Understanding Climate Change: A Beginner's Guide to the UN Framework Convention and its Kyoto Protocol

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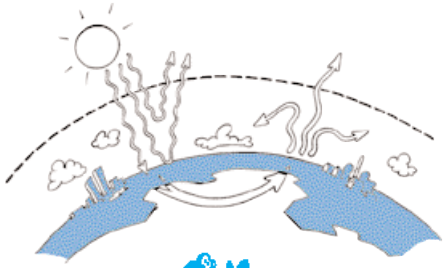
What is the Greenhouse effect?

In the long term, the earth must shed energy into space at the same rate at which it absorbs energy from the sun. Solar energy arrives in the form of short-wavelength radiation. Some of this radiation is reflected away by the earth's surface and atmosphere. Most of it, however, passes straight through the atmosphere to warm the earth's surface. The earth gets rid of this energy (sends it back out into space) in the form of long wavelength, infra-red radiation.

Most of the infra-red radiation emitted upwards by the earth's surface is absorbed in the atmosphere by water vapour, carbon dioxide, and the other naturally occurring "greenhouse gases". These gases prevent energy from passing directly from the surface out into space. Instead, many interacting processes (including radiation, air currents, evaporation, cloud-formation, and rainfall) transport the energy high into the atmosphere. From there it can radiate into space. This slower, more indirect process is fortunate for us, because if the surface of the earth could radiate energy into space unhindered, the earth would be a cold, lifeless place - a bleak and barren planet rather like Mars.

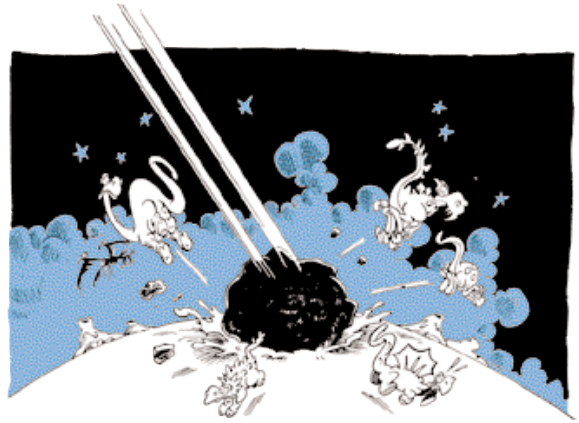
By increasing the atmosphere's ability to absorb infra-red energy, our greenhouse gas emissions are disturbing the way the climate maintains this balance between incoming and outgoing energy. A doubling of the concentration of long-lived greenhouse gases (which is projected to occur early in the 21st century) would, if nothing else changed, reduce the rate at which the planet can shed energy into space by about 2 per cent. Energy cannot simply accumulate. The climate somehow will have to adjust to get rid of the extra energy - and while 2 per cent may not sound like much, over the entire earth that amounts to trapping the energy content of some 3 million tons of oil every minute.

Scientists point out that we are altering the energy "engine" that drives the climate system. Something has to change to absorb the shock.



First Act: the Convention

A giant asteroid could hit the earth!
Something else could happen!
The global temperature could rise! Wake up!



The last several decades have been a time of international soul-searching about the environment. What are we doing to our planet? More and more, we are realizing that the Industrial Revolution has changed forever the relationship between humanity and nature. There is real concern that by the middle or the end of the 21st century human activities will have changed the basic conditions that have allowed life to thrive on earth.

The 1992 **United Nations Framework Convention on Climate Change** is one of a series of recent agreements through which countries around the world are banding together to meet this challenge. Other treaties deal with such matters as pollution of the oceans, dryland degradation, damage to the ozone layer, and the rapid extinction of plant and animal species. The Climate Change Convention focuses on something particularly disturbing: we are changing the way energy from the sun interacts with and escapes from our planet's atmosphere. By doing that, we risk altering the global climate. Among the expected consequences are an increase in the average temperature of the earth's surface and shifts in world-wide weather patterns. Other unforeseen effects cannot be ruled out.

We have a few problems to face up to.

Problem No 1 (the BIG problem):

Scientists see a real risk that the climate will change rapidly and dramatically over the coming decades and centuries. Can we handle it?

A giant asteroid did hit the earth about 65 million years ago. *Splat*. Scientists speculate that the collision threw so much dust into the atmosphere that the world was dark for three years. Sunlight was greatly reduced, so many plants could not grow, temperatures fell, the food chain collapsed, and many species, including the largest ever to walk the earth, died off.

That, at least, is the prevailing theory of why the dinosaurs became extinct. Even those who weren't actually hit by the asteroid paid the ultimate price.

The catastrophe that befell the dinosaurs is only one illustration, if dramatic, of how changes in climate can make or break a species.

According to another theory, human beings evolved when a drying trend some 10 million years ago was followed around three million years ago by a sharp drop in world temperature. The ape-like higher primates in the Great Rift Valley of Africa were used to sheltering in trees, but, under this long-term climate shift, the trees were replaced with grassland. The 'apes' found themselves on an empty plain much colder and drier than what they were used to, and extremely vulnerable to predators.

Extinction was a real possibility, and the primates appear to have responded with two evolutionary jumps - first to creatures who could walk upright over long distances, with hands free for carrying children and food; and then to creatures with much larger brains, who used tools and were omnivorous (could eat both plants and meat). This second, large-brained creature is generally considered to be the first human.

Shifts in climate have shaped human destiny ever since, and people have largely responded by adapting, migrating, and growing smarter. During a later series of ice ages, sea levels dropped and humans moved across land bridges from Asia to the Americas and the Pacific islands. Many subsequent migrations, many innovations, many catastrophes have followed. Some can be traced to smaller climatic fluctuations, such as a few decades or centuries of slightly higher or lower temperatures, or extended droughts. Best known is the Little Ice Age that struck Europe in the early Middle Ages, bringing famines, uprisings, and the withdrawal of northern colonies in Iceland and Greenland. People have suffered under the whims of climate for millennia, responding with their wits, unable to influence these large events.

Until now. Ironically, we humans have been so remarkably successful as a species that we may have backed ourselves into a corner. Our numbers have grown to the point where we have less room for large-scale migration should a major climate shift call for it. And the products of our large brains - our industries, transport, and other activities - have led to something unheard of in the past. Previously the global climate changed human beings. Now human beings seem to be changing the global climate. The results are uncertain, but if current predictions prove correct, the climatic changes over the coming century will be larger than any since the dawn of human civilization.

The principal change to date is in the earth's atmosphere. The giant asteroid that felled the dinosaurs threw large clouds of dust into the air, but we are causing something just as profound if more subtle. We have changed, and are continuing to change, the balance of gases that form the atmosphere. This is especially true of such key "greenhouse gases" as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). (Water vapour is the most important greenhouse gas, but human activities do not affect it directly.) These naturally occurring gases make up less than one tenth of one per cent of the total atmosphere, which consists mostly of oxygen (21 per cent) and nitrogen

(78 per cent). But greenhouse gases are vital because they act like a blanket around the earth. Without this natural blanket the earth's surface would be some 30°C colder than it is today.

The problem is that human activity is making the blanket "thicker". For example, when we burn coal, oil, and natural gas we spew huge amounts of carbon dioxide into the air. When we destroy forests the carbon stored in the trees escapes to the atmosphere. Other basic activities, such as raising cattle and planting rice, emit methane, nitrous oxide, and other greenhouse gases. If emissions continue to grow at current rates, it is almost certain that atmospheric levels of carbon dioxide will double from pre-industrial levels during the 21st century. If no steps are taken to slow greenhouse gas emissions, it is quite possible that levels will triple by the year 2100.

The most direct result, says the scientific consensus, is likely to be a "global warming" of 1.4 to 5.8°C over the next 100 years. That is in addition to an apparent temperature increase of around 0.6°C over the 20th century, at least some of which may be due to past greenhouse gas emissions.

Just how this would affect us is hard to predict because the global climate is a very complicated system. If one key aspect - such as the average global temperature - is altered, the ramifications ripple outward. Uncertain effects pile onto uncertain effects. For example, wind and rainfall patterns that have prevailed for hundreds or thousands of years, and on which millions of people depend, may change. Sea-levels may rise and threaten islands and low-lying coastal areas. In a world that is increasingly crowded and under stress - a world that has enough problems already - these extra pressures could lead directly to more famines and other catastrophes.

While scientists are scrambling to understand more clearly the effects of our greenhouse gas emissions, countries around the globe have joined together to confront the problem.

How the Convention responds

• ***It recognises that there is a problem.*** That's a significant step. It is not easy for the nations of the world to agree on a common course of action, especially one that tackles a problem whose consequences are uncertain and which will be more important for our grandchildren than for the present generation. Still, the Convention was negotiated in a little over two years, some 185 states have ratified and so are legally bound by it. The treaty took effect on 21 March 1994.

• ***It sets an "ultimate objective" of stabilizing "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system."*** The objective does not specify what these concentrations should be, only that they be at a level that is not dangerous. This acknowledges that there is currently no scientific certainty about what a dangerous level would be. Scientists believe it will take about another decade (and the next generation of supercomputers) before today's uncertainties (or many of them) are significantly reduced. The Convention's objective thus remains meaningful no matter how the science evolves.

• ***It directs that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."*** This highlights the main concerns about food production - probably the most climate-sensitive human activity - and economic development. It also suggests (as most climatologists believe) that some change is inevitable and that adaptive as well as preventive measures are called for.

Again, this leaves room for interpretation in the light of scientific findings and the trade-offs and risks that the global community is willing to accept.

PROBLEM No 2 :

If the consequences of a problem are uncertain, do you ignore the problem or do you do something about it anyway?

Climate change is a threat to mankind. But no one is certain about its future effects or their severity. Responding to the threat is expected to be complicated and difficult. There is even some remaining disagreement over whether any problem exists at all: while many people worry that the effects will be extremely serious, others still argue that scientists cannot prove that what they suspect will happen will actually happen. In addition, it is not clear who (in the various regions of the world) will suffer most. Yet if the nations of the world wait until the consequences and victims are clear, it will probably be too late to act. What should we do?

The truth is that in most scientific circles the issue is no longer whether or not climate change is a potentially serious problem. Rather, it is how the problem will develop, what its effects will be, and how these effects can best be detected. Computer models of something as complicated as the planet's climate system are not far enough advanced yet to give clear and unambiguous answers. Nevertheless, while the when, where, and how remain uncertain, the big picture painted by these climate models cries out for attention.

For example:

• **Regional rain patterns may change.** At the global level, the evapo-transpiration cycle is expected to speed up. This means that it would rain more, but the rain would evaporate faster, leaving soils drier during critical parts of the growing season. New or worsening droughts, especially in poorer countries, could reduce supplies of clean, fresh water to the point where there are major threats to public health. Because they still lack confidence in regional scenarios, scientists are uncertain about which areas of the world risk becoming wetter and which drier. But with global water resources already under severe strain from rapid population growth and expanding economic activity, the danger is clear.

• **Climate and agricultural zones may shift towards the poles.** Increased summer dryness may reduce mid-latitude crop yields, and it is possible that today's leading grain-producing areas (such as the Great Plains of the United States) would experience more frequent droughts and heat waves. The poleward edges of the mid-latitude agricultural zones - northern Canada, Scandinavia, Russia, and Japan in the northern hemisphere, and southern Chile and Argentina in the southern hemisphere - might benefit from higher temperatures. However, in some areas rugged terrain and poor soil would prevent these countries from compensating for reduced yields in today's more productive areas. A warming of more than 2.5°C could reduce global food supplies and contribute to higher food prices.

• **Melting glaciers and the thermal expansion of sea water may raise sea levels, threatening low-lying coastal areas and small islands.** The global mean sea level has already risen by around 10 to 20 centimetres during the past century, and global warming is expected to cause a further rise of 9 to 88 cm by the year 2100. The most vulnerable land would be the unprotected, densely populated coastal regions of some of the world's poorest countries. Bangladesh, whose coast is already prone to devastating floods, would be a likely victim, as would many small island states such as the Maldives.

These scenarios are alarming enough to raise concern, but too uncertain for easy decisions by governments. The picture is fuzzy. Some governments, beleaguered by other problems and responsibilities and bills to pay, have understandably been tempted to do nothing at all. Maybe the threat will go away. Or someone else will deal with it. Maybe another giant asteroid will hit the earth. Who knows?

How the Convention responds

• ***It establishes a framework and a process for agreeing to specific actions later.*** The diplomats who wrote the Framework Convention on Climate Change saw it as a launching pad for potential further action in the future. They recognized that it would not be possible in the year 1992 for the world's governments to agree on a detailed blueprint for tackling climate change. But by establishing a framework of general principles and institutions, and by setting up a process through which governments meet regularly, they got things started.

A key benefit of this approach is that it allowed countries to begin discussing the issue even before they all fully agreed that it is, in fact, a problem. Even skeptical countries have felt it is worthwhile participating. (Or, to put it another way, they would have felt uneasy about being left out.) This created legitimacy for the issue, and a sort of international peer pressure to take the subject seriously.

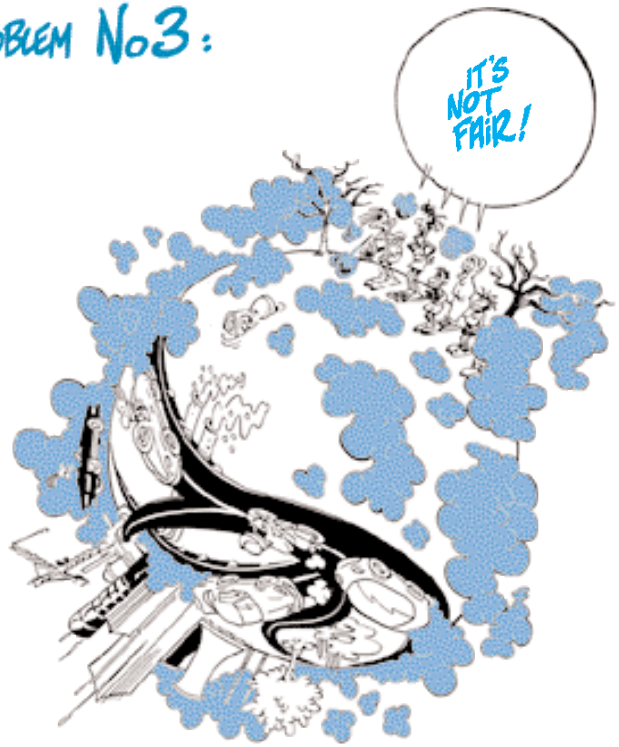
The Convention is designed to allow countries to weaken or strengthen the treaty in response to new scientific developments. For example, they can agree to take more specific actions (such as reducing emissions of greenhouse gases by a certain amount) by adopting "amendments" or "protocols" to the Convention. This is what happened in 1997 with the adoption of the Kyoto Protocol.

The treaty promotes action in spite of uncertainty on the basis of a recent development in international law and diplomacy called the "precautionary principle." Under traditional international law, an activity generally has not been restricted or prohibited unless a direct causal link between the activity and a particular damage can be shown. But many environmental problems, such as damage to the ozone layer and pollution of the oceans, cannot be confronted if final proof of cause and effect is required. In response, the international community has gradually come to accept the precautionary principle, under which activities that threaten serious or irreversible damage can be restricted or even prohibited before there is absolute scientific certainty about their effects.

• ***The Convention takes preliminary steps that clearly make sense for the time being.*** Countries ratifying the Convention - called "Parties to the Convention" in diplomatic jargon - agree to take climate change into account in such matters as agriculture, energy, natural resources, and activities involving sea-coasts. They agree to develop national programmes to slow climate change. The Convention encourages them to share technology and to cooperate in other ways to reduce greenhouse gas emissions, especially from energy, transport, industry, agriculture, forestry, and waste management, which together produce nearly all greenhouse gas emissions attributable to human activity.

• ***The Convention encourages scientific research on climate change.*** It calls for data gathering, research, and climate observation, and it creates a "subsidiary body" for "scientific and technological advice" to help governments decide what to do next. Each country that is a Party to the Convention must also develop a greenhouse gas "inventory" listing its national sources (such as factories and transport) and "sinks" (forests and other natural ecosystems that absorb greenhouse gases from the atmosphere). These inventories must be updated regularly and made public. The information they provide on which activities emit how much of each gas is essential for monitoring changes in emissions and determining the effects of measures taken to control emissions.

Problem No3:



If a giant asteroid hits the earth, that's nobody's fault. The same cannot be said for global warming.

There is a fundamental unfairness to the climate change problem that chafes at the already uneasy relations between the rich and poor nations of the world. Countries with high standards of living are mostly (if unwittingly) responsible for the rise in greenhouse gases. These early industrializers - Europe, North America, Japan, and a few others - created their wealth in part by pumping into the atmosphere vast amounts of greenhouse gases long before the likely consequences were understood. Developing countries now fear being told that they should curtail their own fledgling industrial activities - that the atmosphere's safety margin is all used up.

Because energy-related emissions are the leading cause of climate change, there will be growing pressure on all countries to reduce the amounts of coal and oil they use. There also will be pressure (and incentives) to adopt advanced technologies so that less damage is inflicted in the future. Buying such technologies can be costly.

Countries in the early stages of industrialization - countries struggling hard to give their citizens better lives - don't want these additional burdens. Economic development is difficult enough already. If they agreed to cut back on burning the fossil fuels that are the cheapest, most convenient, and most useful for industry, how could they make any progress?

There are other injustices to the climate change problem. The countries to suffer the most if the predicted consequences come about, if agricultural zones shift or sea levels rise or rainfall patterns change, will probably be in the developing world. These nations simply do not have the scientific or economic resources, or the social safety nets, to cope with disruptions in climate. Also, in many of these countries rapid population growth has pushed many millions of people onto marginal land, the sort of land that can change most drastically due to variations in climate.

How the Convention Responds

• ***It puts the lion's share of the responsibility for battling climate change - and the lion's share of the bill - on the rich countries.*** The Convention tries to make sure that any sacrifices made in protecting our shared atmosphere will be shared fairly among countries in accordance with their "common but differentiated responsibilities and respective capabilities and their social and economic conditions". It notes that the largest share of historical and current emissions originates in developed countries. Its first basic principle is that these countries should take the lead in combating climate change and its adverse impacts. Specific commitments in the treaty relating to financial and technological transfers apply only to very richest countries, essentially the members of the Organization for Economic Cooperation and Development (OECD). They agree to support climate change activities in developing countries by providing financial support above and beyond any financial assistance they already provide to these countries.

Specific commitments concerning efforts to limit greenhouse gas emissions and enhance natural sinks apply to the OECD countries as well as to 12 "economies in transition" (Central and Eastern Europe and the former Soviet Union). Under the Convention, the OECD and transition countries were expected to try to return by the year 2000 to the greenhouse gas emission levels they had in 1990 (as a group they succeeded).

• ***The Convention recognises that poorer nations have a right to economic development.*** It notes that the share of global emissions of greenhouse gases originating in developing countries will grow as these countries expand their industries to improve social and economic conditions for their citizens.

• ***It acknowledges the vulnerability of poorer countries to the effects of climate change.*** One of the Convention's basic principles is that the specific needs and circumstances of developing countries should be given "full consideration" in any actions taken. This applies in particular to those whose fragile ecosystems are highly vulnerable to the impacts of climate change. The Convention also recognizes that states which depend on income from coal and oil would face difficulties if energy demand changes.

Problem No 4:

If the whole world starts consuming more and living the good life, can the planet stand the strain?

As the human population continues to grow, the demands human beings place on the environment increase. The demands are becoming all the greater because these rapidly increasing numbers of people also want to live better lives. More and better food, more and cleaner water, more electricity, refrigerators, automobiles, houses and apartments, land on which to put houses and apartments...

Already there are severe problems supplying enough fresh water to the world's billions. Burgeoning populations are draining the water from rivers and lakes, and vast underground aquifers are steadily being depleted. What will people do when these natural "tanks" are empty? There are also problems growing and distributing enough food - widespread hunger in many parts of the world attests to that. There are other danger signals. The global fish harvest has declined sharply; as large as the oceans are, the most valuable species have been effectively fished out.

Global warming is a particularly ominous example of humanity's insatiable appetite for natural resources. During the last century we have dug up and burned massive stores of coal, oil, and natural gas that took millions of years to accumulate. Our ability to burn up fossil fuels at a rate that is much, much faster than the rate at which they were created has upset the natural balance of the carbon cycle. The threat of climate change arises because one of the only ways the atmosphere - also a natural resource - can respond to the vast quantities of carbon being liberated from beneath the earth's surface is to warm up.

Meanwhile, human expectations are not tapering off. They are increasing. The countries of the industrialized "North" have 20 per cent of the world's people but use about 80 per cent of the world's resources. By global standards, they live extremely well. It's nice living the good life, but if everyone consumed as much as the North Americans and Western Europeans consume - and billions of people aspire to do just that - there probably would not be enough clean water and other vital natural resources to go around. How will we meet these growing expectations when the world is already under so much stress?

How the Convention responds

• ***It supports the concept of "sustainable development".*** Somehow, mankind must learn how to alleviate poverty for huge and growing numbers of people without destroying the natural environment on which all human life depends. Somehow a way has to be found to develop economically in a fashion that is sustainable over a long period of time. The buzzword for this challenge among environmentalists and international bureaucrats is "sustainable development". The trick will be to find methods for living well while using critical natural resources at a rate no faster than that at which they are replaced. Unfortunately, the international community is a lot farther along in defining the problems posed by sustainable development than it is in figuring out how to solve them.

• ***The Convention calls for developing and sharing environmentally sound technologies and know-how.*** Technology will clearly play a major role in dealing with climate change. If we can find practical ways to use cleaner sources of energy, such as solar power, we can reduce the consumption of coal and oil. Technology can make industrial processes more efficient, water purification more viable, and agriculture more productive for the same amount of resources invested. Such technology must be made widely available - it must somehow be shared by richer and more scientifically advanced countries with poorer countries that have great need of it.

• ***The Convention emphasises the need to educate people about climate change.*** Today's children and future generations must learn to look at the world in a different way than it was looked at by most people during the 20th century. This is both an old and a new idea. Many (but not all!) pre-industrial cultures lived in balance with nature. Now scientific research is telling us to do much the same thing. Economic development is no longer a case of "bigger is better" - bigger cars, bigger houses, bigger harvests of fish, bigger doses of oil and coal. We must no longer think of human progress as a matter of imposing ourselves on the natural environment. The world - the climate and all living things - is a closed system; what we do has consequences that eventually come back to affect us. Tomorrow's children - and today's adults, for that matter - will have to learn to think about the effects of their actions on the climate. When they make decisions as members of governments and businesses, and as they go about their private lives, they will have to take the climate into account.

In other words, human behaviour will have to change - probably the sooner the better. But such things are difficult to prescribe and predict. People will need stronger signals and incentives if they are to do more for the good of the global climate. That leads to...

Second Act: The Protocol

The 1992 Convention was a good start. But as the years passed, and the scientific evidence continued to accumulate, people naturally asked, "what's next"?

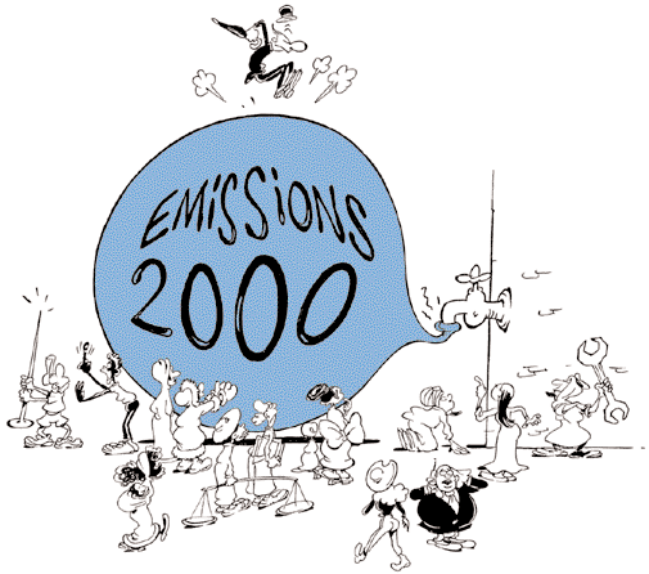
In 1997, governments responded to growing public pressure by adopting the Kyoto Protocol. A protocol is an international agreement that stands on its own but is linked to an existing treaty. This means that the climate protocol shares the concerns and principles set out in the climate convention. It then builds on these by adding new commitments which are stronger and far more complex and detailed than those in the Convention.

This complexity is a reflection of the enormous challenges posed by the control of greenhouse gas emissions. It is also a result of the diverse political and economic interests that had to be balanced in order to reach an agreement. Billion-dollar industries will be reshaped; some will profit from the transition to a climate-friendly economy, others will not.

Because the Kyoto Protocol will affect virtually all major sectors of the economy, it is considered to be the most far-reaching agreement on environment and sustainable development ever adopted. This is a sign that the international community is willing to face reality and start taking concrete actions to minimize the risk of climate change. The Protocol's negotiators were able to take this important step forward only after facing up to some tough questions.

Problem No5:

Emissions are still growing. Isn't it time to take some serious action?



Three years after the Climate Change Convention was adopted at the Rio Earth Summit, the Intergovernmental Panel on Climate Change (IPCC) published its second major assessment of climate change research. Written and reviewed by some 2,000 scientists and experts, the report was soon famous for concluding that the climate may have already started responding to past emissions. It also confirmed the availability of many cost-effective strategies for reducing greenhouse gas emissions (the IPCC's third assessment was published in 2001).

Meanwhile, although emissions in some countries stabilized, emissions levels continued to rise around the world. More and more people came to accept that only a firm and binding commitment by developed countries to reduce greenhouse gases could send a signal strong enough to convince businesses, communities, and individuals to change their ways.

Finally, there was the practical matter that the year 2000 was fast approaching, and with it the Convention's non-binding "aim" for industrialized countries - to return emissions to 1990 levels by the year 2000 - would expire. Clearly, new steps were needed.

How the Protocol responds

• ***It sets legally binding targets and timetables for cutting developed country emissions.*** The Convention encouraged these countries to stabilize emissions; the Protocol commits them to reducing their collective emissions by at least 5%. Each country's emissions levels will be calculated as an average of the years 2008-2012; these five years are known as the first commitment period. Governments must make "demonstrable progress" towards this goal by the year 2005.

These arrangements will be periodically reviewed. The first review is likely to take place in the middle of the first decade of the new century. At this time the Parties will take "appropriate action" on the basis of the best available scientific, technical, and socio-economic information. Talks on targets for the second commitment period must start by 2005.

The Protocol will only become legally binding when at least 55 countries, including developed countries accounting for at least 55% of developed countries' 1990 CO_2 emissions, have ratified it. This should happen some time in 2003.

• ***The Protocol addresses the six main greenhouse gases.*** These gases are to be combined in a "basket", so that reductions in each gas are credited towards a single target number. This is complicated by the fact that, for example, a kilo of methane has a stronger effect on the climate than does a kilo of carbon dioxide. Cuts in individual gases are therefore translated into "CO_2 equivalents" that can be added up to produce one figure.

Cuts in the three major gases – carbon dioxide, methane, and nitrous oxide - will be measured against a base year of 1990 (with exceptions for some countries with economies in transition). Cuts in the three long-lived industrial gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) – can be measured against either a 1990 or 1995 baseline.

Carbon dioxide is by far the most important gas in the basket. It accounted for over four fifths of total greenhouse gas emissions from developed countries in 1995, with fuel combustion representing all but several percent of this amount. Fortunately, CO_2 emissions from fuel are relatively easy to measure and monitor.

Deforestation is the second largest source of carbon dioxide emissions in developed countries. Under the Protocol, targets can be met in part by improving the ability of forests and other natural sinks to absorb carbon dioxide from the atmosphere. Calculating the amount absorbed, however, is methodologically complex. Governments must still agree on a common approach.

The second most important gas covered by the Protocol is methane. Methane is released by rice cultivation, domesticated animals such as cattle, and the disposal and treatment of garbage and human wastes. Methane emissions are generally stable or declining in the developed countries and their control does not seem to pose as great a challenge as carbon dioxide.

Nitrous oxide is emitted mostly as a result of fertilizer use. As with methane, emissions from developed countries are stable or declining. Nitrous oxide and methane emissions are also similar in being relatively difficult to measure.

One major group of greenhouse gases that the Protocol does not cover is chlorofluorocarbons. This is because CFCs are being phased out under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. Thanks to this agreement, atmospheric concentrations of many CFCs are stabilizing and expected to decline over the coming decades.

However, the Protocol does address three long-lived and potent greenhouse gases that, like CFCs, have been created by industry for specialized applications. The use of HFCs and PFCs threatens to go up dramatically in part because they are being adopted as ozone-safe replacements for CFCs. Governments are now working to make sure that the incentives and controls for ozone depletion and global warming are compatible.

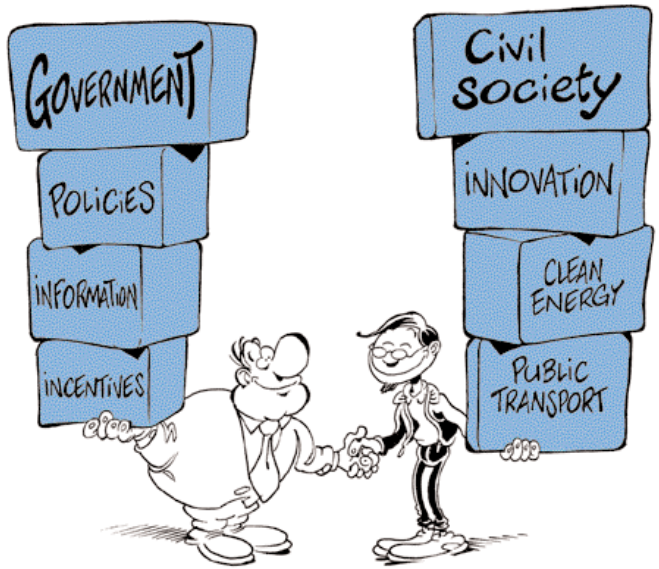
The third man-made gas, sulphur hexafluoride, is used as an electric insulator, heat conductor, and freezing agent. Molecule for molecule, its global warming potential is thought to be 23,900 times greater than that of carbon dioxide.

• ***The Protocol recognizes that emissions cuts must be credible and verifiable.*** Ensuring that governments comply with their targets will be essential to the Protocol's success. Each country will need an effective national system for estimating emissions and confirming reductions. Standardized guidelines must be crafted to make figures comparable from one country to the next and the whole process transparent.

The Protocol allows governments that cut emissions more than they are required to by their national target to "bank" the "excess" as credits for future commitment periods. But what happens if a country's emissions are higher than what is permitted by its target? Non-compliance provisions still need to be developed. Clearly, though, the best approach both politically and environmentally will be to start by helping governments to comply rather than emphasizing punitive or confrontational measures.

Problem No 6:

How can we make our behavior and our economies more climate-friendly?



Minimizing greenhouse gas emissions will require policymakers to take some tough decisions. Every time a subsidy is added or removed, and every time a regulation or reform is put in place, somebody says "ouch". Even though the economy as a whole stands to benefit from well-designed, market-oriented policies for reducing emissions, action - or inaction - by government always helps create winners and losers in the marketplace.

The challenge for policymakers is to design policies that fully engage the energies of civil society. Their goal must be to open the floodgates of industrial creativity. Experience shows that companies often respond rapidly and positively to incentives and pressures. Given the right policy environment, the business sector will roll out low-emissions technologies and services faster than many now believe possible.

Schools, community groups, the media, families, and consumers also have a crucial role to play. Individuals can make a real difference by changing their habits and making thoughtful purchases and investments. If consumers are convinced that the rules of the game are changing, they will start taking the myriad small decisions that, when added together, can have a dramatic impact on emissions.

If large segments of society are willing to make these changes, we can expect an early transition to more energy-efficient, technologically innovative, and environmentally sustainable societies. The trick is getting started.

How the Protocol responds

• ***It highlights effective domestic policies and measures for reducing emissions.*** National governments can build a fiscal and policy framework that discourages emissions. They can phase out counter-productive subsidies on carbon-intensive activities, and they can introduce energy-efficiency and other regulatory standards that promote the best current and future technologies. Taxes, tradable emissions permits, information programmes, and voluntary programmes can all contribute.

Local and urban governments - which often have direct responsibility for transport, housing, and other greenhouse gas-emitting sectors of the economy - can also play a role. They can start designing and building better public transport systems and creating incentives for people to use them rather than private automobiles. They can tighten construction codes so that new houses and office buildings will be heated or cooled with less fuel.

Meanwhile, industrial companies need to start shifting to new technologies that use fossil fuels and raw materials more efficiently. Wherever possible they should switch to renewable energy sources such as wind and solar power. They should also redesign products such as refrigerators, automobiles, cement mixes, and fertilizers so that they produce lower greenhouse gas emissions. Farmers should look to technologies and methods that reduce the methane emitted by livestock and rice fields. Individual citizens, too, must cut their use of fossil fuels - take public transport more often, switch off the lights in empty rooms - and be less wasteful of all natural resources.

The Protocol also flags the importance of conducting research into innovative technologies, limiting methane emissions from waste management and energy systems, and protecting forests and other carbon sinks.

• ***The Protocol encourages governments to work together.*** Policymakers can learn from one other and share ideas and experiences. They may choose to go further, coordinating national policies in order to have more impact in a globalized marketplace. Governments should also consider the effects of their climate policies on others, notably developing countries, and seek to minimize any negative economic consequences.

Problem No 7:

How should we divide up the work - while sharing the burden fairly?

The Climate Change Convention calls on the rich countries to take the initiative in controlling emissions. In line with this, the Kyoto Protocol sets emission targets for the industrialized countries only - although it also recognizes that developing countries have a role to play.

Agreeing how to share the responsibility for cutting emissions amongst the 40 or so developed countries was a major challenge. Lumping all developed countries into one big group risks ignoring the many differences between them. Each country is unique, with its own mix of energy resources and price levels, population density, regulatory traditions, and political culture.

For example, the countries of Western Europe tend to have lower per capita emissions than do countries such as Australia, Canada, and the US. Western Europe's emissions levels have generally stabilized since 1990 - the base year for measuring emissions - while other developed countries have seen their emissions rise. Japan made great strides in energy efficiency in the 1980s, while countries such as Norway and New Zealand have relatively low emissions because they rely on hydropower or nuclear energy. Meanwhile, the energy-intensive countries of Central and Eastern Europe and the former Soviet Union have seen emissions fall dramatically since 1990 due to their transition to market economies. These differing national profiles make it difficult to agree on a one-size-fits-all solution.

How the Protocol responds

• ***It assigns a national target to each country.*** In the end, it was not possible to agree in Kyoto on a uniform target for all countries. The resulting individual targets were not based on any rigorous or objective formula. Rather, they were the outcome of political negotiation and compromise.

The overall 5% target for developed countries is to be met through cuts of 8% in the European Union (EU), Switzerland, and most Central and East European states; 7% in the US (although the US has stated that it is no longer committed to the Kyoto Protocol); and 6% in Canada, Hungary, Japan, and Poland. New Zealand, Russia, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%.

The EU has made its own internal agreement to meet its 8% target by distributing different rates to its member states, just as the entire developed group's 5% target was shared out. These targets range from a 28% reduction by Luxembourg and 21% cuts by Denmark and Germany to a 25% increase by Greece and +27% for Portugal.

• ***The Protocol offers additional flexibility to the countries with economies in transition.*** In particular, they have more leeway in choosing the base year against which emissions reductions are to be measured. They also do not share the commitment of the richer developed countries to provide "new and additional financial resources" and to facilitate technology transfer for developing country Parties.

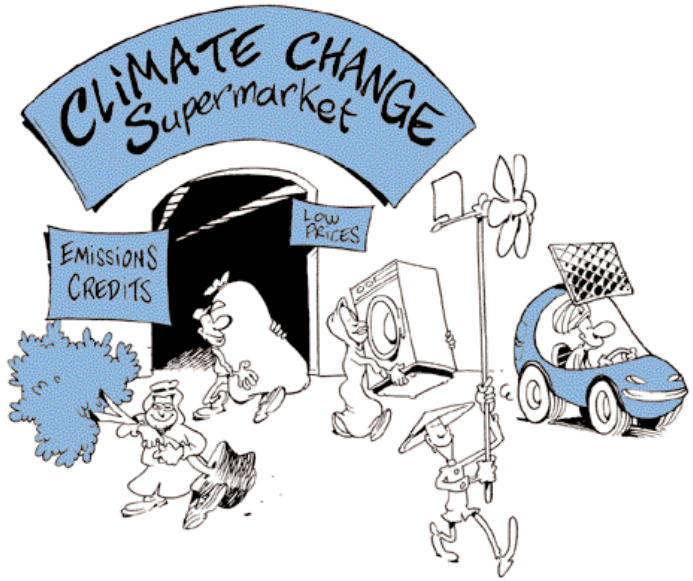
• ***It also reconfirms the broader commitments of all countries - developed and developing.*** Under the Convention, both developed and developing countries agree to take measures to address emissions and adapt to future climate change impacts; submit information on their national climate change programmes and emissions levels; facilitate technology transfer; cooperate on scientific and technical research;and promote public awareness, education, and training. These commitments are reaffirmed in the Protocol, which also sets out ways of advancing their implementation.

The issue of emissions targets for developing countries, and the broader question of how commitments should evolve in the future given continuing growth in global emissions, has generated a great deal of intense debate. A proposal that the Protocol should establish a procedure whereby developing countries could take on voluntary commitments to limit (that is, reduce the rate of increase in) their emissions was not accepted in Kyoto. Many developing countries resist formal commitments, even if voluntary, that would put an upper limit on their emissions, noting that their per capita emissions are still low compared to those of developed countries. Once developed countries start to convincingly demonstrate that they are taking effective actions to achieve their emissions targets, the debate on how new countries might eventually be brought into the structure of specific commitments may be revived.

This is in keeping with the step-by-step approach of the intergovernmental climate regime. The Kyoto Protocol is not an end result, and can be strengthened and built on in the future. What's more, although developing countries are not currently subject to any specific timetables and targets, they are expected to take measures to address climate change and to report on the actions they are taking. There is a good deal of evidence that many developing countries are indeed taking steps that should help their emissions grow at a slower rate than their economic output. This is particularly true in the field of energy.

Problem No 8:

I don't want to spend more money on this than is absolutely necessary!



People are keen to combat climate change because they fear it may be destructive and costly. At the same time, they naturally want to buy their "climate insurance" at the lowest price possible.

Fortunately, the costs of climate change policies can be minimized through "no regrets" strategies. Such strategies make economic and environmental sense whether or not the world is moving towards rapid climate change. For example, boosting energy efficiency not only reduces greenhouse gas emissions but lowers the cost of energy, thus making industries and countries more competitive in international markets; it also eases the health and environmental costs of urban air pollution. At the same time, the precautionary principle and the expected net damages from climate change justify adopting policies that do entail some costs.

Calculating the costs of climate change policies is not easy. How quickly power plants and other infrastructure are replaced by newer and cleaner equipment, how interest rate trends affect corporate planning and investment, and the way businesses and consumers respond to climate change policies are just a few of the variables to consider.

Costs can also vary from place to place. In general, the costs of improving energy efficiency should be lower in countries that are the most energy inefficient. Countries in the early stages of industrialization may offer cheaper opportunities for installing modern environmentally friendly technologies than do countries whose industrial plant is already developed. And so on.

How the Protocol responds

• ***The Protocol innovates by giving Parties credit for reducing emissions in other countries.*** It establishes three "mechanisms" for obtaining these credits. The idea is that countries that find it particularly expensive to reduce emissions at home can pay for cheaper emissions cuts elsewhere. The global economic efficiency of reducing emissions is increased while the overall 5% reduction target is still met. The Protocol stipulates, however, that credit for making reductions elsewhere must be supplementary to domestic emissions cuts.

Governments must still decide just how the three mechanisms for doing this will function. The rules they adopt will strongly influence the costs of meeting emissions targets. They will also determine the environmental credibility of the mechanisms - that is, their ability to contribute to the Protocol's aims rather than opening up "loopholes" in emissions commitments.

• ***An emissions trading regime will allow industrialized countries to buy and sell emissions credits amongst themselves***. Countries that limit or reduce emissions more than is required by their agreed target will be able to sell the excess emissions credits to countries that find it more difficult or more expensive to meet their own targets. The rules, however, have not yet been decided on.

Some observers are concerned that the Kyoto targets of some countries are so low that they can be met with minimal effort. These countries could then sell large quantities of emission credits (known as "hot air"), reducing pressure on other industrialized countries to make domestic cuts. Governments are debating the best way to ensure that emissions trading does not undermine incentives for countries to cut their own domestic emissions.

• ***Joint implementation (JI) projects will offer "emissions reduction units" for financing projects in other developed countries.*** A joint implementation project could work like this: Country A faces high costs for reducing domestic emissions, so it invests in low-emissions technologies for a new power plant in Country B (very likely an economy in transition). Country A gets credit for reducing emissions (at a lower cost that it could domestically), Country B receives foreign investment and advanced technologies, and global greenhouse gas emissions are reduced: a "win-win-win" scenario.

Not only governments, but businesses and other private organizations will be able to participate directly in these projects. Some aspects of this approach have already been tested under the Convention through a voluntary programme for "Activities Implemented Jointly". Reporting rules, a monitoring system, institutions, and project guidelines must still be adopted. Not only must this infrastructure establish the system's credibility, but it must ensure that JI projects transfer appropriate and current technology, avoid adverse social and environmental impacts, and avoid distorting the local market.

• ***A Clean Development Mechanism will provide credit for financing emissions-reducing or emissions-avoiding projects in developing countries.*** This promises to be an important new avenue through which governments and private corporations will transfer clean technologies and promote sustainable development. Credit will be earned in the form of "certified emissions reductions".

Whereas joint implementation and emissions trading merely shift around the pieces of the industrial countries' overall 5% target, the CDM involves emissions in developing countries (which do not have targets). This in effect increases the overall emissions cap. Verification is therefore particularly important for this mechanism.

The Protocol already details some of the ground rules. The CDM will be governed by the Parties through an Executive Board, and reductions will be certified by one or more independent organizations. To be certified, a deal must be approved by all involved parties, demonstrate a measurable and long-term ability to reduce emissions, and promise reductions that would be additional to any that would otherwise occur. A share of the proceeds from CDM projects will be used to cover administrative expenses and to help the most vulnerable developing countries meet the costs of adapting to climate change impacts. Again, the operational guidelines must still be worked out.

Conclusion :

The 21st century and beyond

Climate change would have lasting consequences. One giant asteroid came along 65 million years ago, and that was it for the dinosaurs.

In facing up to man-made climate change, human beings are going to have to think in terms of decades and centuries. The job is just beginning. Many of the effects of climate shifts will not be apparent for two or three generations. In the future, everyone may be hearing about and living with this problem.

The Framework Convention takes this into account. It establishes institutions to support efforts to carry out long-term commitments and to monitor long-term efforts to minimize and adjust to climate change. The Conference of the Parties, in which all states that have ratified the treaty are represented, is the Convention's supreme body. It met for the first time in 1995 and will continue to meet on a regular basis to promote and review the implementation of the Convention. The Conference of the Parties is assisted by two subsidiary bodies (or committees), one for scientific and technological advice and the other for implementation. It can establish other bodies as well, whether temporary or permanent, to help it with its work.

It can also strengthen the Convention, as it did in Kyoto in 1997. The Protocol's five per cent cut may seem a modest start, but given the rise in emissions that would otherwise be expected and remember that emissions in a number of developed countries have risen steadily since the 1990 base year many countries are going to have to make a significant effort to meet their commitment.

The Kyoto Protocol makes an important promise: to reduce greenhouse gases in developed countries by the end of the first decade of the new century. It should be judged a success if it arrests and reverses the 200-year trend of rising emissions in the industrialized world and hastens the transition to a climate-friendly global economy.

Key greenhouse gases affected by human activities

	CO_2 (Carbon Dioxide)	CH_4 (Methane)	N_2O (Nitrous Oxide)	CHC-11 (Chlorofluoro-carbon 11)	HFC-23 (Hydrofluoro-carbon-23)	CF_4 (Perfluoro-methane)
Pre-industrial concentration	~280 ppm	~700 ppb	~270 ppb	zero	zero	40 ppt
1998 concentration	365 ppm	1745 ppb	314 ppb	268ppt	14 ppt	80 ppt
Rate of increase change*	1.5 ppm/yr[a]	7.0 ppb/yr[a]	0.8 ppb/yr	-1.4 ppt/yr	0.55 ppt/yr	1 ppt/yr
Lifetime (years)	5-200yr[c]	12yr[d]	114yr[d]	45yr	260yr	>50.000yr

Notes:
[a] Rate has fluctuated between 0.9 ppm/yr and 2.8 ppm/yr for CO_2 and between 0 and 13 ppb/yr for CH_4 over the period 1990 to 1999.
[b] Rate is calculated over the period 1990 to 1999.
[c] No single lifetime can be defined for CO_2 because of the different rates of uptake by different removal processes.
[d] This lifetime has been defined as an "adjustment time" that takes into account the indirect effect of the gas on its own residence time.

Source: "Climate 2001, The Scientific Basis, Technical Summary of the Working Group I Report", p.38.

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