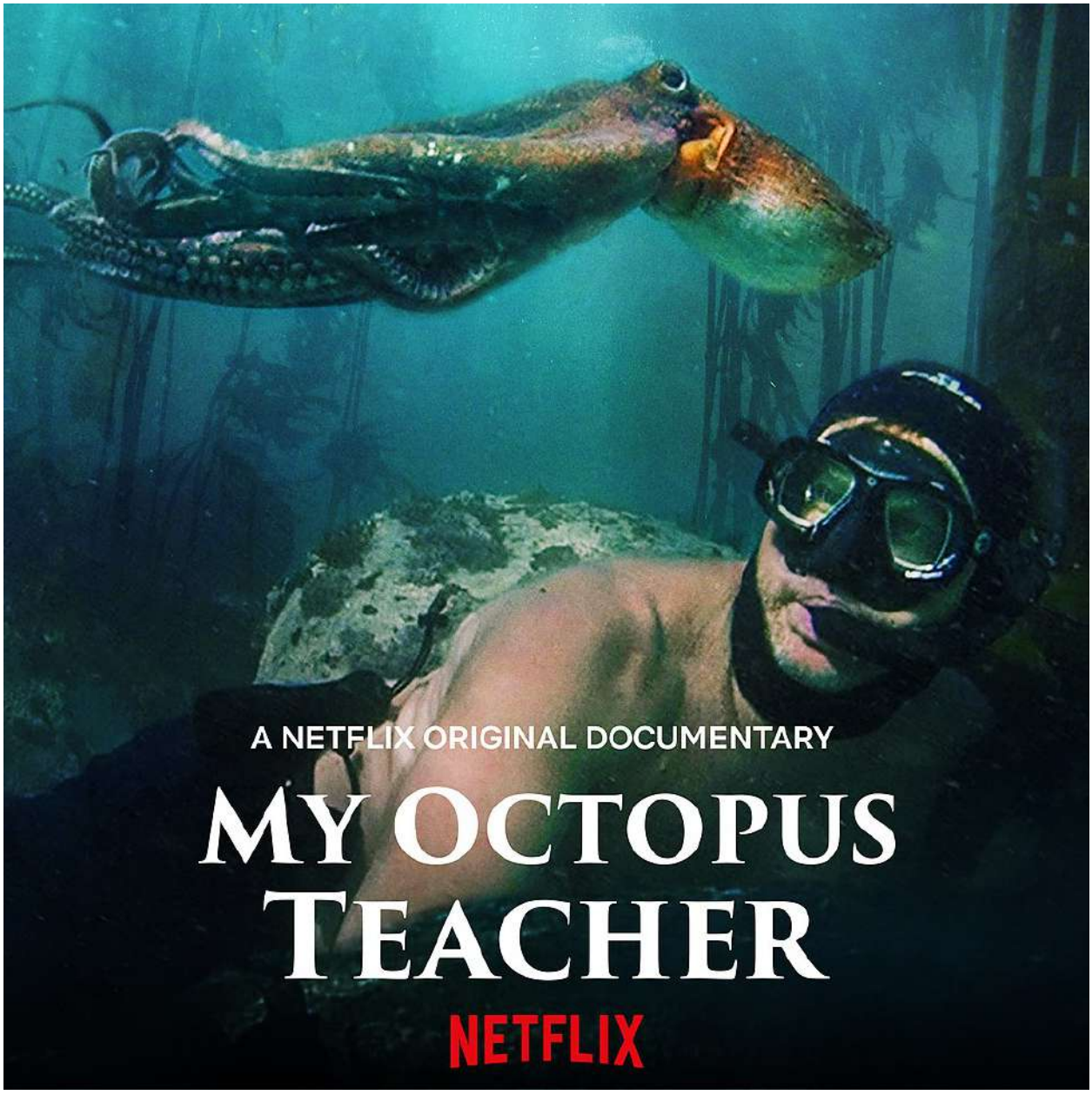

Figure 8.6: **Craig Foster dives with an octopus in the kelp forests off South Africa.**

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.

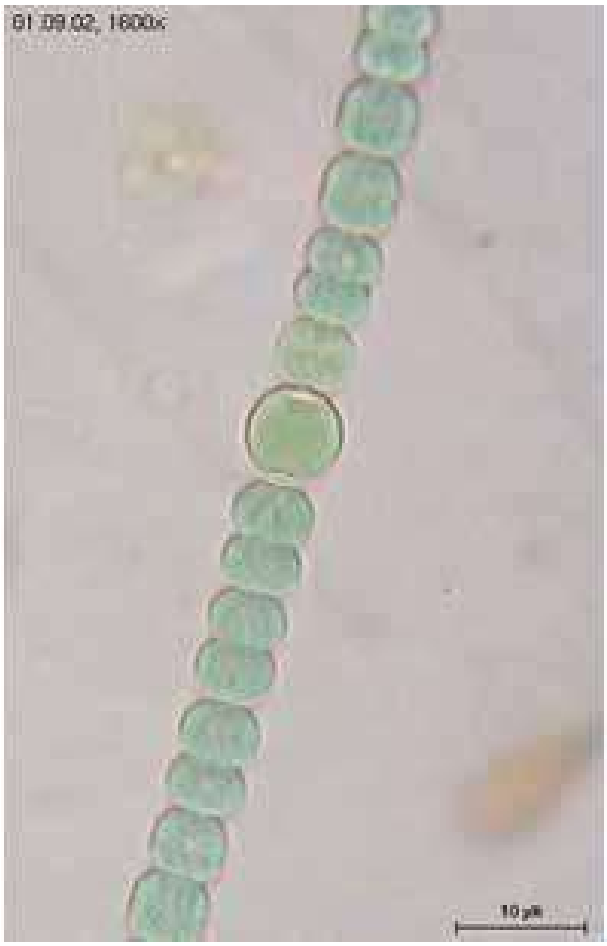

Figure 8.7: **Cyanobacteria (blue-green alga) Anabaena spherica.**

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.

[4] http://www.umb.no/statisk/ior/refsnes/asche.pdf

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.

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^{o}C 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.

[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

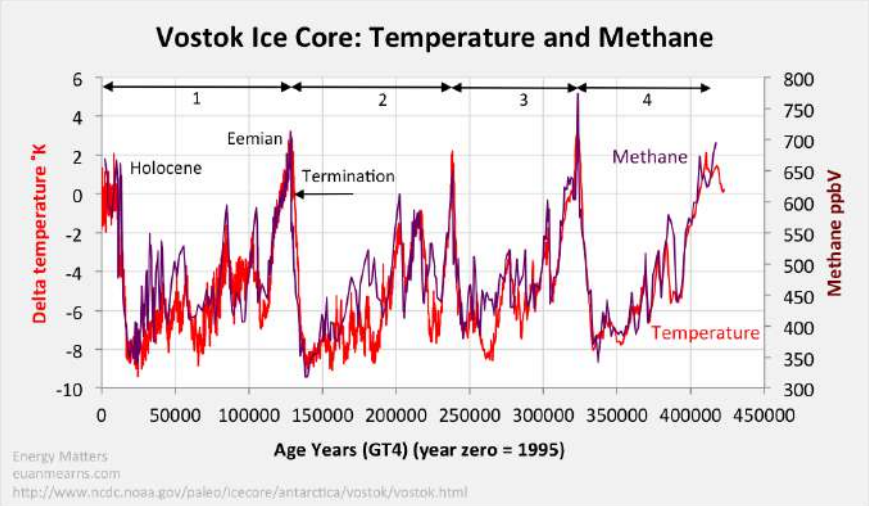

Figure 8.9: **In ice core data, we see a close correlation between temperature and atmospheric CO_2. There is also a close correlation between temperature and atmospheric methane.**

"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."

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

[7]http://news.nationalgeographic.com/2017/07/sea-level-rise-flood-global-warming-science/

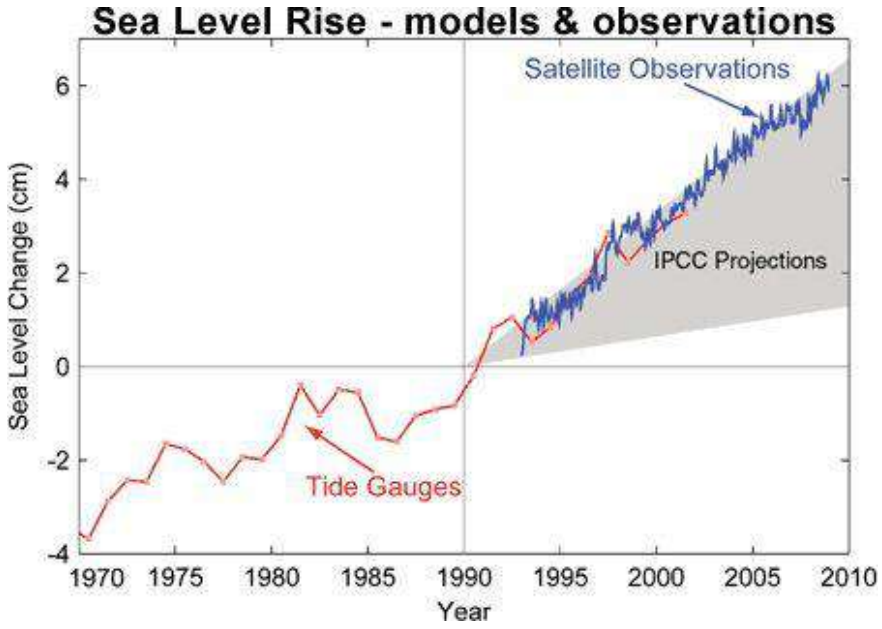

Figure 8.10: **Observed sea-level rise, 1970-2010.**

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

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.**

"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

[8]http://www.ucsusa.org/sites/default/files/attach/2017/07/when-rising-seas-hit-home-full-report.pdf

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."**

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^{o}C 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.

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 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.'

[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

"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.

The lead author, Prof. Emeritus Charles Geisler of Cornell University says:

[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 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,"

Suggestions for further reading

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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,

[1] https://www.footprintnetwork.org/our-work/ecological-footprint/

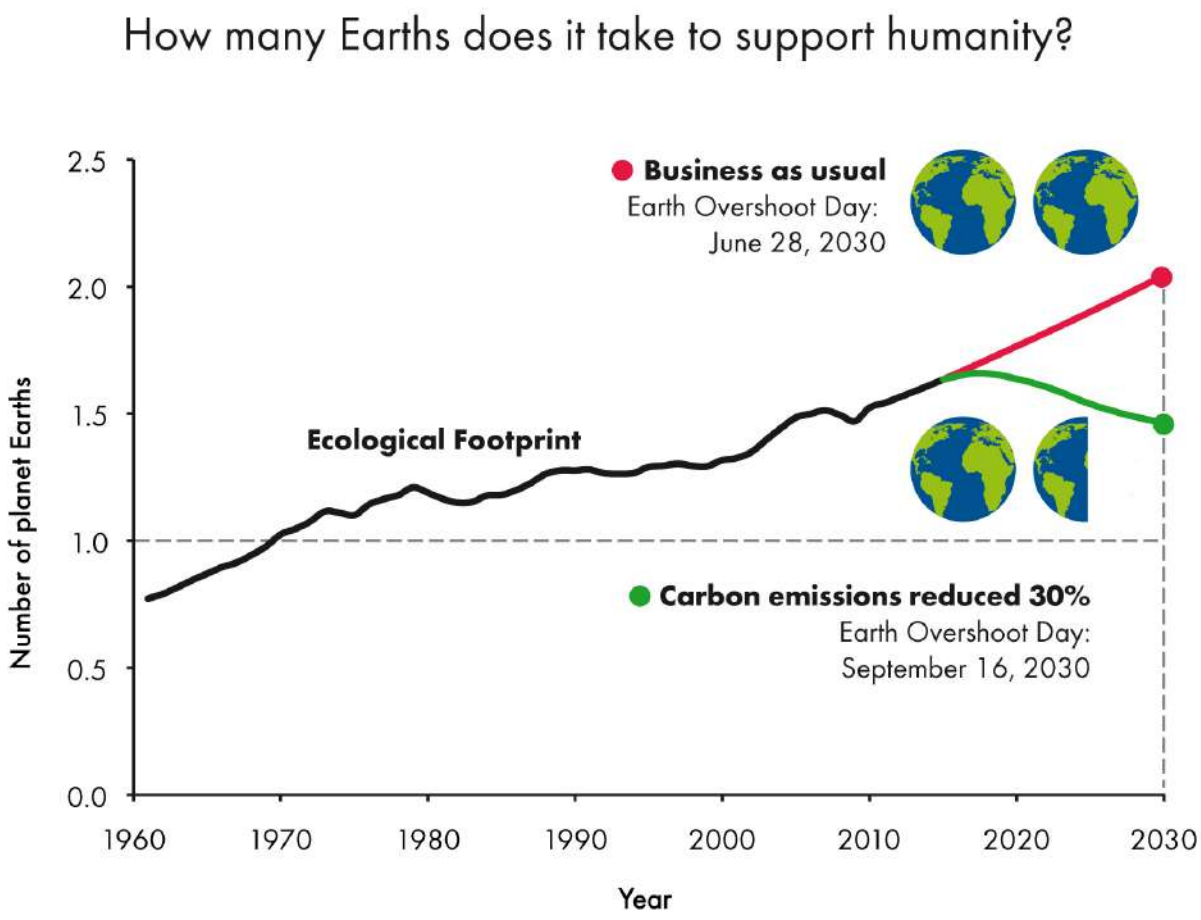

Figure 9.1: **The business as usual course would lead us to disaster.**

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)."

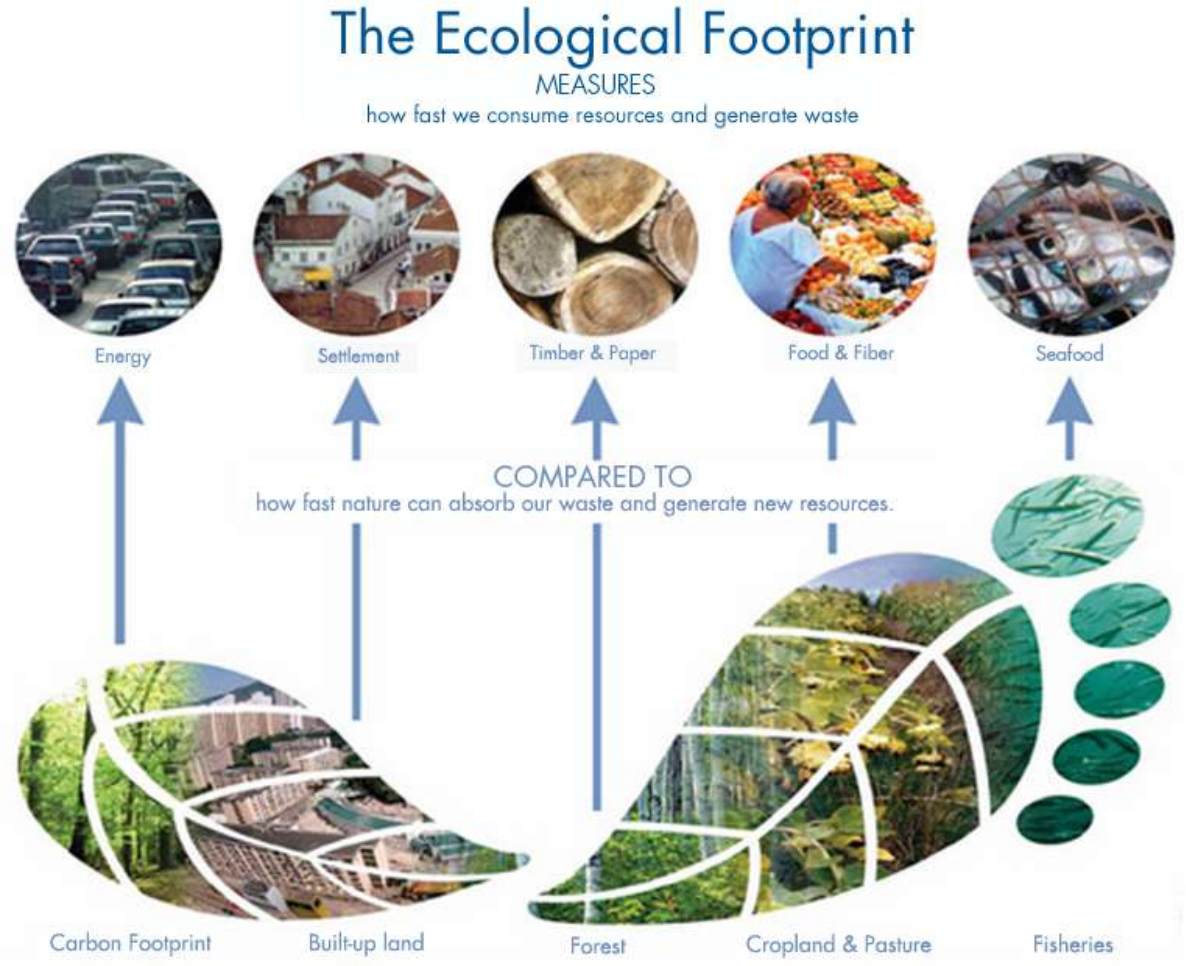

Figure 9.2: **Both the Ecological Footprint and biocapacity are expressed in global hectares - globally comparable, standardized hectares with world average productivity.**

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?

'Silent Spring' Is Now Noisy Summer

Pesticides Industry Up in Arms Over a New Book

By JOHN M. LEE

The $300,000,000 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,

Rachel Carson Stirs Conflict—Producers Are Crying 'Foul'

fending 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 spring."

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.**

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."**

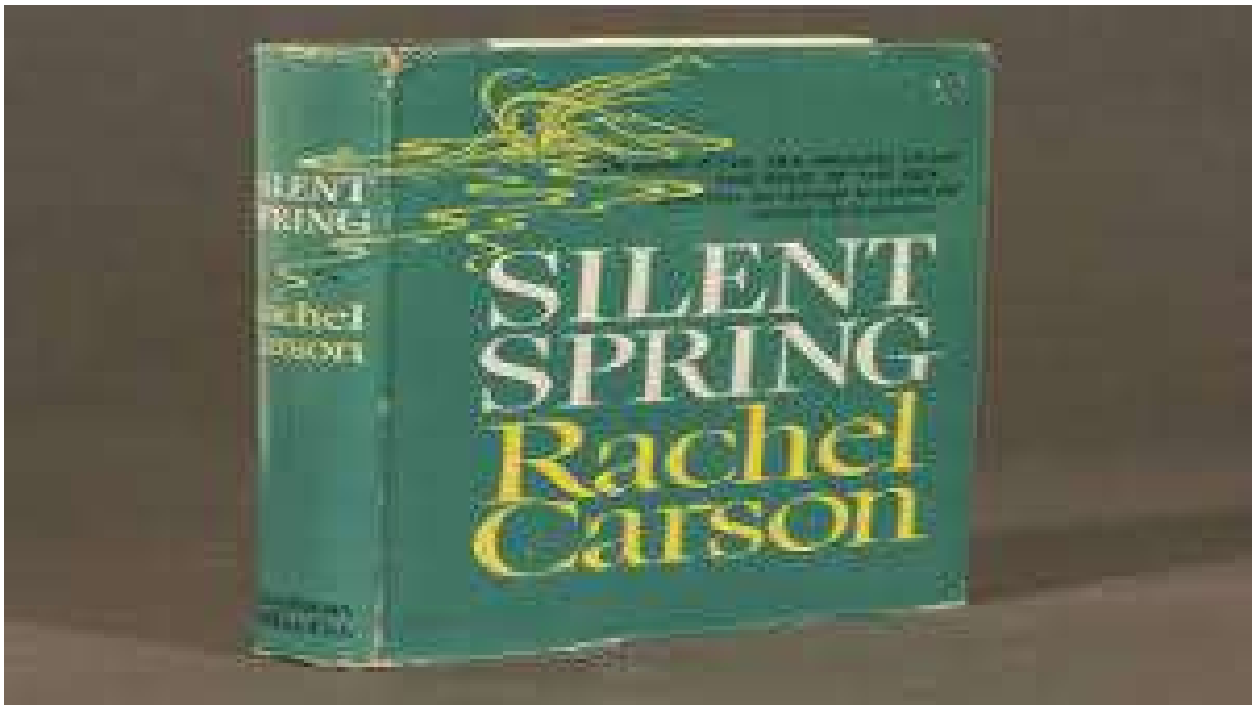

Figure 9.5: ***The Silent Spring*** **was an international best-seller, and it ignited the environmental movement.**

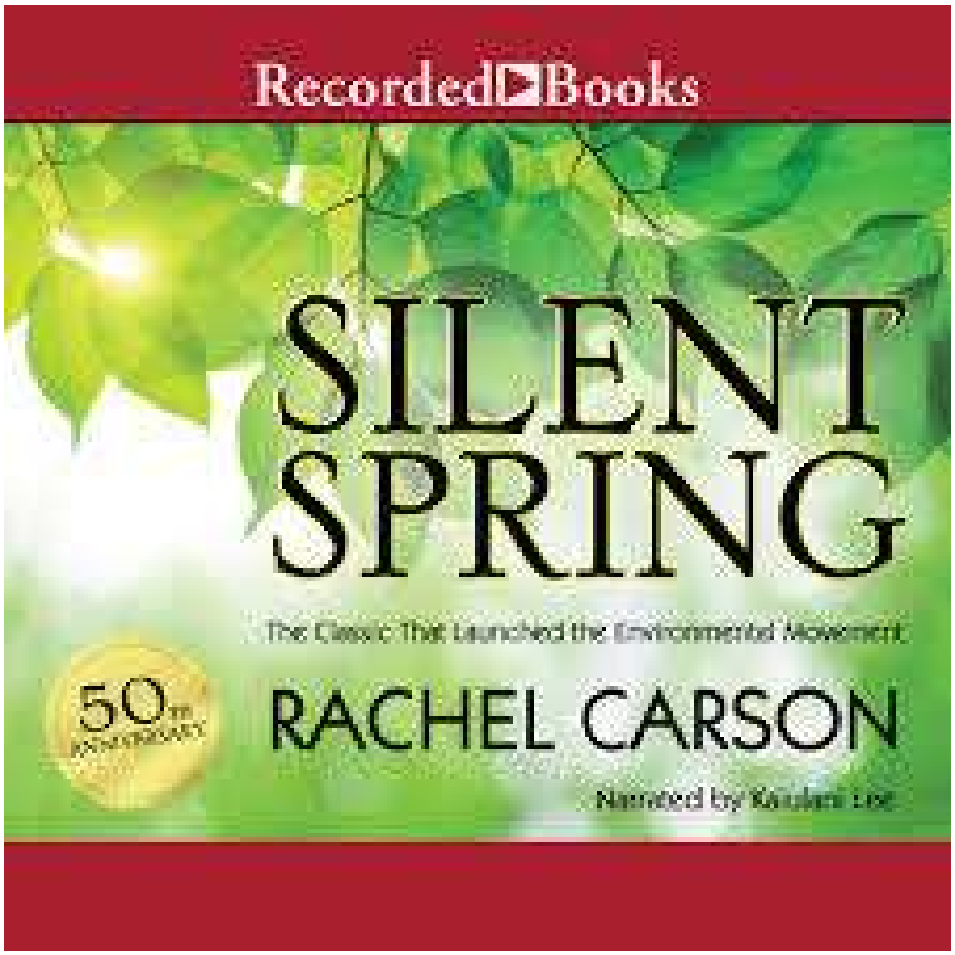

Figure 9.6: **An audio version of *The Silent Spring*.**

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.

[2]https://news.vice.com/article/indonesia-is-killing-the-planet-for-palm-oil

"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 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

[3]http://www.onegreenplanet.org/animalsandnature/beef-production-is-killing-the-amazon-rainforest/

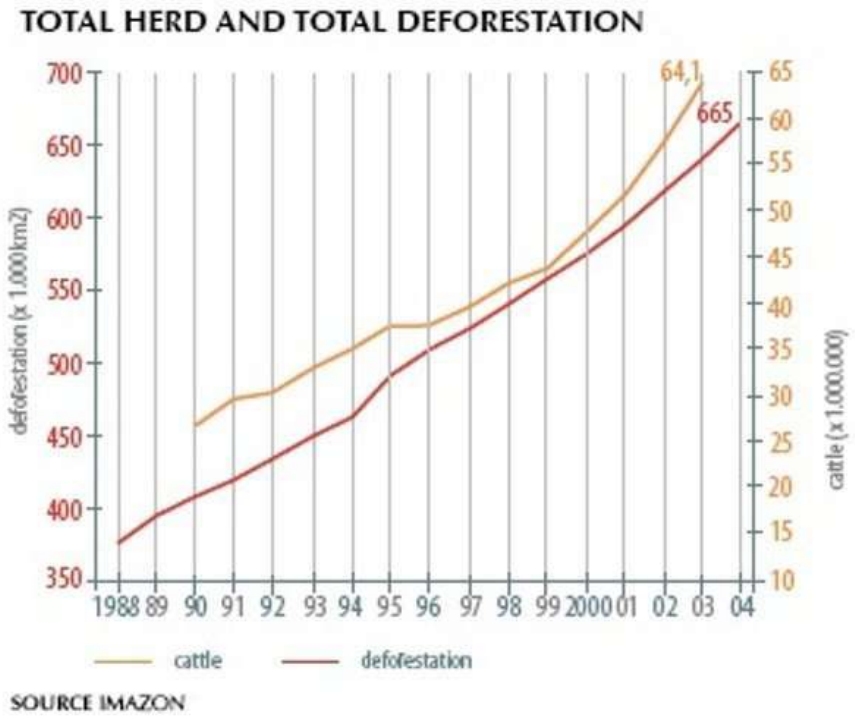

Figure 9.9: **Total cattle herds and total deforestation in Amazonia between 1988 and 2104. Deforestation is measured in thousands of square kilometers, while herd size is measured in millions.**

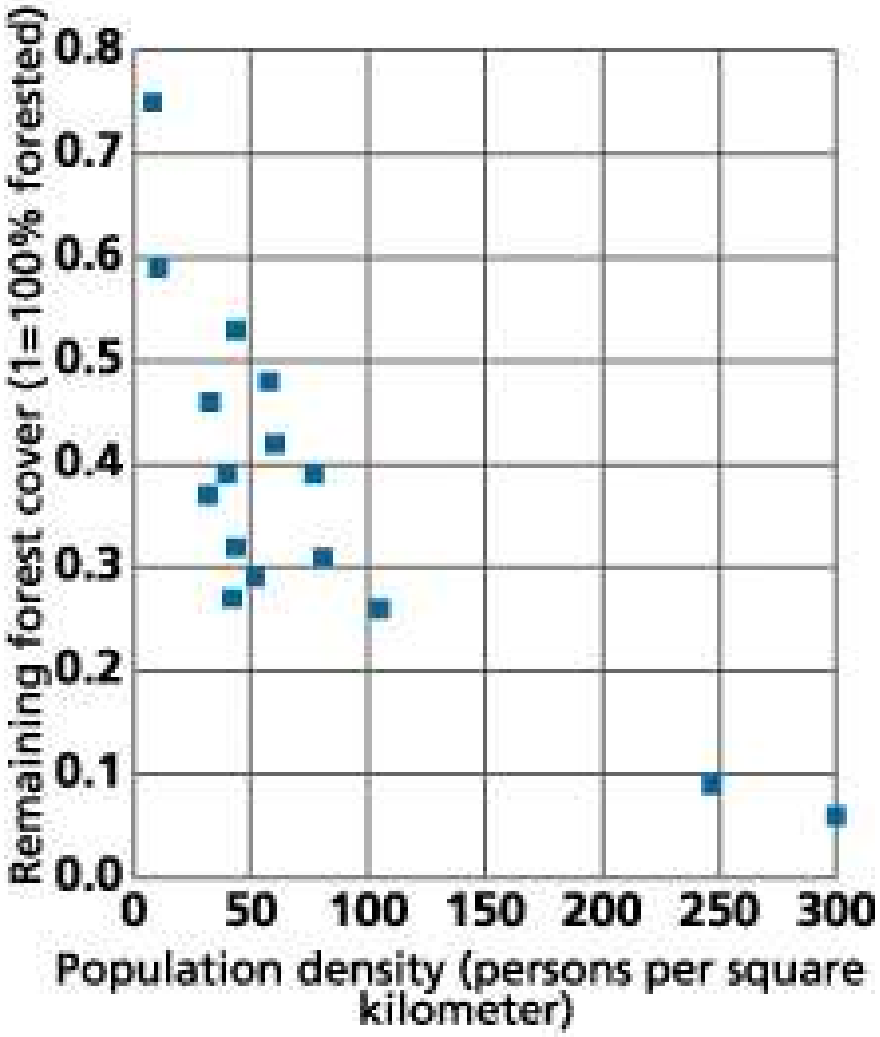

Figure 9.10: **Population density and forest size.**

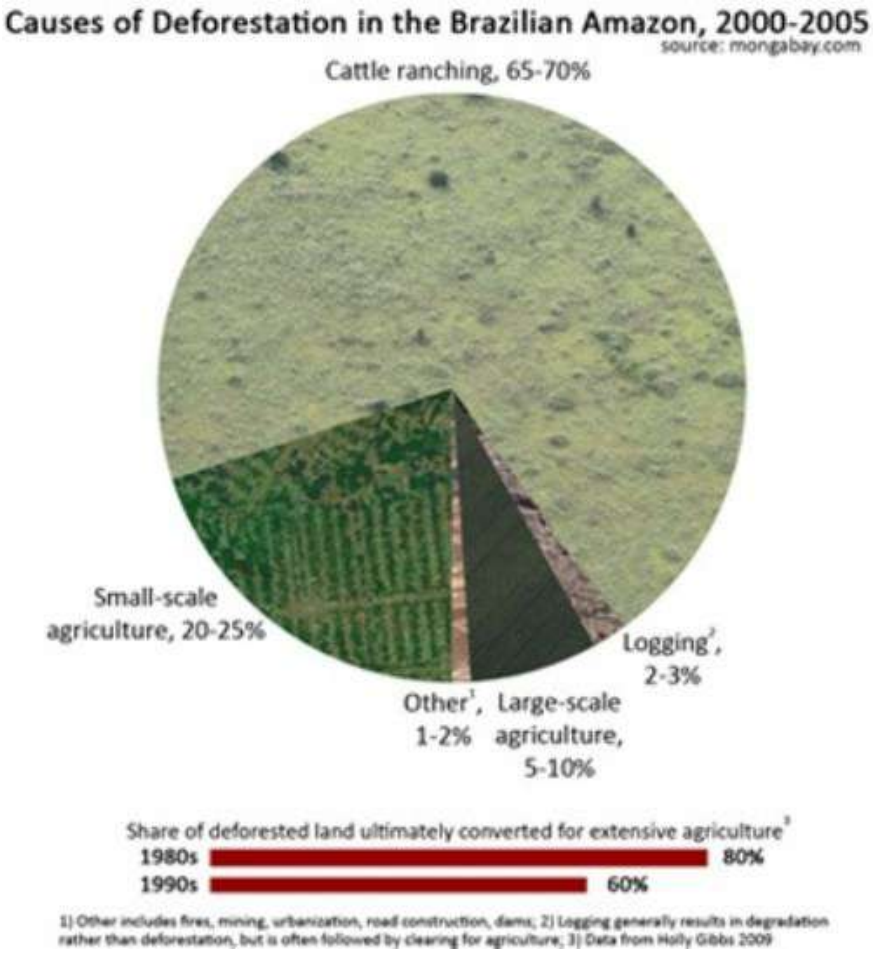

Figure 9.11: **This figure shows the causes of Amazonian deforestation. The largest is beef production.**

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.

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 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

[4] http://www.prb.org/Publications/Articles/2004/PopulationGrowthandDeforestationACriticalandComplexRelationship.aspx

[5] Population Action International, *Why Population Matters to Forests*

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, bee-keeping, and other trades. The movement emphasizes economic justice and empowerment of women. This

[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.**

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.

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)
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- *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)

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- *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)
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- *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)
- *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 9.14: **Paul R. Ehrlich in 1974.**

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.[
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- *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.
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- *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.
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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 Planet* (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?

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.**

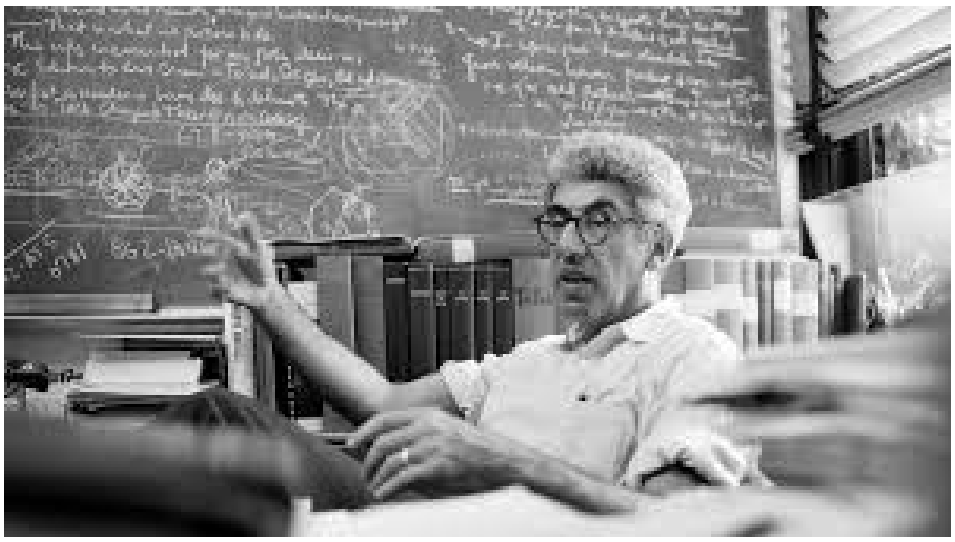
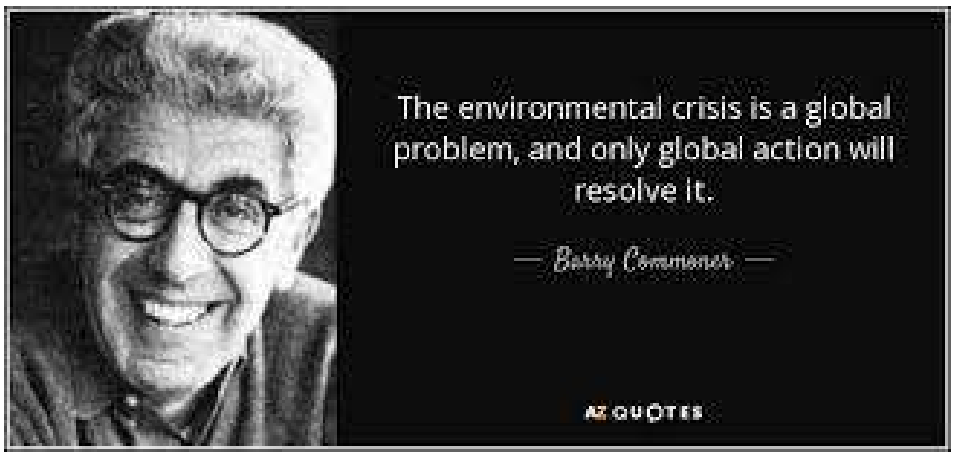
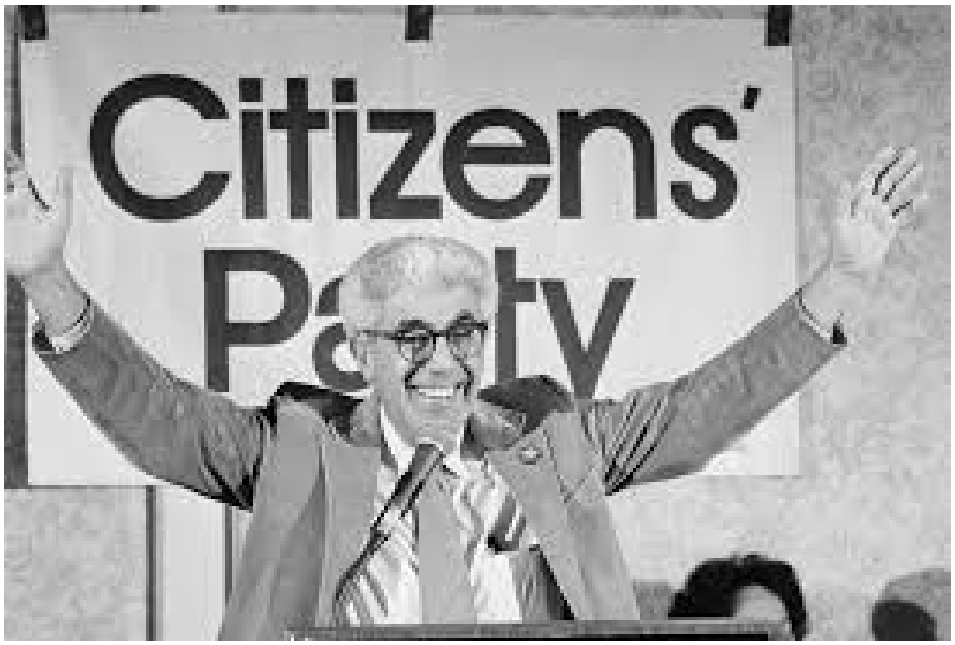


Figure 9.21: **Barry Commoner died at the age of 95 in 2012.**





The 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.

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.

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Chapter 10

VOICES DEFENDING NATURE

10.1 Luther Standing Bear

Luther Standing Bear (1868-1939) was a native American Lakota chief. He spanned both his native traditions and the white culture, having received an education at the Carlisle Industrial School. He became the author of many books, for example *My People, The Soux*, *My Indian Boyhood*, and *Land of the Spotted Eagle*.

Some quotations from Luther Standing Bear

The old Lakota was wise. He knew that man's heart away from nature becomes hard; he knew that lack of respect for growing, living things soon led to lack of respect for humans, too.

Out of the Indian approach to life there came a great freedom, an intense and absorbing respect for life, enriching faith in a Supreme Power, and principles of truth, honesty, generosity, equity and brotherhood as a guide to mundane relations.

As a child I understood how to give, I have forgotten this grace since I have become civilized.

There is a road in the hearts of all of us, hidden and seldom traveled, which leads to an unknown, secret place. The old people came literally to love the soil, and they sat or reclined on the ground with a feeling of being close to a mothering power. Their teepees were

Figure 10.1: **Chief Luther Standing Bear (1868-1939), author and philosopher. In one of his books, he wrote: "I find [a] great distinction between the faith of the Indian and the white man. Indian faith sought the harmony of man with his surroundings, the other sought the dominance of surroundings."**

built upon the earth and their altars were made of earth. The soul was soothing, strengthening, cleansing, and healing. That is why the old Indian still sits upon the earth instead of propping himself up and away from its life giving forces. For him, to sit or lie upon the ground is to be able to think more deeply and to feel more keenly. He can see more clearly into the mysteries of life and come closer in kinship to other lives about him.

Hollow Horn Bear knew that to be leader and adviser of his people he must be honest and reliable, and that his word once given in promise must never be taken back. He knew that he must be a man of will-power, standing for the right no matter what happened to him personally; that he must have strength of purpose, allowing no influence to turn him from doing what was best for the tribe. He must be willing to serve his people without thought of pay. He must be utterly unselfish and kind-hearted to the old and poor and stand ready to give to those in need. Above all, he must be unafraid to deal equal justice to all.

Generosity is a mark of bravery, so all Sioux boys were taught to be generous.

Wherever forests have not been mowed down, wherever the animal is recessed in their quiet protection, wherever the earth is not bereft of four-footed life - that to the white man is an 'unbroken wilderness.' But for us there was no wilderness, nature was not dangerous but hospitable, not forbidding but friendly. Our faith sought the harmony of man with his surroundings; the other sought the dominance of surroundings. For us, the world was full of beauty; for the other, it was a place to be endured until he went to another world. But we were wise. We knew that man's heart, away from nature, becomes hard.

Kinship with all creatures of the earth, sky, and water was a real and active principle. In the animal and bird world there existed a brotherly feeling that kept us safe among them... The animals had rights - the right of man's protection, the right to live, the right to multiply, the right to freedom, and the right to man's indebtedness. This concept of life and its relations filled us with the joy and mystery of living; it gave us reverence for all life; it made a place for all things in the scheme of existence with equal importance to all.

Figure 10.2: **We must be the friend of nature. We must respect nature.**

And here I find the great distinction between the faith of the Indian and the white man. Indian faith sought the harmony of man with his surroundings, the other sought the dominance of surroundings.

Loss of biodiversity

Tropical forests are being destroyed at an alarming rate, with a catastrophic loss of biodiversity. The burning of fossil fuels and the destruction of tropical forests have produced an increase of carbon dioxide in the earth's atmosphere and a steadily increasing average global temperature. Tropical rain forests are thought to be the habitat of more than half of the world's species of plants, animals and insects; and their destruction is accompanied by an alarming rate of extinction of species. The Harvard biologist, E.O. Wilson, estimates that the rate of extinction resulting from deforestation in the tropics may now exceed 4,000 species per year - 10,000 times the natural background rate (*Scientific American*, September, 1989).

The enormous biological diversity of tropical rain forests has resulted from their stability. Unlike northern forests, which have been affected by glacial epochs, tropical forests have existed undisturbed for millions of years. As a result, complex and fragile ecological systems have had a chance to develop. Professor Wilson expresses this in the following words: *Fragile superstructures*

Figure 10.3: **We are not the rulers of nature. We are a part of nature, on equal footing with plants and animals.**

Figure 10.4: **We must learn to derive more of our happiness from enjoyment of the beauty of the natural world.**

Figure 10.5: **Even the humblest living creature is worthy of our respect and wonder. This is what Albert Schweitzer meant when he spoke of "reverence for life".**

of species build up when the environment remains stable enough to support their evolution during long periods of time. Biologists now know that biotas, like houses of cards, can be brought tumbling down by relatively small perturbations in the physical environment. They are not robust at all.

The number of species which we have until now domesticated or used in medicine is very small compared with the number of potentially useful species still waiting in the world's tropical rain forests. When we destroy them, we damage our future. But we ought to regard the annual loss of thousands of species as a tragedy, not only because biological diversity is potential wealth for human society, but also because every form of life deserves our respect and protection.

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, they are rapidly leached away. 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 the Khmer civilization, which built these temples a thousand

years ago, disappeared because of laterization of the soil.

The mathematical properties of exponential growth

Our economists, whose education is based on the assumptions of Adam Smith and other economic thinkers of the early Industrial Revolution, still continue to regard Growth as the Holy Grail. A 5% rate of growth is considered to be the mark of a healthy economy. This blind faith in growth can only be maintained by ignoring not only the rapid approach of the global economy to limits imposed by the carrying capacity of the earth's environment, but also by ignoring the mathematical properties of exponential growth. Economists apparently refuse to look more than a decade or so into the future. What they would see, if they looked a little farther, is that a 5 percent rate of growth implies that whatever is growing will double in 14 years, grow by a factor of 132 in a century, by a factor of 17,292 in two centuries, by a factor of 2,273,996 in three centuries, and so on. Thus, in the long run, economic growth cannot possibly be sustainable; nor can population growth be sustainable, as can be seen from the mathematics of any type of exponential growth.

The goals of education, especially the education of economists, need to be changed in such a way as to include a realistic picture of today's world. All students, especially economists, must learn the fact that in the long run neither population growth nor economic growth is sustainable. A new kind of economics should be taught - not "empty world" economics but "full world" economics; not the economics of growth but the economics of equilibrium and stability.

The social impact of science

Let us consider some other ways in which the world is changing, all of which imply a need for new goals in education. Science and technology have developed extremely rapidly in recent decades, and they will undoubtedly continue to do so in the future. The result has been that humans now have an unprecedented and constantly increasing power over nature, which can be used for both good and evil. Science has given us the possibility of a life free from hunger and free from the constant threat of death through infectious disease. At the same time, however, our constantly accelerating technology has given us the possibility of destroying civilization in a thermonuclear war.

Since it is almost impossible to prevent science from making new discoveries that can be used both constructively and disastrously, one of the new goals of education must be to give voters the knowledge needed to choose wisely the among ways in which our enormous new powers over nature can to be used.

This implies that some familiarity with science is needed even for students who specialize in the humanities. A study of the history and social impact of science ought to be part of the education of both scientists and humanists. This should include discussions of global problems and ethical dilemmas related to scientific and technological progress. Scientists also need some background in the humanities in order to see their work as part of a larger picture.

Global ethics

Traditional education has always tried to produce patriotism in its students. This may once have been a reasonable goal, but today a broader view than narrow nationalism is needed. Global interdependence and communication have increased to such an extent that the absolutely sovereign nation-state has become a dangerous anachronism. If the disaster of a third world war is to be avoided, structures of government and law must be built up at an international level. One of the new goals for education should be to prepare students for this great task. Today's students need a global ethic - a loyalty to humanity as a whole, rather that a narrowly nationalistic loyalty.

History has traditionally been taught in such a way that ones own nation is seen as being heroic and always in the right. History textbooks also emphasizes power, dominance and military conflicts. A reformed teaching of history might instead be a chronicle of the gradual cultural advances of humankind as a whole, giving adequate recognition to the contributions of all nations and peoples, and giving weight to constructive achievements rather than to power struggles and conflicts.

10.2 The earth is our mother

The World People's Conference on Climate Change and the Rights of Mother Earth

This conference took place in Tiquipaya, just outside the city of Cochabamba, Bolivia, from April 19-22, 2010. The event was attended by around 30,000 people from over 100 countries. It was hosted by the Bolivian government, and the proceedings were transmitted online by the organizations OneClimate and Global Campaign for Climate Action.

One of the outstanding results of the conference was the drafting of a Universal Declaration of the Rights of Mother Earth, modeled on the United Nations' Universal Declaration of Human Rights. Both Declarations might be

criticized for being unrealistic,[1] but both have great normative value. They define the goals towards which we ought to be striving.

Proposed Universal Declaration of the Rights of Mother Earth[2]

Preamble

We, the peoples and nations of Earth:

- *considering that we are all part of Mother Earth, an indivisible, living community of interrelated and interdependent beings with a common destiny;*
- *gratefully acknowledging that Mother Earth is the source of life, nourishment and learning and provides everything we need to live well;*
- *recognizing that the capitalist system and all forms of depredation, exploitation, abuse and contamination have caused great destruction, degradation and disruption of Mother Earth, putting life as we know it today at risk through phenomena such as climate change;*
- *convinced that in an interdependent living community it is not possible to recognize the rights of only human beings without causing an imbalance within Mother Earth;*
- *affirming that to guarantee human rights it is necessary to recognize and defend the rights of Mother Earth and all beings in her and that there are existing cultures, practices and laws that do so;*
- *conscious of the urgency of taking decisive, collective action to transform structures and systems that cause climate change and other threats to Mother Earth;*
- *proclaim this Universal Declaration of the Rights of Mother Earth, and call on the General Assembly of the United Nation to adopt it, as a common standard of achievement for all peoples and all nations of the world, and to the end that every individual and institution takes responsibility for promoting through teaching, education, and consciousness raising,*

[1] https://www.transcend.org/tms/2012/12/human-rights-a-letter-to-santa-claus/

[2] https://www.theguardian.com/environment/2011/apr/10/bolivia-enshrines-natural-worlds-rights
https://pwccc.wordpress.com

respect for the rights recognized in this Declaration and ensure through prompt and progressive measures and mechanisms, national and international, their universal and effective recognition and observance among all peoples and States in the world.

Article 1: Mother Earth

1. *Mother Earth is a living being.*
2. *Mother Earth is a unique, indivisible, self-regulating community of interrelated beings that sustains, contains and reproduces all beings.*
3. *Each being is defined by its relationships as an integral part of Mother Earth.*
4. *The inherent rights of Mother Earth are inalienable in that they arise from the same source as existence.*
5. *Mother Earth and all beings are entitled to all the inherent rights recognized in this Declaration without distinction of any kind, such as may be made between organic and inorganic beings, species, origin, use to human beings, or any other status.*
6. *Just as human beings have human rights, all other beings also have rights which are specific to their species or kind and appropriate for their role and function within the communities within which they exist.*
7. *The rights of each being are limited by the rights of other beings and any conflict between their rights must be resolved in a way that maintains the integrity, balance and health of Mother Earth.*

Article 2. Inherent Rights of Mother Earth

1. *Mother Earth and all beings of which she is composed have the following inherent rights:*
   - *(a) the right to life and to exist;*
   - *(b) the right to be respected;*
   - *(c) the right to regenerate its bio-capacity and to continue its vital cycles and processes free from human disruptions;*
   - *(d) the right to maintain its identity and integrity as a distinct, self-regulating and interrelated being;*
   - *(e) the right to water as a source of life;*

Figure 10.6: **The earth is our mother.**

(f) the right to clean air;

(g) the right to integral health;

(h) the right to be free from contamination, pollution and toxic or radioactive waste;

(i) the right to not have its genetic structure modified or disrupted in a manner that threatens it integrity or vital and healthy functioning;

(j) the right to full and prompt restoration the violation of the rights recognized in this Declaration caused by human activities;

2. *Each being has the right to a place and to play its role in Mother Earth for her harmonious functioning.*

3. *Every being has the right to wellbeing and to live free from torture or cruel treatment by human beings.*

Article 3. Obligations of human beings to Mother Earth

1. *Every human being is responsible for respecting and living in harmony with Mother Earth.*

2. *Human beings, and all States guarantee peace and eliminate nuclear, chemical and biological weapons;*

   (a) *act in accordance with the rights and obligations recognized in this Declaration;*

   (b) *recognize and promote the full implementation and enforcement of the rights and obligations recognized in this Declaration;*

   (c) *promote and participate in learning, analysis, interpretation and communication about how to live in harmony with Mother Earth in accordance with this Declaration;*

   (d) *ensure that the pursuit of human wellbeing contributes to the well-being of Mother Earth, now and in the future;*

   (e) *establish and apply effective norms and laws for the defense, protection and conservation of the rights of Mother Earth;*

   (f) *respect, protect, conserve and where necessary, restore the integrity, of the vital ecological cycles, processes and balances of Mother Earth;*

   (g) *guarantee that the damages caused by human violations of the inherent rights recognized in this Declaration are rectified and that those responsible are held accountable for restoring the integrity and health of Mother Earth;*

   (h) *empower human beings and institutions to defend the rights of Mother Earth and of all beings;*

   (i) *establish precautionary and restrictive measures to prevent human activities from causing species extinction, the destruction of ecosystems or the disruption of ecological cycles;*

   (j) *guarantee peace and eliminate nuclear, chemical and biological weapons;*

   (k) *promote and support practices of respect for Mother Earth and all beings, in accordance with their own cultures, traditions and customs;*

   (l) *promote economic systems that are in harmony with Mother Earth and in accordance with the rights recognized in this Declaration.*

Figure 10.7: **Love and respect Mother Earth.**

Figure 10.8: **We need reverence for all life, and even reverence for inanimate nature. We need respect and love for Mother Earth. She will return out love.**

Article 4: Definitions

1. *The term "being" includes ecosystems, natural communities, species and all other natural entities which exist as part of Mother Earth.*

2. *Nothing in this Declaration restricts the recognition of other inherent rights of all beings or specified beings.*

10.3 Henry David Thoreau

In the distant future (and perhaps even in the not-so-distant future) industrial civilization will need to abandon its relentless pursuit of unnecessary material goods and economic growth. Modern society will need to re-establish a balanced and harmonious relationship with nature. In preindustrial societies harmony with nature is usually a part of the cultural tradition. In our own time, the same principle has become central to the ecological counter-culture while the main-stream culture thunders blindly ahead, addicted to wealth, power and growth.

In the 19th century the American writer, Henry David Thoreau (1817-1862), pioneered the concept of a simple life, in harmony with nature. Today, his classic book, *Walden*, has become a symbol for the principles of ecology, simplicity, and respect for nature.

Thoreau was born in Concord Massachusetts, and he attended Harvard from 1833 to 1837. After graduation, he returned home, worked in his family's pencil factory, did odd jobs, and for three years taught in a progressive school founded by himself and his older brother, John. When John died of lockjaw in 1842, Henry David was so saddened that he felt unable to continue the school alone.

Nonviolent civil disobedience

Thoreau refused to pay his poll tax because of his opposition to the Mexican War and to the institution of slavery. Because of his refusal to pay the tax (which was in fact a very small amount) he spent a night in prison. To Thoreau's irritation, his family paid the poll tax for him and he was released. He then wrote down his ideas on the subject in an essay entitled *The Duty of Civil Disobedience*, where he maintains that each person has a duty to follow his own individual conscience even when it conflicts with the orders of his government.

In his essay, Thoreau said: "A common and natural result of an undue respect for law is that you may see a file of soldiers, colonel, captain, cor-

poral, privates, powder-monkeys, and all marching in admirable order over hill and dale to the wars, against their wills, ay, against their common sense and consciences, which makes it very steep marching indeed, and produces a palpitation of the heart. They have no doubt that it is a damnable business in which they are concerned; they are all peaceably inclined. Now, what are they? Men at all? or small movable forts and magazines, at the service of some unscrupulous man in power?"

"Under a government that which imprisons any unjustly", Thoreau wrote, "the true place for a just man is in prison." Civil Disobedience influenced Tolstoy, Gandhi and Martin Luther King, and it anticipated the Nuremberg Principles.

10.4 Harmony with nature

Thoreau became the friend and companion of the transcendentalist writer Ralph Waldo Emerson (1803 1882), who introduced him to a circle of New England writers and thinkers that included Ellery Channing, Margaret Fuller and Nathaniel Hawthorne.

Nathaniel Hawthorne described Thoreau in the following words: "Mr. Thorow [sic] is a keen and delicate observer of nature, a genuine observer, which, I suspect, is almost as rare a character as even an original poet; and Nature, in return for his love, seems to adopt him as her especial child, and shows him secrets which few others are allowed to witness. He is familiar with beast, fish, fowl, and reptile, and has strange stories to tell of adventures, and friendly passages with these lower brethren of mortality. Herb and flower, likewise, wherever they grow, whether in garden, or wild wood, are his familiar friends. He is also on intimate terms with the clouds and can tell the portents of storms. It is a characteristic trait, that he has a great regard for the memory of the Indian tribes, whose wild life would have suited him so well; and strange to say, he seldom walks over a plowed field without picking up an arrow-point, a spear-head, or other relic of the red men, as if their spirits willed him to be the inheritor of their simple wealth."

Walden, an experiment in simple living

At Emerson's suggestion, Thoreau opened a journal, in which he recorded his observations concerning nature and his other thoughts. Ultimately the journal contained more than 2 million words. Thoreau drew on his journal when writing his books and essays, and in recent years, many previously unpublished parts of his journal have been printed.

Figure 10.9: **Henry David Thoreau (1817-1862). Daguerreotype by Benjamin D. Maxham, 1856).**

From 1845 until 1847, Thoreau lived in a tiny cabin that he built with his own hands. The cabin was in a second-growth forest beside Walden Pond in Concord, on land that belonged to Emerson. Thoreau regarded his life there as an experiment in simple living. He described his life in the forest and his reasons for being there in his book *Walden*,

"Most of the luxuries", Thoreau wrote, "and many of the so-called comforts of life, are not only not indispensable, but positive hindrances to the elevation of mankind. With respect to luxuries, the wisest have ever lived a more simple and meager life than the poor. The ancient philosophers, Chinese, Hindoo, Persian, and Greek, were a class than which none has been poorer in outward riches, none so rich in inward."

Elsewhere in "Walden", Thoreau remarks, "It is never too late to give up your prejudices", and he also says, "Why should we be in such desperate haste to succeed, and in such desperate enterprises? If a man does not keep pace with his companions, perhaps it is because he hears a different drummer." Other favorite quotations from Thoreau include "Rather than love, than money, than fame, give me truth", "Beware of all enterprises that require new clothes", "Most men lead lives of quiet desperation" and "Men have become tools of their tools."

Thoreau's closeness to nature can be seen from the following passage, written by his friend Frederick Willis, who visited him at Walden Pond in 1847, together with the Alcott family: "He was talking to Mr. Alcott of the wild flowers in Walden woods when, suddenly stopping, he said: 'Keep very still and I will show you my family.' Stepping quickly outside the cabin door, he gave a low and curious whistle; immediately a woodchuck came running towards him from a nearby burrow. With varying note, yet still low and strange, a pair of gray squirrels were summoned and approached him fearlessly. With still another note several birds, including two crows flew towards him, one of the crows nestling upon his shoulder. I remember that it was the crow resting close to his head that made the most vivid impression on me, knowing how fearful of man this bird is. He fed them all from his hand, taking food from his pocket, and petted them gently before our delighted gaze; and then dismissed them by different whistling, always strange and low and short, each wild thing departing instantly at hearing his special signal."

Thoreau's views on religion

Towards the end of his life, when he was very ill, someone asked Thoreau whether he had made his peace with God. "We never quarreled", he answered.

In an essay published by the Atlantic Monthly in 1853, Thoreau described

a pine tree in Maine with the words: "It is as immortal as I am, and perchance will go to as high a heaven, there to tower above me still." However, the editor (James Russell Lowell) considered the sentence to be blasphemous, and removed it from Thoreau's essay.

In one of his essays, Thoreau wrote: "If a man walk in the woods for love of them half of each day, he is in danger of being regarded as a loafer; but if he spends his whole day as a speculator, shearing off those woods and making the earth bald before her time, he is esteemed an industrious and enterprising citizen."

A few more things that Thoreau said

It is the beauty within us that makes it possible for us to recognize the beauty around us. The question is not what you look at, but what you see.

Simplify your life. Don't waste the years struggling for things that are unimportant. Don't burden yourself with possessions. Keep your needs and wants simple and enjoy what you have. Don't destroy your peace of mind by looking back, worrying about the past. Live in the present. Simplify!

Go confidently in the direction of your dreams. Live the life you've imagined.

Happiness is like a butterfly; the more you chase it, the more it will elude you, but if you turn your attention to other things, it will come and sit softly on your shoulder.

You must live in the present, launch yourself on every wave, find your eternity in each moment. Fools stand on their island of opportunities and look toward another land. There is no other land; there is no other life but this

Be not simply good, be good for something,

Books are the treasured wealth of the world and the fit inheritance of generations and nations.

If you have built castles in the air, your work need not be lost; that

is where they should be. Now put the foundations under them.

If a man does not keep pace with his companions, perhaps it is because he hears a different drummer. Let him step to the music he hears, however measured or far away.

The greatest compliment that was ever paid me was when one asked me what I thought, and attended to my answer.

We need the tonic of wildness...At the same time that we are earnest to explore and learn all things, we require that all things be mysterious and unexplorable, that land and sea be indefinitely wild, unsurveyed and unfathomed by us because unfathomable. We can never have enough of nature.

I see young men, my townsmen, whose misfortune it is to have inherited farms, houses, barns, cattle, and farming tools; for these are more easily acquired than got rid of. Better if they had been born in the open pasture and suckled by a wolf, that they might have seen with clearer eyes what field they were called to labor in.

A man is rich in proportion to the number of things which he can afford to let alone.

The man who goes alone can start today; but he who travels with another must wait till that other is ready

I would not have any one adopt my mode of living on any account; for, beside that before he has fairly learned it I may have found out another for myself, I desire that there may be as many different persons in the world as possible; but I would have each one be very careful to find out and pursue his own way, and not his father's or his mother's or his neighbor's instead. The youth may build or plant or sail, only let him not be hindered from doing that which he tells me he would like to do. It is by a mathematical point only that we are wise, as the sailor or the fugitive slave keeps the polestar in his eye; but that is sufficient guidance for all our life. We may not arrive at our port within a calculable period, but we would preserve the true course.

Be a Columbus to whole new continents and worlds within you,

opening new channels, not of trade, but of thought.

I never found the companion that was so companionable as solitude.

For more than five years I maintained myself thus solely by the labor of my hands, and I found, that by working about six weeks in a year, I could meet all the expenses of living. The whole of my winters, as well as most of my summers, I had free and clear for study.

Perhaps we are led oftener by the love of novelty, and a regard for the opinions of men, in procuring it, than by a true utility.

Our inventions are wont to be pretty toys, which distract our attention from serious things. They are but improved means to an unimproved end, an end which it was already but too easy to arrive at; as railroads lead to Boston or New York. We are in great haste to construct a magnetic telegraph from Maine to Texas; but Maine and Texas, it may be, have nothing important to communicate.

The grass flames up on the hillsides like a spring fire,–"et primitus oritur herba imbribus primoribus evocata,"–as if the earth sent forth an inward heat to greet the returning sun; not yellow but green is the color of its flame;–the symbol of perpetual youth, the grass-blade, like a long green ribbon, streams from the sod into the summer, checked indeed by the frost, but anon pushing on again, lifting its spear of last year's hay with the fresh life below.... So our human life but dies down to its root, and still puts forth its green blade to eternity.

I sometimes wonder that we can be so frivolous, I may almost say, as to attend to the gross but somewhat foreign form of servitude called Negro Slavery, there are so many keen and subtle masters that enslave both north and south. It is hard to have a southern overseer; it is worse to have a northern one; but worst of all when you are the slave-driver of yourself.

I learned this, at least, by my experiment: that if one advances confidently in the direction of his dreams, and endeavors to live the life which he has imagined, he will meet with a success unexpected in common hours.

Books are the treasured wealth of the world and the fit inheritance of generations and nations.

We need the tonic of wildness...At the same time that we are earnest to explore and learn all things, we require that all things be mysterious and unexplorable, that land and sea be indefinitely wild, unsurveyed and unfathomed by us because unfathomable. We can never have enough of nature.

Live in each season as it passes; breathe the air, drink the drink, taste the fruit, and resign yourself to the influence of the earth.

However mean your life is, meet it and live it; do not shun it and call it hard names. It is not so bad as you are. It looks poorest when you are richest. The fault-finder will find faults even in paradise. Love your life, poor as it is. You may perhaps have some pleasant, thrilling, glorious hours, even in a poorhouse. The setting sun is reflected from the windows of the almshouse as brightly as from the rich man's abode; the snow melts before its door as early in the spring. I do not see but a quiet mind may live as contentedly there, and have as cheering thoughts, as in a palace.

As if you could kill time without injuring eternity.

Heaven is under our feet as well as over our heads.

Every generation laughs at the old fashions, but follows religiously the new.

I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived.

The mass of men lead lives of quiet desperation. What is called resignation is confirmed desperation. From the desperate city you go into the desperate country, and have to console yourself with the bravery of minks and muskrats. A stereotyped but unconscious despair is concealed even under what are called the games and amusements of mankind. There is no play in them, for this comes after work. But it is a characteristic of wisdom not to do desperate things.

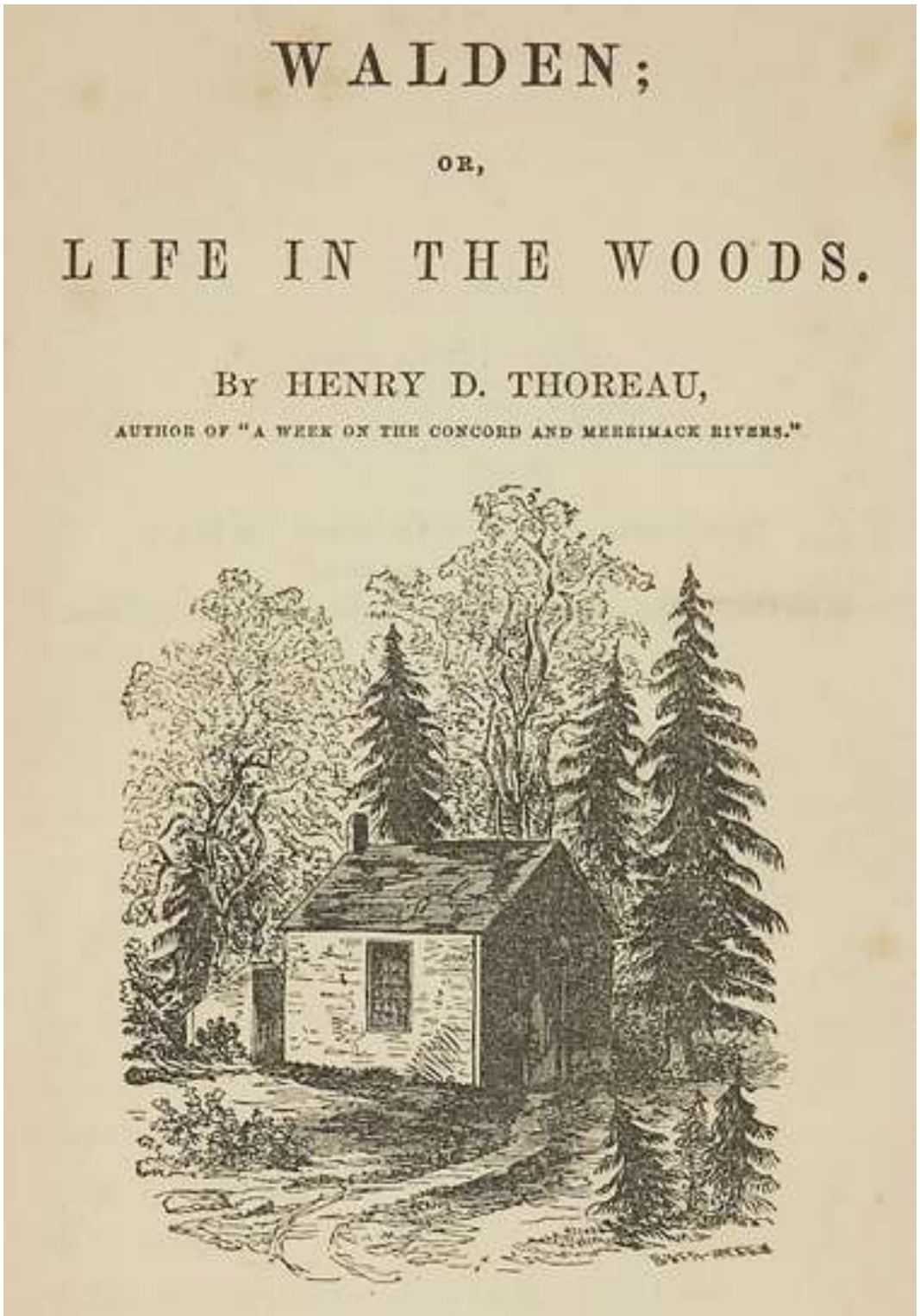

Figure 10.10: **The frontpiece of Thoreau's book, *Walden*.**

Figure 10.11: **A portrait of Ralph Waldo Emerson by Eastman Johnson, 1856. Expressing ideas that he would later develop in his his famous essay *Nature*, Emerson wrote, "Nature is a language and every new fact one learns is a new word; but it is not a language taken to pieces and dead in the dictionary, but the language put together into a most significant and universal sense. I wish to learn this language, not that I may know a new grammar, but that I may read the great book that is written in that tongue."**

Figure 10.12: **Walden Pond, as it looks today. The small cabin which Thoreau built with his own hands was near to the pond. Today Walden has become a place of pilgrimage for the environmental movement. Thoreau's complete *Journals*, which are in fact his major work, have today been published. They contain roughly seven thousand pages, and two million words.**

10.5 On the Duty of Civil Disobedience

Here are a few quotations from Thoreau's essay:

Let every man make known what kind of government would command his respect, and that will be one step toward obtaining it.

After all, the practical reason why, when the power is once in the hands of the people, a majority are permitted, and for a long period continue, to rule, is not because they are most likely to be in the right, nor because this seems fairest to the minority, but because they are physically the strongest. But a government in which the majority rule in all cases can not be based on justice, even as far as men understand it. Can there not be a government in which the majorities do not virtually decide right and wrong, but conscience? - in which majorities decide only those questions to which the rule of expediency is applicable? Must the citizen ever for a moment, or in the least degree, resign his conscience to the legislator? Why has every man a conscience, then? I think that we should be men first, and subjects afterward. It is not desirable to cultivate a respect for the law, so much as for the right. The only obligation which I have a right to assume, is to do at any time what I think right. It is truly enough said that a corporation has no conscience; but a corporation of conscientious men is a corporation with a conscience. Law never made men a whit more just; and, by means of their respect for it, even the well-disposed are daily made the agents of injustice. A common and natural result of an undue respect for the law is, that you may see a file of soldiers, colonel, captain, corporal, privates, powder-monkeys and all, marching in admirable order over hill and dale to the wars, against their wills, aye, against their common sense and consciences, which makes it very steep marching indeed, and produces a palpitation of the heart. They have no doubt that it is a damnable business in which they are concerned; they are all peaceably inclined. Now, what are they? Men at all? or small movable forts and magazines, at the service of some unscrupulous man in power? Visit the Navy Yard, and behold a marine, such a man as an American government can make, or such as it can make a man with its black arts, a mere shadow and reminiscence of humanity, a man laid out alive and standing, and already, as one may say, buried under arms with funeral accompaniment, though it may be...

Unjust laws exist: shall we be content to obey them, or shall we endeavor to amend them, and obey them until we have succeeded, or shall we transgress them at once? Men generally, under such a government as this, think that they ought to wait until they have persuaded the majority to alter them. They think that, if they should resist, the remedy would be worse than the evil. But it is the fault of the government itself that the remedy is worse than the evil. It makes it worse. Why is it not more apt to anticipate and provide for reform? Why does it not cherish its wise minority? Why does it cry and resist before it is hurt? Why does it not encourage its citizens to be on the alert to point out its faults, and do better than it would have them? Why does it always crucify Christ, and excommunicate Copernicus and Luther, and pronounce Washington and Franklin rebels?...

Under a government which imprisons any unjustly, the true place for a just man is also a prison.

Thoreau's essay "On the Duty of Civil Disobedience" influenced Mahatma Gandhi and Rev. Martin Luther King Jr. Here are Dr. King's words about Thoreau's essay:

Here, in this courageous New Englander's refusal to pay his taxes and his choice of jail rather than support a war that would spread slavery's territory into Mexico, I made my first contact with the theory of nonviolent resistance. Fascinated by the idea of refusing to cooperate with an evil system, I was so deeply moved that I reread the work several times. I became convinced that noncooperation with evil is as much a moral obligation as is cooperation with good. No other person has been more eloquent and passionate in getting this idea across than Henry David Thoreau. As a result of his writings and personal witness, we are the heirs of a legacy of creative protest. The teachings of Thoreau came alive in our civil rights movement; indeed, they are more alive than ever before. Whether expressed in a sit-in at lunch counters, a freedom ride into Mississippi, a peaceful protest in Albany, Georgia, a bus boycott in Montgomery, Alabama, these are outgrowths of Thoreau's insistence that evil must be resisted and that no moral man can patiently adjust to injustice.

10.6 The life of John Muir

His strictly religious family in Scotland

John Muir (1838-1914) has often been called "The Father of the National Parks". He was born in Scotland, to a family whose strictly religious father made him study the Bible for hours every day. The young John Muir ultimately memorized all of the New Testament and three-quarters of the Old Testament. Muir remained religious throughout his life, but he later came to see Nature as the great teacher rather than the Bible.

A farm in Wisconsin

In 1849, when John Muir was 11 years old, his family emigrated to America and bought a farm in Portage, Wisconsin. Later, when Muir was 22 years old, he enrolled in the University of Wisconsin, paying his own way, and enthusiastically taking courses on botany and geology; but because he picked courses according to his own interest, he never obtained a degree from the university.

Vocation as a naturalist and writer

John Muir finally found his true vocation in exploring wilderness regions and writing about them. Here is an excerpt from one of his books *Studies in the Sierra*:

In the beginning of the long glacial winter, the lofty Sierra seems to have consisted of one vast undulated wave, in which a thousand separate mountains, with their domes and spires, their innumerable canyons and lake basins, lay concealed. In the development of these, the Master Builder chose for a tool, not the earthquake nor lightning to rend and split asunder, not the stormy torrent nor eroding rain, but the tender snow-flowers, noiselessly falling through unnumbered seasons, the offspring of the sun and sea. If we should attempt to restore the range to its pre-glacial unsculptured condition, its network of profound canyons would have to be filled up, together with all its lake and meadow basins; and every rock and peak, however lofty, would have to be buried again beneath the fragments which the glaciers have broken off and carried away. Careful study of the phenomena presented warrants the belief that the unglaciated condition of the range was comparatively simple; yet the double summits about the head of Kern River and Lake Tahoe, and the outlying spurs of Hoffmann and Merced, would appear to indicate the pri-

mary existence of considerable depressions and elevations. Even these great features, however, may be otherwise accounted for.

Because of the great popularity of his writing, Muir became influential in the movement to preserve wilderness regions as national parks.

Influenced by Thoreau and Emerson

John Muir read the books of Henry David Thoreau and Ralph Waldo Emerson and was much influenced by them. He wrote that on his excursions in Yosemite he traveled alone, carrying "only a tin cup, a handful of tea, a loaf of bread, and a copy of Emerson". In 1871, Emerson traveled to Yosemite with some academic friends, and met John Muir. According to the naturalist John Tallmadge, "Emerson was delighted to find at the end of his career the prophet-naturalist he had called for so long ago ... And for Muir, Emerson's visit came like a laying on of hands".

Co-founding the Sierra Club

Wikipedia states that "The Sierra Club is an environmental organization in the United States. It was founded on May 28, 1892, in San Francisco, California, by the Scottish-American preservationist John Muir, who became its first president...Traditionally associated with the progressive movement, the club was one of the first large-scale environmental preservation organizations in the world, and currently engages in lobbying politicians to promote environmentalist policies."

Camping with President Theodore Roosevelt

In 1903, US President Theodore Roosevelt accompanied John Muir on a visit to Yosemite. Before they even arrived, Muir had managed to convince Roosevelt that the best way to preserve the region's beauty was through federal management. The president then asked Muir to show him the real Yosemite, and the two men set off on a camping trip on which they were largely unaccompanied. They talked late into the night, and slept in the open air. Roosevelt later told an audience, "Lying out at night under those giant Sequoias was like lying in a temple built by no hand of man, a temple grander than any human architect could by any possibility build."

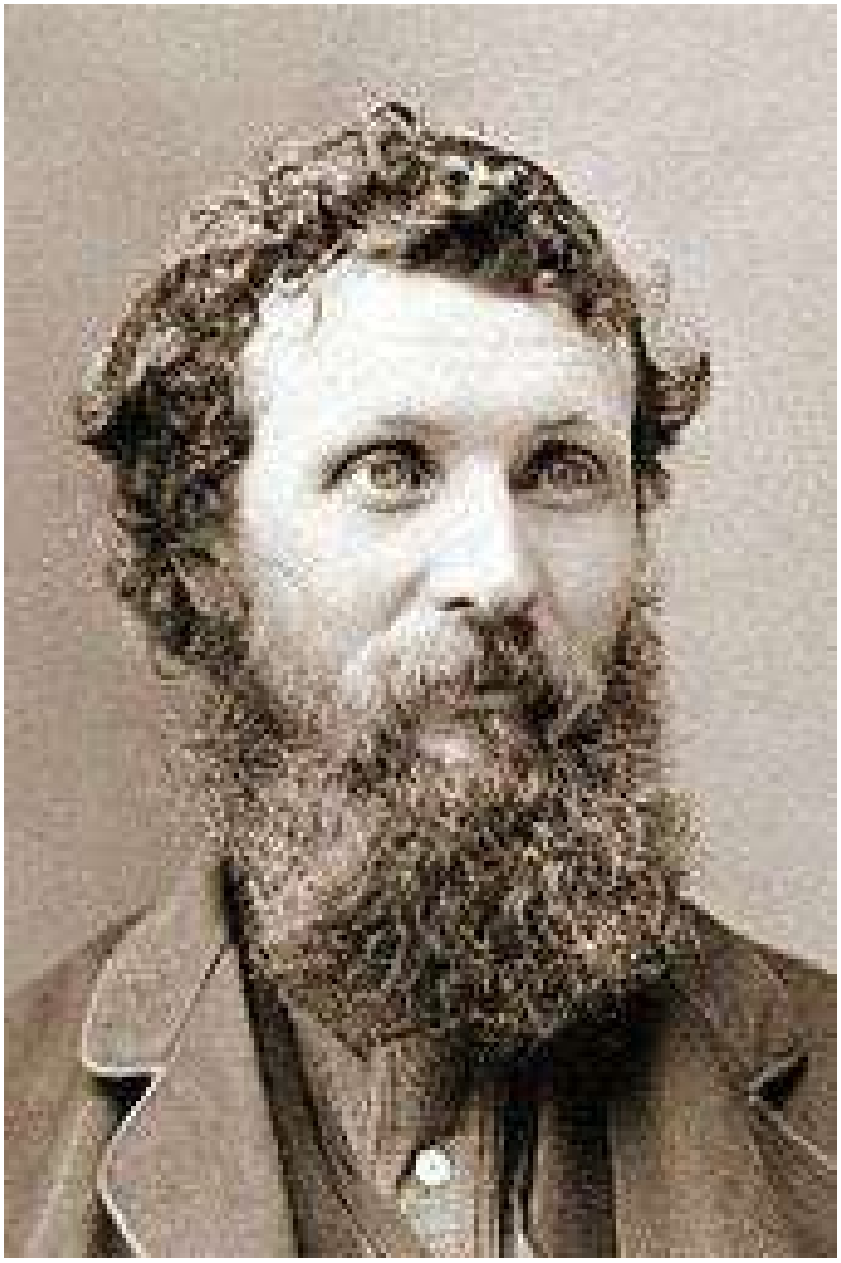

Figure 10.13: **Photo of Muir by Carleton Watkins, circa 1875.**

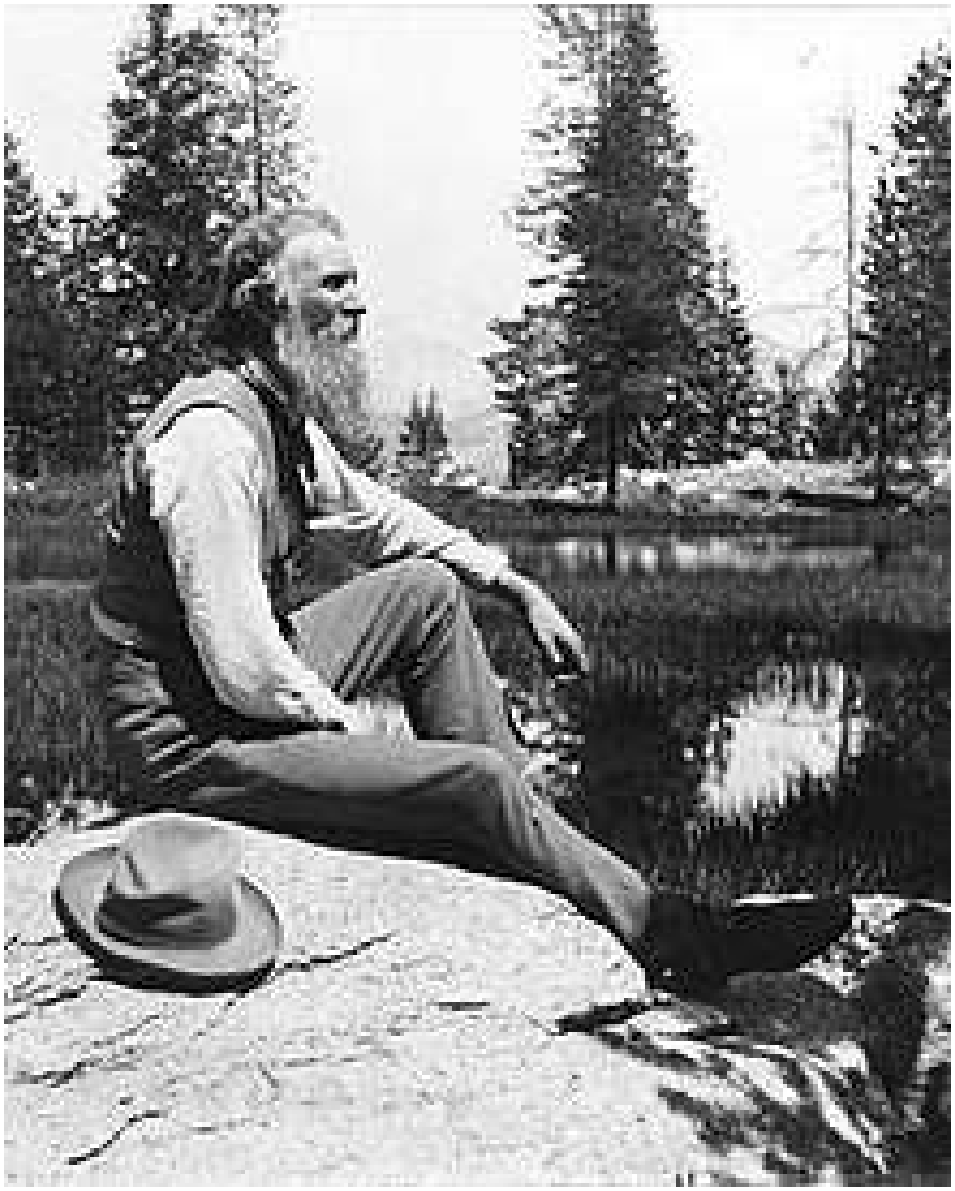

Figure 10.14: **John Muir, c. 1902.**

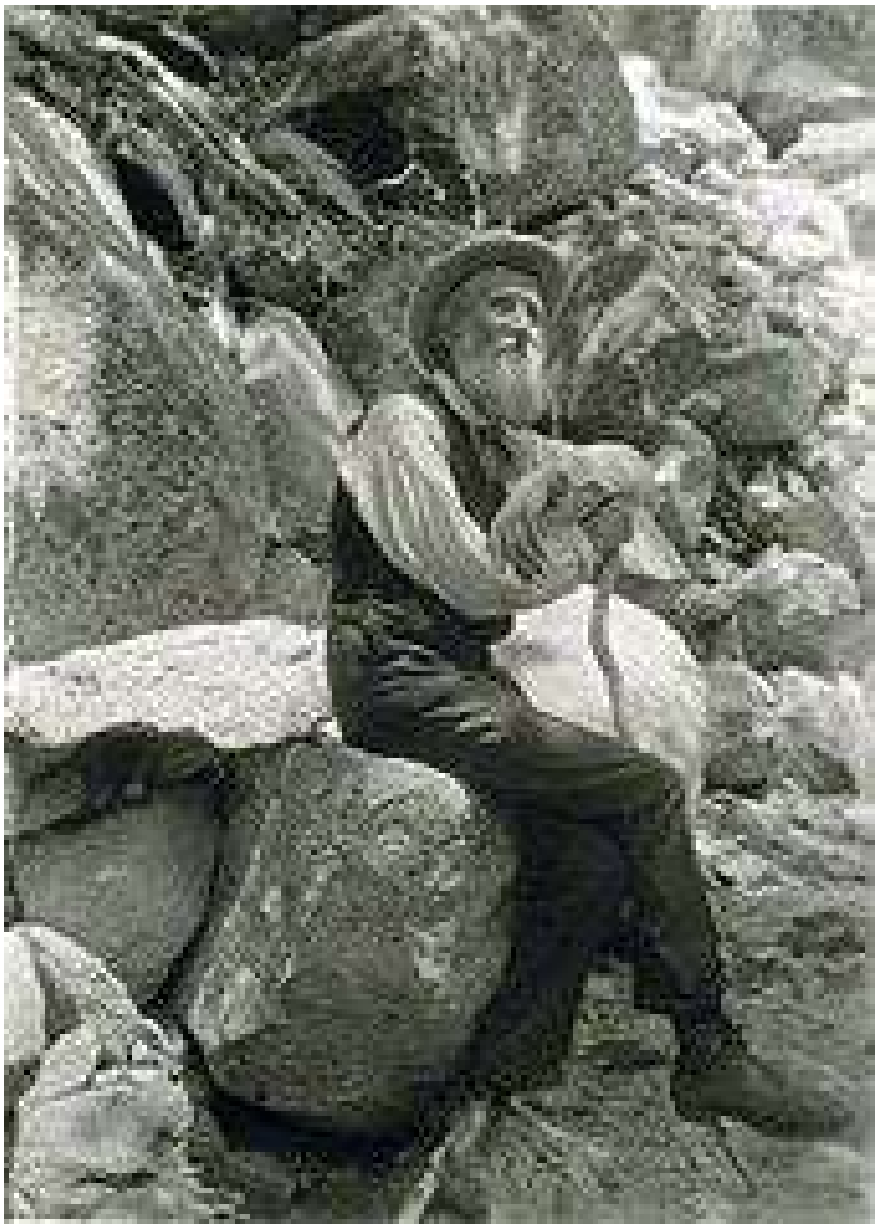

Figure 10.15: **John Muir in 1907. Muir became convinced that glaciers had sculpted many of the features of the Yosemite Valley and surrounding area. This notion was in stark contradiction to the accepted contemporary theory.**

Figure 10.16: **John Muir and US President Theodore Roosevelt at Yosemite. Muir persuaded Roosevelt to make Yosemite a National Park.**

Figure 10.17: **Theodore Roosevelt and Muir, 1906.**

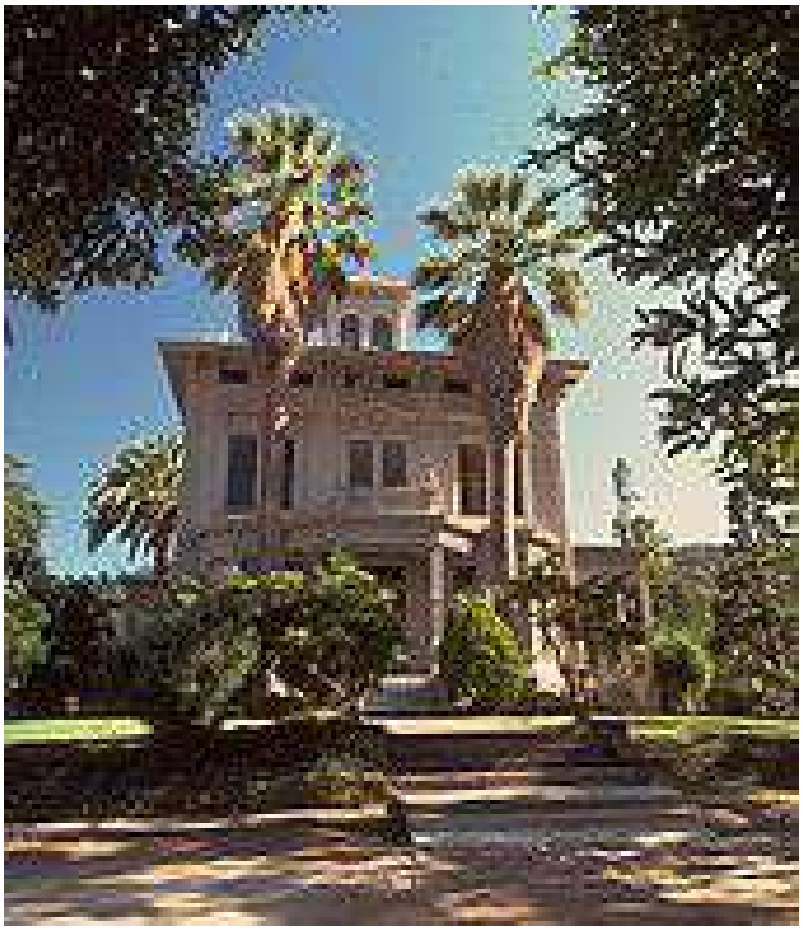

Figure 10.18: **The Muirs' home in Martinez, California, is a US National Historic Site. John Muir married at the age of 40. He was a dutiful husband, father and son-in-law, but sometimes became restless. His understanding family then encouraged him to spend a few months in his true home - the mountain wilderness.**

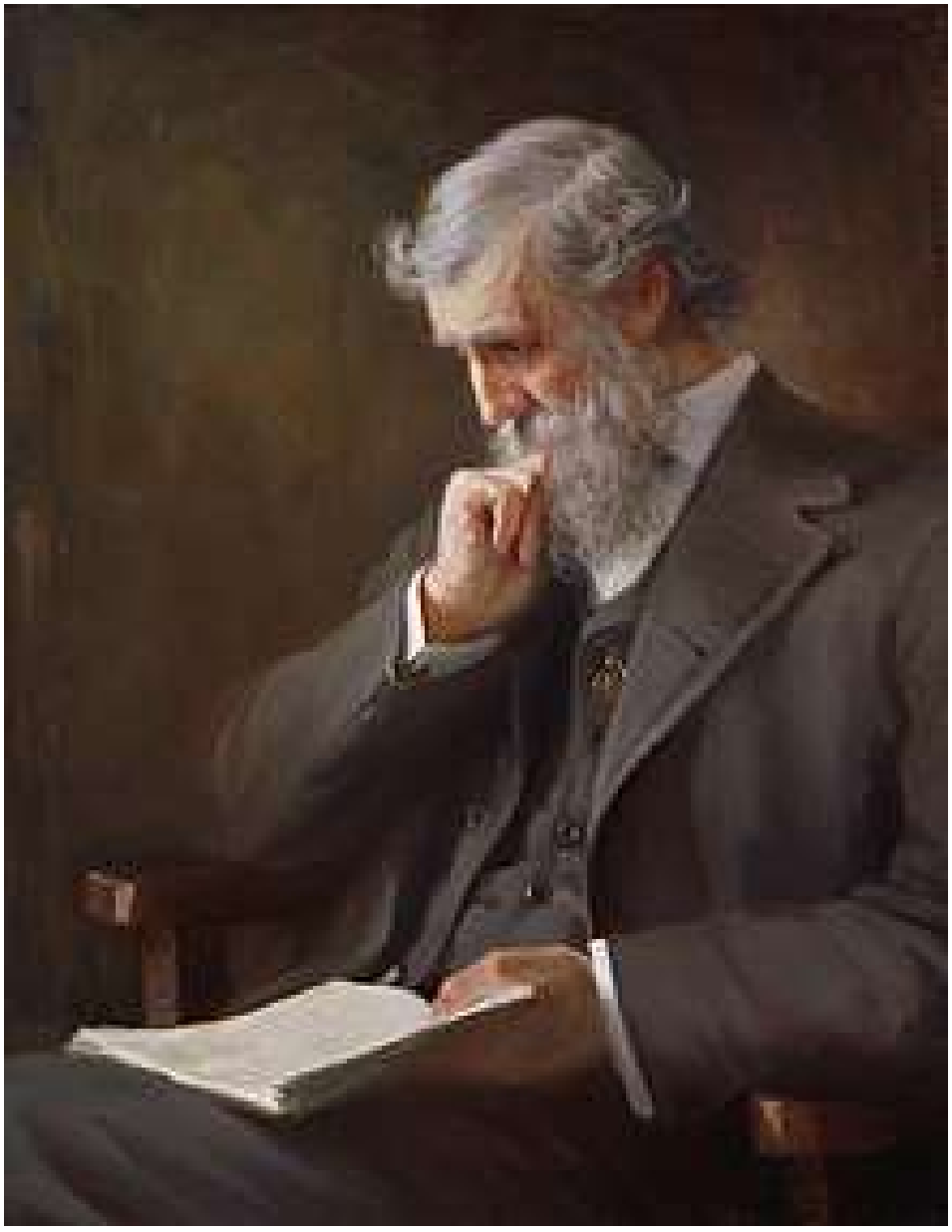

Figure 10.19: **Posthumous portrait by Orlando Rouland (1917).**

Figure 10.20: **Mount Muir located one mile south of Mount Whitney in the High Sierra.**

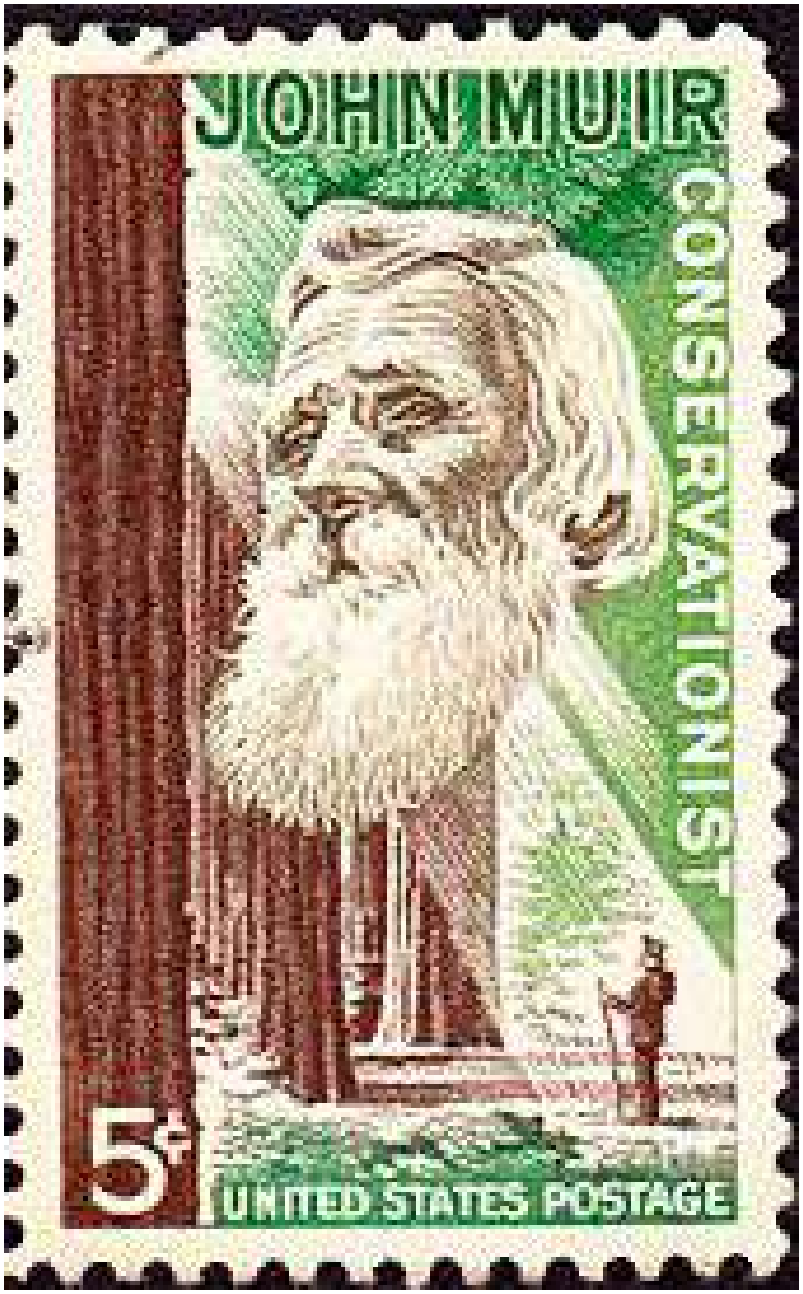

Figure 10.21: **John Muir on a 1964 U.S. commemorative stamp.**

10.7 Places named after John Muir

- Mount Muir
- Mount Muir in Chugach Mountains of Alaska
- Mount Muir (elevation 4688') in Angeles National Forest north of Pasadena, California
- Muir's Peak next to Mount Shasta, California (also known as Black Butte)
- Muir Glacier and Muir Inlet, Alaska
- John Muir Trails in California, Tennessee, Connecticut, and Wisconsin
- John Muir Wilderness (southern and central Sierra Nevada)
- Muir Pass Sequoia and Kings Canyon National Parks, the divide at 11,955' above sea level, between Evolution Creek and Middle Fork of Kings River
- Muir Woods National Monument just north of San Francisco, California
- Muir Beach, California
- John Muir National Historic Site in Martinez, California
- Camp Muir in Mount Rainier National Park
- Camp Muir on Mount Kilimanjaro
- John Muir College, one of the six undergraduate colleges of University of California, San Diego
- John Muir Highway - a section of California State Route 132 between Coulterville and Smith Station at California State Route 120. This road roughly follows part of the route Muir took on his first walk to Yosemite.
- The main-belt asteroid 128523 Johnmuir
- John Muir Country Park, East Lothian. Scotland.
- John Muir Way long distance trail in southern Scotland.
- John Muir House - the headquarters building of East Lothian Council, Scotland.
- John Muir Campus, Dunbar. One of two campuses of Dunbar Primary School, the successor to the school Muir attended.

10.8 National parks in the United States

The United States has 61 national parks. Below are some images from Muir Woods, just north of San Francisco, Yosemite National Park, and Grand Canyon National Park.


MUIR WOODS
NATIONAL MONUMENT

Books and essays by John Muir

Most of these books and essays can be read online. See, for example, Project Gutenberg or the Wikipedia article on John Muir.

Books

- *Studies in the Sierra* (1950 reprint of serials from 1874)
- *Picturesque California* 1888
- *The Mountains of California*. New York: Century, 1894.
- *Stickeen: An Adventure with a Dog and a Glacier* (1897)
- *Our National Parks*. Boston: Houghton, Mifflin, 1901.
- *My First Summer in the Sierra*. Boston: Houghton Mifflin, 1911.
- *The Yosemite*. New York: Century, 1912.
- *The Story of My Boyhood and Youth*. Boston: Houghton Mifflin, 1913.
- *Travels in Alaska*. Boston: Houghton Mifflin, 1915.
- *Letters to a Friend*. Boston: Houghton Mifflin, 1915.
- *A Thousand-mile Walk to the Gulf*. Boston: Houghton Mifflin, 1916.
- *The Cruise of the Corwin*. Boston: Houghton Mifflin, 1917.
- *Steep Trails*. Boston: Houghton, 1918.
- *Nature Writings: The Story of My Boyhood and Youth; My First Summer in the Sierra; The Mountains of California; Stickeen; Selected Essays*. New York: Library of America, 1997.
- Gifford, Terry. *John Muir: His Life and Letters and Other Writings*. London: Seattle: Mountaineers, 1996. ed.
- Tim Flinders. *John Muir: Spiritual Writings* Maryknoll, NY: Orbis Books, 2013

Essays

- *Alaska. The Discovery of Glacier Bay*
- *The American Forests*
- *Among the Animals of the Yosemite*
- *Among the Birds of the Yosemite*
- *The Coniferous Forests of the Sierra Nevada*
- *Features of the Proposed Yosemite National Park*
- *The Forests of Yosemite Park*
- *Fountains and Streams of the Yosemite*
- *In the Heart of the California Alps*
- *Living Glaciers of California*
- *The New Sequoia Forests of California*
- *A Rival of the Yosemite, King's River Canyon*

- *Snow-Storm on Mount Shasta*
- *Studies in the Sierra: The Glacier Meadows of the Sierra*
- *Studies in the Sierra: The Mountain Lakes of California*
- *Studies in the Sierra: The Passes of the Sierra*
- *The Treasures of the Yosemite*
- *The Wild Gardens of the Yosemite Park*
- *The Wild Parks and Forest Reservations of the West*
- *The Wild Sheep of the Sierra*
- *The Yellowstone National Park*
- *The Yosemite National Park*

10.9 Jane Godall; Growing up with a love of animals

Jane Goodall was born in 1934, in the London suburb of Chelsea. Both of her parents came from relatively wealthy families. Her father was an engineer, and later a racing car driver, while her mother was a writer.

When Jane was about a year old, she was given a toy chimpanzee called Jubilee, which had been made by the London Zoo to celebrate their first birth of a chimpanzee in captivity. Among her many later toys, Jubilee remained her favorite. Jane also had many pet animals, including racing snails, caterpillars, a lizard, guinea pigs, a hamster and a canary.

Fascination with Africa

At elementary school in Bournemouth, Jane became an avid reader. Her favorite books were *Doctor Doolittle*, *The Jungle Book*, and *Tarzan* - all three books involving people who were very close to animals and could communicate with them. Jane began to dream of one day going to Africa. ,

10.10 Africa, Leakey and the search for early human behavior

Jane's chance to visit Africa came in 1955, when a school friend invited her to visit her family's farm in Kenya. It was not until 1957 that Jane had saved enough money for the journey. She travelled by ship, and the journey took three weeks; but when she arrived, Africa was everything that she had dreamed

Figure 10.22: **Louis Leakey and Jane Goodall.**

of. To prolong her stay, Jane took an office job in Nairobi, where, by a stroke of luck, she met the paleontologist Louis Leakey.

Leakey was impressed by Jane's enthusiasm and by her extremely wide knowledge of natural history. He asked her to be his secretary, but what he really had in mind was to hire her to investigate the behavior of wild chimpanzees, the closes relatives of humans, hoping that it would cast light on the behavior of early humans.

10.11 The Gombe research project

Searching for hominid fossils

Before starting secretarial work for Louis Leakey, Jane spent some time with the paleontologist and his wife Mary searching for fossil hominids in Tanzinia. It was on this expedition that Leakey made his final decision that Jane would be his team's chimpanzee researcher in Gombe Park, Kenya.

Two women alone in the African bush

Following Leakey's advice, Jane returned to London in 1958 to consult with experts in the fields of primate anatomy and behavior. She was then 25 years old. By 1960, Leakey had raised enough money to fund her research, and she returned to Africa together with her mother, who stayed with her for the first few months. The two women were alone in the untamed wilderness. Gradually they became friends with the local fishermen and tribesmen. After her mother's departure, Jane (still more gradually) became accepted by Gombe Park's chimpanzee's, to whom she gave names, an unusual practice at the time.

Jane's key discoveries

- **Use of tools**: Jane discovered that chimpanzees make and use tools. For example, she observed a chimpanzee removing leaves from a twig in order to make an instrument for digging termites out of logs.

- **Hunting other animals and eating them**: Jane saw chimpanzees hunt and eat monkeys. Chimps had previously been thought to be vegetarians.

Figure 10.23: **Jane Goodall with her husband, Baron Hugo van Lawick, a Dutch wildlife photographer sent to Gombe by The National Geographic.**

- **Chimpanzee troops wage war with rival troops**: Jane observed, for the first time, deadly territorial conflicts between chimpanzee troops. This observation casts troubling light on inherited human behavior.
- **Maternal behavior is learned**: Jane observed chimpanzee mothers teaching their daughters how to care for younger infants. She remarked, "We are not the only beings on the planet with personalities, thoughts, and - most importantly - feelings".
- **Hugging, kissing and body language**: Jane observed chimpanzees hugging and kissing each other, and using the same gestures that humans would use in similar situations. She states that "The nonverbal body language is the same for chimpanzees as it is for us. They use the same gestures and postures in the same context."

Figure 10.24: **Jane and Hugo with their son.**

10.12 Roots and Shoots, and the Jane Goodall Institute

Sponsored by The National Geographic

The National Geographic Society began to sponsor Jane Goodall's work, as well as publishing her articles in their magazine. In 1963, they published her first article, *My Life Among Wild Chimpanzees*, This article was soon followed by her book, *My friends, The Wild Chimpanzees.* A little later, a highly successful television series, *Miss Goodall and the Wild Chimpanzees*, made her work known to a very wide audience.

A Ph.D. from Cambridge University

After she had made a number of important discoveries, Louis Leakey advised Jane Goodall that she ought to obtain an academic degree. This would make her ideas and observations more acceptable to the academic community. Following his advice, and with his help, she returned to England and enrolled as a Ph.D. student in ethology (the study of inherited behavior) at Cambridge University. She graduated in 1965 with a thesis entitled *Behavior of the Free-Ranging Chimpanzee.*

A professor at Stanford and Dar es Salaam

Between 1970 and 1975, Jane Goodall held a professorship at Stanford University; and in 1973 she was appointed as an honorary visiting professor of zoology at the University of Dar es Salaam in Tanzania.

The Shadow of Man

In 1971, Jane Goodall's important book, *The Shadow of Man* was published. Many other books followed, for example *The Chimpanzees of Gombe: Patterns of Behavior*, which was published in 1986, when Jane was 52 years old.

The Jane Goodall Institute

In 1977. Jane Goodall founded an institute dedicated to the continuation of research wok at Gombe and to the preservation of habitat for chimpanzees.

A global youth organization for ecology

In 1991, Jane Goodall founded Roots and Shoots, a global environmental organization dedicated to improving the environment, for for the sake of both people and animals. The organization has local chapters in over 140 countries, with over 8,000 local chapters worldwide.

A few of of Jane Goodall's many awards and honors

- Gold Medal of Conservation from the San Diego Zoological Society in 1974
- J. Paul Getty Wildlife Conservation Prize in 1984
- Albert Schweitzer Medal of the Animal Welfare Institute in 1987
- National Geographic Society Centennial Award in 1988
- Kyoto Prize in Basic Sciences in 1990
- Tyler Prize for Environmental Achievement in 1997
- Gandhi-King Award in 2001
- United Nations Messenger of Peace in 2002
- Benjamin Franklin Medal in 2003
- Dame of the British Empire in 2003
- French Legion of Honor in 2006
- Grand Officer of the Order of Merit of the Italian Republic in 2011

Figure 10.25: **Jane Goodall in Tanzania in 2018.**

Figure 10.26: **An award-winning documentary film about Jane Goodall's life and work makes use of beautiful footage filmed by her first husband, Baron Hugo van Lawick**

Books by Jane Goodall

- 1969 *My Friends the Wild Chimpanzees* Washington, DC: National Geographic Society
- 1971 *Innocent Killers (with H. van Lawick).* Boston: Houghton Mifflin; London: Collins.
- 1971 *In the Shadow of Man* Boston: Houghton Mifflin; London: Collins. Published in 48 languages.
- 1986 *The Chimpanzees of Gombe: Patterns of Behavior* Boston: Bellknap Press of the Harvard University Press. Published also in Japanese and Russian.
- 1990 *Through a Window: 30 years observing the Gombe chimpanzees* London: Weidenfeld & Nicolson; Boston: Houghton Mifflin. Translated into more than 15 languages. 1991 Penguin edition, UK.
- 1991 *Visions of Caliban* (co-authored with Dale Peterson, PhD). Boston: Houghton Mifflin.
- 1999 *Brutal Kinship* (with Michael Nichols). New York: Aperture Foundation.
- 1999 *Reason For Hope; A Spiritual Journey* (with Phillip Berman). New York: Warner Books, Inc. Translated into Japanese and Portuguese.
- 2000 *40 Years At Gombe* New York: Stewart, Tabori, and Chang.
- 2000 *Africa In My Blood* (edited by Dale Peterson). New York: Houghton Mifflin Company.
- 2002 *The Ten Trusts: What We Must Do To Care for the Animals We Love* (with Marc Bekoff). San Francisco: Harper San Francisco
- 2005 *Harvest for Hope: A Guide to Mindful Eating* New York: Warner Books, Inc.
- 2009 *Hope for Animals and Their World: How Endangered Species Are Being Rescued from the Brink* Grand Central Publishing
- 2013 *Seeds of Hope: Wisdom and Wonder from the World of Plants* (with Gail Hudson) Grand Central Publishing

Children's books by Jane Goodall

- 1972 *Grub: The Bush Baby* (with H. van Lawick). Boston: Houghton Mifflin.
- 1988 *My Life with the Chimpanzees* New York: Byron Preiss Visual Publications, Inc. Translated into French, Japanese and Chinese.
- 1989 *The Chimpanzee Family Book* Saxonville, MA: Picture Book Studio; Munich: Neugebauer Press; London: Picture Book Studio. Translated into more than 15 languages, including Japanese and Swahili.
- 1989 *Jane Goodall's Animal World: Chimps* New York: Macmillan.

- 1989 *Animal Family Series: Chimpanzee Family; Lion Family; Elephant Family; Zebra Family; Giraffe Family; Baboon Family; Hyena Family; Wildebeest Family* Toronto: Madison Marketing Ltd.
- 1994 *With Love* New York / London: North-South Books. Translated into German, French, Italian, and Japanese.
- 1999 *Dr. White* (illustrated by Julie Litty). New York: North-South Books.
- 2000 *The Eagle & the Wren* (illustrated by Alexander Reichstein). New York: North-South Books.
- 2001 *Chimpanzees I Love: Saving Their World and Ours* New York: Scholastic Press
- 2004 *Rickie and Henri: A True Story* (with Alan Marks) Penguin Young Readers Group

Films

- 1965 *Miss Goodall and the Wild Chimpanzees* National Geographic Society
- 1975 *Miss Goodall: The Hyena Story* The World of Animal Behavior Series 16mm 1979 version for DiscoVision, not released for LaserDisc
- 1984 *Among the Wild Chimpanzees* National Geographic Special
- 1988 *People of the Forest* with Hugo van Lawick
- 1990 *Chimpanzee Alert* in the Nature Watch Series, Central Television
- 1990 *The Life and Legend of Jane Goodall* National Geographic Society.
- 1990 *The Gombe Chimpanzees* Bavarian Television
- 1995 *Fifi's Boys* for the Natural World series for the BBC
- 1996 *Chimpanzee Diary* for BBC2 Animal Zone
- 1997 *Animal Minds*for BBC
- Goodall voiced herself in the animated TV series *The Wild Thornberrys*.
- 2000 *Jane Goodall: Reason For Hope* PBS special produced by KTCA
- 2001 *Chimps R Us*, on season 11, episode 8. Scientific American Frontiers. Chedd-Angier Production Company.
- 2002 *Jane Goodall's Wild Chimpanzees* (IMAX format), in collaboration with Science North
- 2005 *Jane Goodall's Return to Gombe* for Animal Planet
- 2006 *Chimps, So Like Us* HBO film nominated for 1990 Academy Award
- 2007 *When Animals Talk We Should Listen*, theatrical documentary feature co-produced by Animal Planet
- 2010 *Jane's Journey.* theatrical documentary feature co-produced by Animal Planet
- 2012 *Chimpanzee*, theatrical nature documentary feature co-produced by Disneynature

- 2017 *Jane*, biographical documentary film National Geographic Studios, in association with Public Road Productions. The film is directed and written by Brett Morgen, music by Philip Glass

10.13 Pope Francis defends nature

Early life in Argentina

His Holiness Pope Francis I was born in Buenes Aires, Argentina, in 1936. His original name was Jorge Mario Bergoglio, and both of his parents had emigrated from Italy to Argentina in order to escape from Mussolini's fascism. He was to become the first Pope from outside Europe since the Syrian Gregory II, who reigned in the 8th century.

Ordained as a priest

Jorge Bergoglio was ordained a Catholic priest in 1969. From 1973 to 1979 was Argentina's provincial superior of the Society of Jesus (Jesuits). He became the Archbishop of Buenes Aires in 1998. He made numerous journeys to Europe to study philosophy and languages. In 2001, Bergoglio was created a cardinal by Pope John Paul II.

A life of humility and simplicity

Throughout his career in the church, Bergoglio worked for the betterment of the poor, and chose for himself a life of humility and simplicity. In Argentina, he was known as the "slum archbishop" because of his work with poor slum-dwellers. When he was ordained Pope in 2013, he chose Francis as his papal name because of his admiration for the life and work of St. Francis of Assisi. In Rome, he does not live in the Papal Palace, but in a simple apartment, and he often travels to work by public transport.

10.14 Pope Francis addresses the climate emergency

In June, 2015, His Holiness Pope Francis I addressed the climate crisis in an encyclical entitled "Laudato Si' "[3]. Here are a few excerpts from this enormously important encyclical, which is addressed not only to the world's

[3]https://unfccc.int/news/pope-francis-releases-encyclical-on-climate-and-environment

1.2 billion Catholics, but also to concerned people of all faiths. After reviewing the contributions of his predecessors. Pope Francis makes the following points:

23. The climate is a common good, belonging to all and meant for all. At the global level, it is a complex system linked to many of the essential conditions for human life. A very solid scientific consensus indicates that we are presently witnessing a disturbing warming of the climatic system. In recent decades this warming has been accompanied by a constant rise in the sea level and, it would appear, by an increase of extreme weather events, even if a scientifically determinable cause cannot be assigned to each particular phenomenon. Humanity is called to recognize the need for changes of lifestyle, production and consumption, in order to combat this warming or at least the human causes which produce or aggravate it. It is true that there are other factors (such as volcanic activity, variations in the earth's orbit and axis, the solar cycle), yet a number of scientific studies indicate that most global warming in recent decades is due to the great concentration of greenhouse gases (carbon dioxide, methane, nitrogen oxides and others) released mainly as a result of human activity. As these gases build up in the atmosphere, they hamper the escape of heat produced by sunlight at the earth's surface. The problem is aggravated by a model of development based on the intensive use of fossil fuels, which is at the heart of the worldwide energy system. Another determining factor has been an increase in changed uses of the soil, principally deforestation for agricultural purposes.

24. Warming has effects on the carbon cycle. It creates a vicious circle which aggravates the situation even more, affecting the availability of essential resources like drinking water, energy and agricultural production in warmer regions, and leading to the extinction of part of the planet's biodiversity. The melting in the polar ice caps and in high altitude plains can lead to the dangerous release of methane gas, while the decomposition of frozen organic material can further increase the emission of carbon dioxide. Things are made worse by the loss of tropical forests which would otherwise help to mitigate climate change. Carbon dioxide pollution increases the acidification of the oceans and compromises the marine food chain. If present trends continue, this century may well witness extraordinary climate change and an unprecedented destruction of ecosystems, with serious consequences for all of us. A rise in the sea level, for ex-

Figure 10.27: **His Holiness Pope Francis I has delivered an extremely important encyclical addressing the urgent problem of climate change.**

Figure 10.28: **Pope Francis among the people at St. Peter's Square, 12 May, 2013 - "Papa Rock Star".**

Figure 10.29: **On April 16, 2019, Pope Francis met with teenage climate activist Greta Thunberg, and encouraged her to continue with her important work.**

ample, can create extremely serious situations, if we consider that a quarter of the world's population lives on the coast or nearby, and that the majority of our megacities are situated in coastal areas.

25. Climate change is a global problem with grave implications: environmental, social, economic, political and for the distribution of goods. It represents one of the principal challenges facing humanity in our day. Its worst impact will probably be felt by developing countries in coming decades. Many of the poor live in areas particularly affected by phenomena related to warming, and their means of subsistence are largely dependent on natural reserves and ecosystemic services such as agriculture, fishing and forestry. They have no other financial activities or resources which can enable them to adapt to climate change or to face natural disasters, and their access to social services and protection is very limited. For example, changes in climate, to which animals and plants cannot adapt, lead them to migrate; this in turn affects the livelihood of the poor, who are then forced to leave their homes, with great uncertainty for their future and that of their children. There has been a tragic rise in the number of migrants seeking to flee from the growing poverty caused by environmental degradation. They are not recognized by international conventions as refugees; they bear the loss of the lives they have left behind, without enjoying any legal protection whatsoever. Sadly, there is widespread indifference to such suffering, which is even now taking place throughout our world. Our lack of response to these tragedies involving our brothers and sisters points to the loss of that sense of responsibility for our fellow men and women upon which all civil society is founded.

26. Many of those who possess more resources and economic or political power seem mostly to be concerned with masking the problems or concealing their symptoms, simply making efforts to reduce some of the negative impacts of climate change. However, many of these symptoms indicate that such effects will continue to worsen if we continue with current models of production and consumption. There is an urgent need to develop policies so that, in the next few years, the emission of carbon dioxide and other highly polluting gases can be drastically reduced, for example, substituting for fossil fuels and developing sources of renewable energy. Worldwide there is minimal access to clean and renewable energy. There is still a need to develop adequate storage technologies. Some countries have

made considerable progress, although it is far from constituting a significant proportion. Investments have also been made in means of production and transportation which consume less energy and require fewer raw materials, as well as in methods of construction and renovating buildings which improve their energy efficiency. But these good practices are still far from widespread.

II: THE ISSUE OF WATER

27. Other indicators of the present situation have to do with the depletion of natural resources. We all know that it is not possible to sustain the present level of consumption in developed countries and wealthier sectors of society, where the habit of wasting and discarding has reached unprecedented levels. The exploitation of the planet has already exceeded acceptable limits and we still have not solved the problem of poverty.

28. Fresh drinking water is an issue of primary importance, since it is indispensable for human life and for supporting terrestrial and aquatic ecosystems. Sources of fresh water are necessary for health care, agriculture and industry. Water supplies used to be relatively constant, but now in many places demand exceeds the sustainable supply, with dramatic consequences in the short and long term. Large cities dependent on significant supplies of water have experienced periods of shortage, and at critical moments these have not always been administered with sufficient oversight and impartiality. Water poverty especially affects Africa where large sectors of the population have no access to safe drinking water or experience droughts which impede agricultural production. Some countries have areas rich in water while others endure drastic scarcity.

29. One particularly serious problem is the quality of water available to the poor. Every day, unsafe water results in many deaths and the spread of water-related diseases, including those caused by microorganisms and chemical substances. Dysentery and cholera, linked to inadequate hygiene and water supplies, are a significant cause of suffering and of infant mortality. Underground water sources in many places are threatened by the pollution produced in certain mining, farming and industrial activities, especially in countries lacking adequate regulation or controls. It is not only a question of industrial waste. Detergents and chemical products, commonly used in many

places of the world, continue to pour into our rivers, lakes and seas.

30. Even as the quality of available water is constantly diminishing, in some places there is a growing tendency, despite its scarcity, to privatize this resource, turning it into a commodity subject to the laws of the market. Yet access to safe drinkable water is a basic and universal human right, since it is essential to human survival and, as such, is a condition for the exercise of other human rights. Our world has a grave social debt towards the poor who lack access to drinking water, because they are denied the right to a life consistent with their inalienable dignity. This debt can be paid partly by an increase in funding to provide clean water and sanitary services among the poor. But water continues to be wasted, not only in the developed world but also in developing countries which possess it in abundance. This shows that the problem of water is partly an educational and cultural issue, since there is little awareness of the seriousness of such behaviour within a context of great inequality.

31. Greater scarcity of water will lead to an increase in the cost of food and the various products which depend on its use. Some studies warn that an acute water shortage may occur within a few decades unless urgent action is taken. The environmental repercussions could affect billions of people; it is also conceivable that the control of water by large multinational businesses may become a major source of conflict in this century.

III: LOSS OF BIODIVERSITY

32. The earth's resources are also being plundered because of short-sighted approaches to the economy, commerce and production. The loss of forests and woodlands entails the loss of species which may constitute extremely important resources in the future, not only for food but also for curing disease and other uses. Different species contain genes which could be key resources in years ahead for meeting human needs and regulating environmental problems.

33. It is not enough, however, to think of different species merely as potential "resources" to be exploited, while overlooking the fact that they have value in themselves. Each year sees the disappearance of thousands of plant and animal species which we will never know, which our children will never see, because they have been lost

for ever. The great majority become extinct for reasons related to human activity. Because of us, thousands of species will no longer give glory to God by their very existence, nor convey their message to us. We have no such right.

34. It may well disturb us to learn of the extinction of mammals or birds, since they are more visible. But the good functioning of ecosystems also requires fungi, algae, worms, insects, reptiles and an innumerable variety of microorganisms. Some less numerous species, although generally unseen, nonetheless play a critical role in maintaining the equilibrium of a particular place. Human beings must intervene when a geosystem reaches a critical state. But nowadays, such intervention in nature has become more and more frequent. As a consequence, serious problems arise, leading to further interventions; human activity becomes ubiquitous, with all the risks which this entails. Often a vicious circle results, as human intervention to resolve a problem further aggravates the situation. For example, many birds and insects which disappear due to synthetic agrotoxins are helpful for agriculture: their disappearance will have to be compensated for by yet other techniques which may well prove harmful. We must be grateful for the praiseworthy efforts being made by scientists and engineers dedicated to finding solutions to man-made problems. But a sober look at our world shows that the degree of human intervention, often in the service of business interests and consumerism, is actually making our earth less rich and beautiful, ever more limited and grey, even as technological advances and consumer goods continue to abound limitlessly. We seem to think that we can substitute an irreplaceable and irretrievable beauty with something which we have created ourselves.

35. In assessing the environmental impact of any project, concern is usually shown for its effects on soil, water and air, yet few careful studies are made of its impact on biodiversity, as if the loss of species or animals and plant groups were of little importance. Highways, new plantations, the fencing-off of certain areas, the damming of water sources, and similar developments, crowd out natural habitats and, at times, break them up in such a way that animal populations can no longer migrate or roam freely. As a result, some species face extinction. Alternatives exist which at least lessen the impact of these projects, like the creation of biological corridors, but few countries demonstrate such concern and foresight. Frequently, when

certain species are exploited commercially, little attention is paid to studying their reproductive patterns in order to prevent their depletion and the consequent imbalance of the ecosystem.

36. Caring for ecosystems demands far-sightedness, since no one looking for quick and easy profit is truly interested in their preservation. But the cost of the damage caused by such selfish lack of concern is much greater than the economic benefits to be obtained. Where certain species are destroyed or seriously harmed, the values involved are incalculable. We can be silent witnesses to terrible injustices if we think that we can obtain significant benefits by making the rest of humanity, present and future, pay the extremely high costs of environmental deterioration.

37. Some countries have made significant progress in establishing sanctuaries on land and in the oceans where any human intervention is prohibited which might modify their features or alter their original structures. In the protection of biodiversity, specialists insist on the need for particular attention to be shown to areas richer both in the number of species and in endemic, rare or less protected species. Certain places need greater protection because of their immense importance for the global ecosystem, or because they represent important water reserves and thus safeguard other forms of life.

38. Let us mention, for example, those richly biodiverse lungs of our planet which are the Amazon and the Congo basins, or the great aquifers and glaciers. We know how important these are for the entire earth and for the future of humanity. The ecosystems of tropical forests possess an enormously complex biodiversity which is almost impossible to appreciate fully, yet when these forests are burned down or levelled for purposes of cultivation, within the space of a few years countless species are lost and the areas frequently become arid wastelands. A delicate balance has to be maintained when speaking about these places, for we cannot overlook the huge global economic interests which, under the guise of protecting them, can undermine the sovereignty of individual nations. In fact, there are "proposals to internationalize the Amazon, which only serve the economic interests of transnational corporations". We cannot fail to praise the commitment of international agencies and civil society organizations which draw public attention to these issues and offer critical cooperation, employing legitimate means of pressure,

to ensure that each government carries out its proper and inalienable responsibility to preserve its country's environment and natural resources, without capitulating to spurious local or international interests.

39. The replacement of virgin forest with plantations of trees, usually monocultures, is rarely adequately analyzed. Yet this can seriously compromise a biodiversity which the new species being introduced does not accommodate. Similarly, wetlands converted into cultivated land lose the enormous biodiversity which they formerly hosted. In some coastal areas the disappearance of ecosystems sustained by mangrove swamps is a source of serious concern.

40. Oceans not only contain the bulk of our planet's water supply, but also most of the immense variety of living creatures, many of them still unknown to us and threatened for various reasons. What is more, marine life in rivers, lakes, seas and oceans, which feeds a great part of the world's population, is affected by uncontrolled fishing, leading to a drastic depletion of certain species. Selective forms of fishing which discard much of what they collect continue unabated. Particularly threatened are marine organisms which we tend to overlook, like some forms of plankton; they represent a significant element in the ocean food chain, and species used for our food ultimately depend on them.

41. In tropical and subtropical seas, we find coral reefs comparable to the great forests on dry land, for they shelter approximately a million species, including fish, crabs, molluscs, sponges and algae. Many of the world's coral reefs are already barren or in a state of constant decline. "Who turned the wonderworld of the seas into underwater cemeteries bereft of colour and life?" This phenomenon is due largely to pollution which reaches the sea as the result of deforestation, agricultural monocultures, industrial waste and destructive fishing methods, especially those using cyanide and dynamite. It is aggravated by the rise in temperature of the oceans. All of this helps us to see that every intervention in nature can have consequences which are not immediately evident, and that certain ways of exploiting resources prove costly in terms of degradation which ultimately reaches the ocean bed itself.

42. Greater investment needs to be made in research aimed at un-

derstanding more fully the functioning of ecosystems and adequately analyzing the different variables associated with any significant modification of the environment. Because all creatures are connected, each must be cherished with love and respect, for all of us as living creatures are dependent on one another. Each area is responsible for the care of this family. This will require undertaking a careful inventory of the species which it hosts, with a view to developing programmes and strategies of protection with particular care for safeguarding species heading towards extinction.

10.15 Pope Francis meets Leonardo DiCaprio

A long personal audience with Pope Francis

Proe Francis granted the famous actor a long personal audience, during which they discussed the climate emergency. DiCaprio said later that he was deeply impressed with the seriousness with which Pope Francis addressed the crisis.

DiCaprio describes *Before the Flood* at its premier

At the European premier of his film[4] in London in October, 2016, Leonardo DiCaprio introduced it with the following words:

Before The Flood **is the product of an incredible three-year journey that took place with my co-creator and director Fisher Stevens. We went to every corner of the globe to document the devastating impacts of climate change and questioned humanity's ability to reverse what may be the most catastrophic problem mankind has ever faced. There was a lot to take in. All that we witnessed on this journey shows us that our world's climate is incredibly interconnected and that it is at urgent breaking point. ... We wanted to create a film that gave people a sense of urgency, that made them understand what particular things are going to solve this problem. We bring up the issue of a carbon tax, for example, which I haven't seen in a lot of documentaries. Basically, sway a capitalist economy to try to invest in renewables, to bring less money and subsidies out of oil companies. These are the things that are really going to make**

[4]https://wow.filmsforaction.org/watch/before-the-flood-2016/

Figure 10.30: **Pope Francis and Leonardo DiCaprio discussing DiCaprio's important film, *Before the Flood*.**

a massive difference. ... We need to use our vote ... We cannot afford to have political leaders out there that do not believe in modern science or the scientific method or empirical truths ... We cannot afford to waste time having people in power that choose to believe in the 2 percent of the scientific community that is basically bought off by lobbyists and oil companies.

Evangelli Gaudium

In his exhortation *Evangelli Gaudium*, Pope Francis wrote:

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... A new tyranny is thus born, invisible and often virtual, which unilaterally and relentlessly imposes its own laws and rules. To all this we can add widespread corruption and self-serving tax evasion, which has taken on worldwide dimensions. The thirst for power and possessions knows no limits.

Figure 10.31: **Leonardo DiCaprio presented Pope Francis with the reproduction of a painting by Hieronymus Bosch, *The Garden of Earthly Delights*. The painting had stood beside the famous actor's bed when he was a child. It shows the world before and after the Biblical deluge.**

Figure 10.32: **Leonardo DiCaprio's important and eloquent film is the result of interviews with experts in all parts of the world, as well as personal observations.**

Figure 10.33: **Leonardo DiCaprio discussing the climate emergency with US President Barack Obama.**

10.16 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:

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


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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 10.34: **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%..."**

10.17 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.


STOP
BURNING
MY
ANCESTORS
SCHOOL
4 CLIMATE


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


THERESA
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Figure 10.35: **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.**

5

Concerns of young protesters are justified

In an article in the journal *Science* dated 12 April, 2019, [6] 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

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

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

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 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 10.36: **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."**

10.18 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.

10.19 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

Figure 10.37: **A firefighter battles fire in California. The world is currently 1 degree Centigrade warmer than preindustrial levels.**

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. 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.

10.20 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.[7]:

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."

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

10.21 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[8]:

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 Or-

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

wellian.

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 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 pro-

ponents 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 manage-

ment. 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 Chal-

lenges 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 °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...

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. [9]

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. [10]

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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