

**A POLITICO-GEOGRAPHICAL ANALYSIS OF
GLOBAL WARMING**

*Dissertation submitted to the Jawaharlal Nehru University
in partial fulfillment of the requirements
for the award of the degree of*

MASTER OF PHILOSOPHY

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2002



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CERTIFICATE

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the degree of Master of Philosophy (M.Phil.) of this university. It is her
ginal work and may be placed before the examiners for evaluation. This
sertation has not been submitted for the award of any other degree of
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Acknowledgement

Under divine guidance, following the completion of my dissertation, I would like to take this golden opportunity to express my heartiest thanks giving to my guide, parents, friends and well wishers. First of all, I would like to extend my deepest gratitude to my supervisor, Dr. S S Deora, for his compassionate attitude, valuable guidance and fatherly affection that has enabled me to work with utmost freedom, precision and led to the timely submission of my research work.

Secondly, I would like to thanks my parents and my brother whose constant support and abysmal belief in me, has helped me to retain my mental and physical freshness amidst all up's and downs.

I also owe a deep debt of gratitude to the various well-known writers whose works have been freely consulted.

Last but not the least, I would like to quote the help extended by J.N.U, World Bank, TERI and British Council library staffs, and my friends Amrita, Bimala and Sanjay, whose moral support has helped me to be innovative and intellectually prompt.

If there is any shortcoming that would be attributable to my failure to make the most of the suggestions received.

(Tanusree Sengupta)

*To
My parents*

Preface

Cold war geopolitics may be dead, but struggles over space, power and information are more intensified than ever. In a world of globalizing economies with universe of instantaneous information conditioning the political culture as a whole, there is a need to rethink about the domain of political geography. There are now many complicated and confusing themes emerging up which posses all potentiality to reshape the functional boundaries of the territorial states. One such issue is global warming which seeks to redefine the validity of the territorial states and the concept of the human security as a whole. In recent times the issues of environment seem to be one of the most potential arenas in shaping the course of the politico-geographical thoughts. The World is now experiencing a new geopolitical impetus arising out of the issues of environmental politics. However the issue like global warming is relatively new to the pantheon of politico-geographical studies. This study is a modest attempt to look into the issue of global warming from the viewpoint of a political geographer.

This study is divided into five chapters. *Chapter one* explains the science of global warming with the concomitant development of international responses on this aspect. It seeks to focus attention on the scientific consensus on global warming which form the basis of political responses. It is an introductory chapter and hardly goes deep

into the political discourses rather tries to present the issue in a superficial but in all pervasive way to provide a total insight.

The *second chapter* seeks to assess the impact of global warming on spatio-temporal scale. There is increasing scientific evidences that humans are gradually but certainly changing the earth's climate. Green house gas emission from fossil fuel use are altering the atmosphere, creating an uncertain future of global warming, altered pattern of precipitation and sea level rise for generation to come. The understanding of the impacts is very necessary as it determines and could mould the international response of the nations.

In the *third chapter* an attempt has been made to superimpose the science and society to that with the political frame over space.

Global problems require global accord to resolve the difficulties in a collective way. In an effort to prevent further damage to the fragile atmosphere and the belief that action is required now the political community (representing the nation or a group of nations) has been prolific in dissemination of global accord on global warming. The *fourth chapter* deals with the analysis of the international efforts to negotiate on the protocols and accord on global warming.

The world faces new global dangers that require whole new security strategies. In the *fifth chapter* an attempt is made to view the notion of sustainable development as a new security measure for the threatened earth to cope with the global dangers like global warming.

This kind of studies requires empirical orientation to achieve some theoretical basis out of the hypothesis. Analytical-descriptive methodology is supposed to be the best-suited methodology for this kind of research. Although objectivity is targeted but subjectivity may intrude in interpreting the objective reality. It also demands enquiry at the deep structure level to synthesis the observable confusing facts. Published environmental reports and statistics, books, newspaper clippings, webfolios, and earlier research works have been the main source of secondary information. The spatio-temporal scale of the study is based on macro level data as the evidences of global warming can be felt only over a vast area.

The topic is relatively new in the field of politico-geographical enquiry. Some of the initial quests have been directed in this regard by a few of the scholars mainly of the west. No doubt, the topic has an enormous potentiality to explore and research.

ABBREVIATION

C02 : Carbon di oxide

EU: European Union

GCOS : Global Climate Observing System

GCOS: Global Climate Observing System

GDP: Gross domestic product

GHG: Green house gases

GIS: Geographic Information System

GRID: Global Resource Information Database

IPCC : Inter -Governmental Panel On Climate Change.

OCED: Organization for Economic Co-operation and Development

TOGA: Tropical Ocean Global Atmosphere

U.N : United Nations

UNEP: United Nations Environment Programme

UNFCCC: United Nations Framework Convention on Climate Change

WCP: World Climate Programme

WCIP: World Climate Impact Studies Programme

WMO: World Meteorological Organization

WWW: World Weather Watch

Chapter I

**POLITICO-GEOGRAPHICAL PERSPECTIVE ON
GLOBAL WARMING: AN INTRODUCTION**

The potential threat of global climate change is a very serious problem before humanity. One of the most critical aspects of global climate change is the issue of the increasing warming up of the earth and its atmosphere, called "*global warming*"¹. During the last few decades the issue of global warming has drawn great deal of international attention as a section of scientists have confirmed that the impacts of global warming have already started manifesting, imposing a challenge before humanity to save his precious planet.

Various gases in the earth's atmosphere absorb the long wave infrared radiation remitted by the earth surface and trap the heat absorbs through the atmosphere. These gases in general are known as green house gases. Scientists all over the world are progressively concluding that human activity is chiefly responsible for the increasing concentration of such "*green house gases*"² responsible for the problem of an additional warming of the earth surface. In course of the rampant economic growth man has destroyed the natural environment. In the last century, the rapid increase in the consumption of hydro-carbon as well as the vigorous expansion of the industrial and domestic market for halo-carbons have drastically altered the atmospheric concentration of numerous trace gases. As a result the world is now struck with several environmental problems; including the common problem of acid rain, melting of glacial ice, large scale evaporation of water in tropics, increase in cloudiness in higher latitudes and so on. The implications of these changes on human life are likely to be enormous and may cause a

¹ See Appendix -I for the mechanism of global warming

² UNCED, ' Study on a global system of tradable carbon emission entitlements' Geneva, 1992, chapter I,p.4.

series of adverse effects. According to Inter-Governmental Panel On Climatic Change (IPCC) estimates, about 300 million people would be severely affected by a one meter rise in sea level due to the effect of deglaciation of Antarctic ice and consequent submergence of the low lying coastal areas. Hundreds of people will be rendered environmental refugees. Does this mean to stop all the developmental activities which bear an adverse impact of environment or to go for the costlier 'green technology'³, which in most of the cases is beyond the affordable reach of the developing countries. This has created the problem of striking a new balance with nature while continuing to expand economic opportunities for the billions of people who still lack a decent standard of living.

Today the pulse of environmental awareness surges around the globe. This obviously calls for global efforts. During the last two decades governments, non-governmental organizations, private industries, scientific and technical bodies, the United Nations and other international agencies, environmental activists - virtually every cross-section of interests and groups, all over the world have been engaged in articulating their perceptions. Several legal agreements and conventions have been signed by several of the nations being guided by the primary responsibility of 'our common future'⁴.

³ The problem of how to change production-consumption pattern was an issue first placed on an agenda for multilateral negotiation at UNCED in 1992. The instruments like green technology which, encourage energy conservation, use of renewable energy sources, waste reduction, recycling and reuse were suggested. Refer-Baker.S, Kousis.M, Richardson et al (ed) 1997*The politics of sustainable developmen* Routledge press, London. Pp 171-177

⁴ 'our common future'-World commission on environment and development's report on environmental protection released in 1987

Our past has never been the same, not that of the present. It was the western industrial Nations who have degraded the environment beyond the level of replenishment. Yet when it comes to the payment of compensation, it is always the developing countries of Asia, Africa and Latin America with millions of people aspiring to live like their counterparts the West , have to pay for it for the sake of the Global community.

However the idea of the rising up of a global community is still utopian. The world is marked by too much inequality. Therefore, attaining equal policy responses is not possible. More over 'ganging and bullying up'⁵, hierarchical exploitation, economic domination restrict the success of international agreements, conventions and protocols. This has led to the emergence of a new geo-political scenario.

The indications of global warming that have shown themselves particularly since the later half of the 20th century, has become one of the greatest challenges before the mankind in the 21st century. This has led much to do with the intensified interest in research in this area. On the other hand it has been compounded by the wide public awareness about the impact of human activities on the environment. There has been a growing concern about the environmental problems caused by pollution. Consequently a great deal of efforts has been put to climatic research in the recent years. However, most of these have been directed to support the theoretical modeling of atmospheric circulation in response to global climate change, its responses to carbon-di-oxide increase and to other human disturbances of the environment.

⁵ see John.F.Mearsheimer, 'Back to the Future; Instability in Europe after cold war ' *Foreign affair*, wsl, pp 111-123

Surprisingly, very few studies have been focused to the politico-geographical dimension of this aspect. The environmental issues like global warming being more fundamentally related to the question of human existence possess a full potential to dominate the future trends of global geopolitics as Human being has to find a way out to ensure his own existence on earth. Therefore, the topic like politico-geographical perspective of global warming is gaining more and more importance with the passage of time. Political geography should widen its horizon by incorporating such issues.

Origin and Evolution of Environmental Politics on the Issue of Global Warming

The industrial revolution marked a significant change in the nature of economic activity. The development of steam power and later on the internal combustion engine as a source of power was the landmark of this change. It led to a rapid expansion of industrial and manufactured output. This process began in parts of Europe towards the end of the eighteenth century and by the nineteenth century it spread throughout the Europe and North America. One of its main characteristics was the continuous success in harnessing fossil fuels to widen the production processes. Carbon dioxide emissions, in turn are mainly the direct result of the consumption of fossil fuels. Thus, as the process of industrialization contributed a growing share for industrial output in total economic activity; it also increased the level of carbon dioxide emission beyond the critical limit. By the time the rest of the world embarks upon the process of industrialization the level of Carbon dioxide concentrations in the atmosphere has already disrupted the balance of Nature.

When the consensus⁶ began to emerge on the problem of Carbon dioxide emissions, the adverse effects had already started manifesting themselves. Over a hundred years ago J. Tyndall (1861) , pointed out that atmospheric carbon dioxide together with water vapour absorbed long wave radiation , lead to increase in the earth's temperature. Variation in carbon dioxide concentration could result in climatic fluctuation and would influence man's activities. It was as early as in 1896, that a Swedish chemist, Arrhenius advances the theory that carbon dioxide emissions from combustion of coal would enhance earth's greenhouse effect and lead to global warming. However the issue remains dormant until the most important responses were made through the United Nations. The Intergovernmental Panel on Climate change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to review the state of knowledge about human induced climate change and to assess the possible responses. The IPCC suggested that a framework convention should articulate a multilateral green house gases control strategy, while simultaneously encouraging unilateral action by the largest emitters and the establishment of specific national commitments.

The first such assessment, published in 1990, was influential enough in formulating the Framework Convention on Climate Change (UNFCCC). The UNFCCC was adopted at the 1992-Earth conference, United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro as an international response to the problem

⁶ *see appendix-IV for The History of an International Scientific Consensus*

of the earth's changing climate. It seeks to serve as a means through which governments could opt to deal with the threat of the global warming. The ultimate objective of the convention was to stabilize green house gas concentrations in the atmosphere at a level that would prevent the dangerous interface with earth's climate.

The second assessment report, *Climate Change 1995*, produced the widely cited estimate that global warming would raise average temperature by 1^o to 3.5^o C by 2100 and would produce a sea level rise of 0.13 - 0.94 meters. The report took the further step of explicitly linking the warming to anthropogenic emissions of green house gases. The UNFCCC in its Article 1 defines *Climate Change* as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which in addition to natural climate variability is observed over comparable time periods". A broad consensus emerged among the world's leading experts that the impact of human activities on the global climate is just becoming detectable. The concern is that these changes might continue to intensify because of the interplay between past actions and the normal time lags with in the global climate response system.

The UNFCCC requires industrialized countries to achieve quantified targets for decreasing green house gas emissions. In order to strengthen the international response, the landmark Kyoto-Protocol was adopted in 1997. Under the Kyoto-Protocol, countries agreed to cut in emissions of the three most important gases: carbon dioxide, methane and nitrous oxide. The convention lists participating countries in two designations: *the Annex I and Annex II Parties and Non-Annex I Parties*.

The Annex I parties include both the 24 relatively wealthy countries that were the members of the organization for Economic Co-operation and Development (OECD) in 1992, the European Union and the countries with economies in transition, Russian federation and several other central and eastern European countries. These countries are committed to adopting national policies and measures aimed at reducing their greenhouse gas emission. They also agreed to submit regular reports, known as *national communications*, detailing their green house gas emissions. *The Annex II* parties, a subset of the annex I parties, include wealthier countries- the 24 OCED countries and the EU, which have a special obligation to help developing countries with financial and technological resources. The remaining 129 developing countries including China, Mexico, India, Brazil and South Korea were designated Non-Annex Parties.

The Kyoto Protocol laid down a target of a 5 percent reduction in GHG by 38 developed countries by the year 2010. More than 80 countries have signed Kyoto pact at that time. As of May 2000, 184 countries had ratified the UNFCCC. Since 1994, when the UNFCCC entered into force, the conference of the parties and the decision making body has met five times. In addition, The UNFCCC's subsidiary bodies have met twelve times. Various workshops have been held to implement climate change goals in such areas as agriculture, energy and resources.

However, the United States has abandoned the Kyoto protocol in March, 2001. Therefore the participation of other G8 nation's have become crucial to get the accord into force. The cynical view of UN summit on global warming was becoming evident since November 2000, at the Hague summit in Holland, which attracted more

businessmen than bonafied environmentalists. The two weeks UN Conference in Germany (Bonn) in July 2001, has not been able to bridge the divide between other developed nations and US over the accord of Global warming.

Dimensions of Global Warming Debate

There is still many debates and absolutely no consensus among the scientists about global warming .In 1992, over 400 scientists from around the world signed the Heidelberg Appeal prior to the UNCED conference in Rio. They expressed their doubts about the validity of the scientific knowledge on global warming and asked the delegates not to bind the world to any radical treaties based on global warming. Today scientists agreeing with the Heidelberg Appeal number over 4,000!

Whether the earth is warming or cooling, it self is a debatable issue as some of the prominent scientists of the days believe that global warming is actually a myth designed to counter balance the 'hegemonic white House effect'⁷. This group of scholars believe that the globalization of environmental green law in 1992 at the United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro is infact a part of the targeted environmental politics, imposes threat to the growth process of the nations. While the other group of scientists argues that global warming is a bare fact and has started manifesting. Many of the atmospheric scientists claimed that there is a dearth of data to suggest that man is radically altering the temperature

⁷ under hegemony there is only one major power in the international political system. The rest are minor power that can not challenge the major power directly. White house symbolizes American hegemonic power in *Patrick J. Michaels (2001) The Decline and Fall of Global Warming*, The Economic Freedom Network site on internet.

on the planet. However the UNFCCC report says that majority of the scientists agree that global warming is a fact.

Facts or Myth

Global Warming Skeptics: Leading opponents of the Kyoto treaty (Specially in the U.S.) maintain that the agreement is based on unreliable and inconclusive data about the threat of global warming. They argue that there are too many gaps in the theory to warrant the broad and expensive mandates outlined in the several protocols organized till date. Energy companies contend that scientists simply do not know for certain whether human activities are to blame for temperature increases that have been measured over the past 100 years. It has been argued that the Earth has been lurching in and out of warm and cool periods and the present climate shift may reflect a part of that natural cycle. Prof. William O'Keefe,⁸ notes that measurements of rising carbon dioxide and rising temperatures do not coincide. He points out that most of the observed increase in temperatures took place before 1940, while the largest surge in greenhouse gas emissions have occurred over the past 50 years. Global warming skeptics also attack the computer models that scientists use to predict the long-term effects of carbon dioxide on the climate. They argue that such computer models are poor predictors of long-term climate change. There are simply too many unknown factors affecting climate and a computer programmer to understand and predict climate changes reliably.

It has been also argued that the climate has always changed and it has a natural rhythm. Some scientists note that there may be alternative

⁸ Prof William O'Keefe was the executive vice president of the American Petroleum Institute.

causes of the warming trend measured during the 20th century. One promising factor could be the solar radiation. Since the 1970s, scientists have enough evidences that the sun undergoes cyclical periods of activity that affect how brightly it shines. That cycle, some scientists believe, may be responsible for changing temperatures on Earth.

Some skeptics⁹ of global warming challenge the notion that the Earth is warming at all. They believed that there is no credible evidence that the earth is currently warming because of human activities. They found that satellite measurements in the lower atmosphere for the past 23 years show no significant temperature change. The frequently quoted combined temperature record from weather stations is biased in favour of proximity to cities, airports. Buildings, roads and vehicles, all of which have become slightly warmer over the years from increased energy consumption. Surface measurements from remote areas show no evidence of significant warming. The methods used to predict future global warming are based on computer models, and even the models are changing their forecasts from time to time. In 1990 the UN Intergovernmental Panel on Climate Change said global temperatures would climb more than 3 degrees C by the year 2100 if there is no radical cuts in greenhouse gas emissions such as carbon dioxide and methane. Now it has been projected that the earth might only warm 1 degree C. - The earth was that warm a thousand years ago during the

⁹ The study done by Santer et al. (1996), although it is often cited as the definitive evidence for the greenhouse hypothesis, was especially controversial (Michaels and Knappenberger 1996) because the portion of the troposphere that showed the most dramatic warming during the study period (1963-1987) was found to show no change. The study done by Santer et al. (1996), although it is often cited as the definitive evidence for greenhouse hypothesis, was especially controversial (Michaels and Knappenberger 1996) because the portion of the troposphere that showed the most dramatic warming during the study period (1963-1987) was found to show no change.

last climactic optimum! The data showing a warming trend are based on temperature measurements taken at ground level. Some scientists, however, say that temperatures measured from air satellites are more accurate since they are less affected by the sources of heat, in particular cities that can distort temperature readings taken at ground level. Satellite measurements began in 1979, and have actually shown a statistically significant cooling trend. Over the last two decades, satellite sensors show that the earth has been cooling. However only If the measurements is started since 1850, at the end of the little ice age , the point "alarmists" love to start their charts, the earth has heated about 1degreeC. From about 800 A.D to 1200 A.D, the earth's average climate was warmer by at least 1 degree C than it is today. From 1200 a.d. onward, the earth began to cool. The period between 1450 and 1850 is the period scientists refer to as the *little ice age*¹⁰. The most severe storms in history set in during this time and are related to global cooling rather than global warming. The worst storms on record in the North Sea occurred during this time. Storms in 1421 and 1446 claimed 100,000 lives while a storm in 1570 claimed over 400,000.Only two of the 20 deadliest storms occurred since 1962 and none of them occurred in the 1980s or 1990s, when a section of the scientists first warned about the global warming "crisis." By 1850, the cooling cycle reversed and the earth began warming to the temperature norms. In this way a connection was established between the earth's normal temperature cycle to that with the sunspot cycle^{10a}.

¹⁰ Iceage signifies a geological period of widespread glacial activity. The most recent ice age was that of the Pleistocene period, two million years ago. Since post glacial period however, many important fluctuation of climate took place. There has been deterioration marked by minor glacial advances such as the little ice age in Alps from 1550-1850.

^{10a} The periodic changes in solar output

Sea level measurements are even more biased than weather stations, they believe. The sea monitoring stations are mainly located near Northern Hemisphere ports, and are subjected to local and short-term sea surface changes, which are difficult to allow for scientific observation. Sites in remote low population places, such as the smaller Pacific islands show no evidence of recent sea level change. Scientists concerned about global warming are especially troubled by dramatic signs of climate change in Antarctica—from rapidly melting glaciers to unexplained declines in penguin populations. Records show that average winter temperatures today are 10 degrees higher in parts of Antarctica than 50 years ago. Many climatic experts believe that if the warming trend continues the vast Antarctic ice sheets would melt, causing catastrophic coastal flooding as the world's oceans rise. However the skeptics seek to explain that the most pristine continent on Earth is heating up primarily because of increased greenhouse gas emissions from cars, power plants and other human endeavors, is just a myth. They argue that new geologic evidence unearthed from deep-sea mud deposits strongly suggests that Antarctica experienced periods of extreme warming and cooling long before the invention of the automobile. The changes over the years in the proportion of the most important gases are virtually unknown. The greenhouse gas like carbon dioxide is increasing in concentration linearly at the rate of 0.4% a year. There are no established harmful effects of this increase. Besides the rate of increase of the other important greenhouse gas, methane, has fallen steadily for the past 17 years. Therefore many scientists believe that the cause of these highly variable climate changes is still a mystery.

It is said that the planet's temperature has increased 1.5 degrees C since the mid of 19th century, two-thirds of which occurred before 1940, when carbon dioxide emissions by humans were minimal. Since 1979, carbon dioxide emissions from fossil fuels have risen 19%; yet the planet cooled 0.09 degree C during that period. Therefore One of the seriously ask doubts is how the earth's temperature rose before human-caused CO2 was put into the atmosphere? This is a case of an effect coming before the cause. Moreover, the chief hothouse gas is water vapor-not carbon dioxide or methane. It accounts for over 90% of global heat retention. Currently, human activity puts about 6 billion tons of CO2 into the atmosphere per year. Non-human activity, mostly volcanoes, accounts for about 200 billion tons. Human activity, then, constitutes 2-3% of carbon dioxide, which itself is less than 10% of the total. As professor of physics at Purdue University L. van Zandt commented-¹¹

"Human activity, carried out at the present rate (more than 12 years) cannot possibly account for more than 6 per cent of the observed change in CO2 levels. Entirely shutting off civilization-or even killing everybody-could only have a tiny effect on global warming, if there is any such thing- Why do all these supposedly educated, supposedly sane people want to end civilization?"

There are huge uncertainties in the model outputs. No model has ever successfully predicted any future climate sequence. There is no

¹¹ refer *Environmental Health Perspective*, volume 108:8, August 2000. Also refer Dansgard and et.al (GRIP) 'climate instability during the last interglacial period recorded in ice core' *Nature* 364, 1993. Pp 203-207

consensus on whether the current fluctuations are normal variations or caused by human activity. On the basis of all these counter arguments the critiques of the global warming hypothesis seek to conclude that the attempts to suggest a relationship with unusual weather events and changes in greenhouse gases have been unsuccessful.

Environmental Dangers Foreseen: The evidences that human-induced global warming is real and underway is becoming increasingly clear and compelling according to a large group of scientists. In response to skeptics of global warming, environmentalists and many scientists believe that there is ample evidence that human activities are changing the Earth's climate. The IPCC report that predicted warming, is based on a review of data by nearly 2,500 international scientists and climatologists. D. James Baker¹², an administrator at the U.S. National Oceanic and Atmospheric Administration, says, "*There's better scientific consensus on this than on any issue I know -- except maybe Newton's second law of dynamics*"

Intergovernmental Panel on Climate Change (IPCC), has confirmed that the world is warming. Major indicators over the last 100 years show that global temperature has increased by half a degree Centigrade. Given current trends of increase in atmospheric concentration of greenhouse gases, carbon dioxide in particular, it may warm by another one to Three-and-a-half degrees Centigrade by the year 2080. The last four years have been the hottest in the long history of climate. The hottest year on record was 1998. The World Meteorological Organization (WMO) has already predicted and assessed

¹² refer J.Baker et.al (1993) 'Sea level change and the state of balance' , *climate* 6, 29, pp 2247-62

that climate change will lead to extreme weather events for example, drought, cyclone, extreme floods, these kind of events will increase not only in frequency but will cover more area and will increase in intensity, will be more destructive. Natural disasters will increase. In the last few decades the rapid increase in the consumption of fossil fuels and the rapid expansion of industrial and domestic market for halocarbons have drastically altered the atmospheric concentration of numerous trace gases. The world is now facing with the problem of climatic disorder, which can not be set right by the hemeo-static mechanism of the nature. On regional scales, rain is being acidified, air quality in the boundary layer as indicated by the rising concentration of oxides of nitrogen-sulfur-and hydrocarbons is being severely degraded. On the global scale the stratospheric ozone layer is being depleted as well as the increasing concentration of carbon di oxides resulting in global warming. For example it is feared that the warming trend would accelerate between 0.3-0.4 C per decade. The 1990s have been the hottest decade of the millennium. According to the World Meteorological Organisation the high temperature of 1999 was "remarkable because it occurred despite the typical cooling influence of the tropical La Niña¹³". However, warming is not the only aspect of climate change. But it is by far the most evident.

Scientists note that the past 10-year period has been the hottest decade on record, according to ground-level temperature measurements.

¹³ La-Nina marks a period of strong trade winds and low sea temperature and occurs about every 3-7 years. The phenomenon is a product of a change in the pressure gradient. While El-Nina is just the opposite phenomena of La-Nina. It is a southward flowing nutrient poor current of warm water off the coast of western South America , caused by a break down of trade wind circulation.

The data show that 1995 was the hottest year ever recorded since measurements began in the late 1800s. The next hottest year was 1990, while 1996 ranked as the fifth hottest. Many scientists defend the ground-level measurements since they provide the best long-term method to measure and track temperature changes. There has been satellite data for 17 years only, they note, while, some scientists say that atmospheric effects, such as changing levels of ozone, have distorted satellite measurements. Scientists also defend the use of computer models, which they say have become more reliable in recent years. One way to test the computers' accuracy is to compare their predictions with the current climate. While the models have not been extremely precise in painting a long-term portrait of specific regional weather patterns, they have provided fairly accurate predictions of the Earth's general climate features, such as seasonal temperature shifts. The models have also been successful at predicting the effects on climate of weather disruptions, such as the periodic warming of the Pacific Ocean known as El Niño. Besides the observed rise in temperature, environmentalists point to other phenomena that appear to support the notion of global warming. Some studies by *Thomas C.D Lennon, Reilly and et al*¹⁴ reported that the growing seasons in the Northern Hemisphere are apparently getting longer. Their research suggests that the onset of the spring growing cycle arrived an average of eight days earlier in 1991 than in 1981. The study's results seemed to harmonize with other research showing that snow in the Arctic Ocean regions is melting earlier each year.

¹⁴ Thomas, C.D. and Lennon, J.J. (1999) 'Birds extend their ranges northwards' *Nature* 399: 213. And Reilly, J. 1994. 'Crops and Climate Change' *Nature*, 367: 118-119.

While scientists acknowledge that Earth's temperatures have fluctuated in the past, the rise in temperatures that will accompany a doubling of carbon dioxide will mark the swiftest and sharpest climate change in all 10,000 years of recorded human civilization. Such a dramatic climate change could have disastrous effects on the environment, wildlife and human society. In some areas, hotter annual temperatures could cause more dramatic and destructive weather events, such as hurricanes and tornadoes. Since warmer air holds more water, levels of annual precipitation could increase in some areas, disrupting regional ecosystems. Other areas could experience longer drier seasons and more frequent droughts, and forests could disappear. Animal and plant species that are not able to adapt fast enough to their changing environments could become extinct. Furthermore, because water expands as it is warmed, hotter average temperatures would cause a rise in sea levels, thereby flooding many low-lying areas. Warmer temperatures could also cause the Earth's polar ice caps to melt, which would increase the threat of flooding. The IPCC report predicted a rise in sea levels of six inches to 37 inches (15 centimeters to 95 centimeters) over the next 100 years if warming trends continues, and warned that millions of people could be forced to relocate them.

However there is no doubt that the questions of climate and environmental change are getting high attention all over the globe and not only among the scientists. For more than a decade, scientists and policy makers have engaged in a sometimes-vitriolic debate about the Earth's climate. The debate concerns potential changes associated with increasing atmospheric greenhouse gases, popularly known as global warming. The debate can be summarized as Global Warming: YES or

NO? with the associated policy prescriptions: Global Warming: YES = global emissions reductions, while Global Warming: NO = business as usual.

On the Global Warming: YES side of the debate are those who seek to warn of impending environmental doom caused by profligate lifestyles and a lack of concern for human impact on the environment. They have hitched their existing social and environmental concerns to global warming. They see the issue as a way to mobilize public support. Still, the majority of them have taken the moral high ground of collective future.

The propagator of the Global Warming: NO side of the debate see themselves in pulling back the curtain to reveal the frail wizards who manipulate scientific models for political motives. They seek to expose the great uncertainty involved in the models. Some of the climatic experts of this group have promised that rising greenhouse-gas levels will benefit society.

So who has won the debate? The answer depends on how one judge victory. Many nations have accepted that global warming is reality. Many companies as well, including Ford and British Petroleum, have begun to acknowledge the need for emissions policies in response to climate change. However global warming debate is no longer about whether to act. Even in the United States, where the Senate has refused to ratify the Kyoto Protocol, the question now is how to act.

From the standpoint of science, however, the debate is a draw. Much has been learned about climate over the past decade, but arguably the relationship between human activities, the atmosphere, and indeed

the global environment is much more complicated than scientists had thought. Modeling past climate has proven hard enough, but accurate predictions of future climate remain out of reach. An oil crisis, a volcano, or a breakthrough in energy technology would render irrelevant the predictions of even the most sophisticated computer model.

Human-caused or not, climatic changes are likely to have impacts on society and the environment. Natural disasters, human health, biodiversity, endangered species, water resources, international trade, financial services, transportation networks, agriculture. These impacts are occurring today, and they hold the prospect of increasing in the future. The global warming debate has focused almost exclusively on preventing climate change. And it has addressed greenhouse-gas emissions as the sole cause. But climate is only part of the impacts, and greenhouse gases are only one potential cause of changes in climate.

On the other hand, if *climate change* is redundant and changing climate is an attribute of a dynamic Earth, two possibilities may follow. If the Intergovernmental Panel on Climate Change (IPCC) is correct, humans will contribute to climate change in the future. And even if the IPCC happens to be wrong, the climate will still continue to change as it always has. Viewing from this angle it can be said that the entire debate on global warming has ignored the need for society to adapt to climate because adapting to climate means accepting that we cannot control it. Many assume that humans can in fact never control future climate but can adapt to it. While some believed that to fight with this new global danger, new forms of security strategies are required based on which the possibility of the emergence of a global neighborhood has been predicted. The problems like global warming are the example of global

pollution in which the activities of one nation or even one person can effect all people of all nations. Because the problem is global, all nations have to be involved in their solution. Global warming thus is well up in the current political agenda.

End note

- I. Chlorofluoro carbons (CFCs) are man made chemicals. They are non toxic, nonflammable and used for manufacturing purposes. They destroy ozone (isotope of oxygen) which protect the biosphere from the harmful UV rays of the sun. Once CFCs are released in the atmosphere they remain for a long time and produced cumulative effect of warming. On the other hand, the natural source of Methane (CH₄) is wet paddy field, livestock and organic wastes.
- II. On green house effect further details can be found in F.B. Mudge (1997) 'The development of the green house theory of global climate change from Victorian times' Weather 52, pp.13-16. Also refer J.T.Houghton (1986)'The physics of atmosphere' second ed, CUP.
- III. Adaptability to climate change means to the degree to which adjustments are possible in practices to project of actual changes.
- IV. Homeo-static mechanism means the self-responding or feedback system of nature to counter balance any sudden change.

Chapter II

**ASSESSMENT OF THE IMPACTS OF GLOBAL
WARMING - A SPATIAL DIMENTION**



Projection of the Cause and Effects of Global Warming Trends over Space and it's Probable Impacts

Whether man-made global warming is a real truth or just a physical impossibility, is indeed a matter of debate as discussed in the previous chapter but there is no doubt about the fact that this has drawn a lot of public attention as it seeks to influence the course of international relation. Politicians and policy framers are actively responding to it. There fore it is necessary to understand the cause and effect relationship of the problem of global warming.

It was once thought that carbon dioxide was the only green house gas. Research over the past two decades has identified other gases such as nitrous oxide, methane, chlorofluorocarbon and tropospheric ozone as potential greenhouse gases. Increasing energy use since the industrial revolution has led to the rapid accumulation of these green house gases well above the naturally occurring or historical level. The atmospheric concentration of carbon dioxide is now above 353 ppmv, 25 per cent higher than the pre-industrial (1750-1800) value of about 280 ppmv and is currently rising at a rate of about 0.5 percent per year due to anthropogenic emissions (Mostafa.K.Tolba¹⁵, '*saving our planet*', 1992). The Intergovernmental panel on Climate Change (IPCC) has estimated that if anthropogenic emissions of carbon dioxide could be kept at present day rates, atmospheric carbon dioxide would increase to 460-560 ppmv by the year 2100 because of the long residence time of carbon dioxide in the

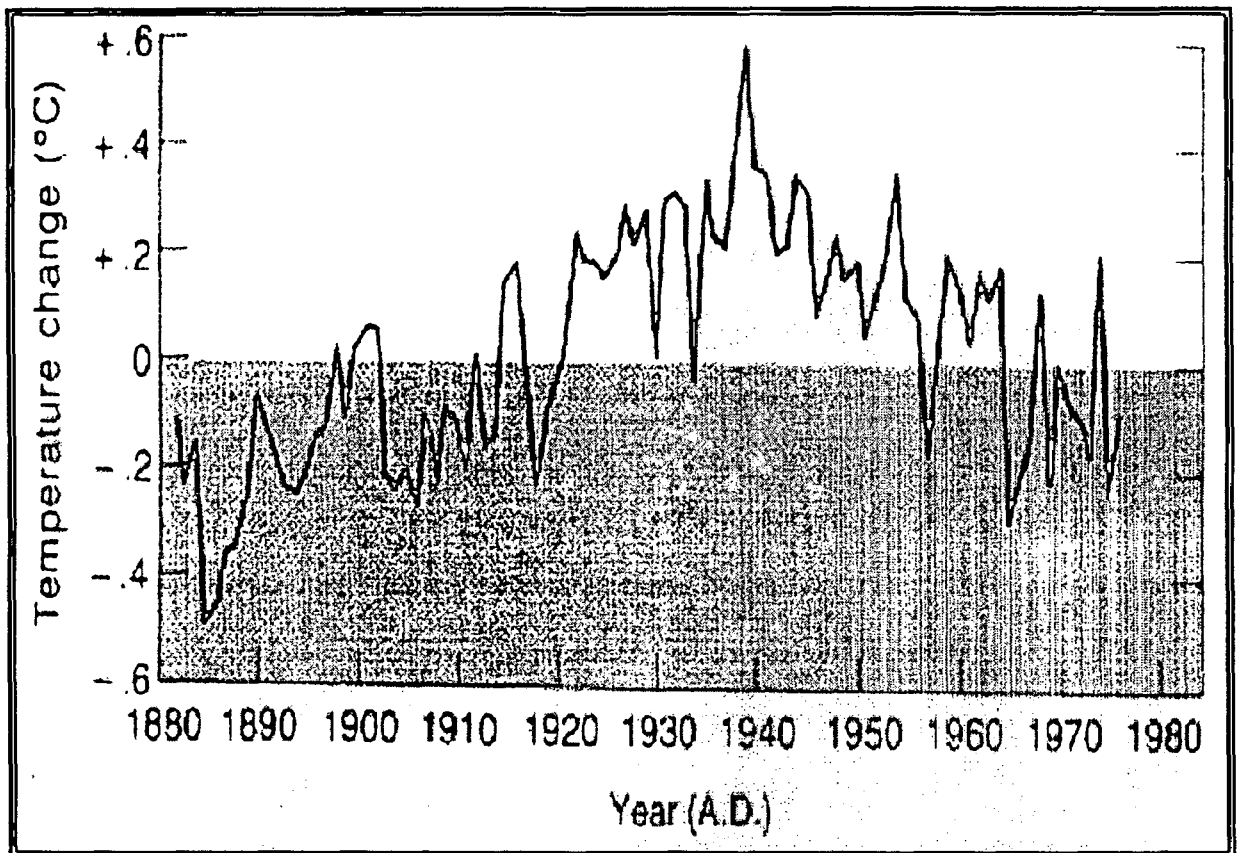
¹⁵ Tolba K. Mostafa (1992) '*Saving Our Planet: Challenges and Hopes*': Chapman & Hall; chap 3; pp 27-30, 223-227; chap 21; pp 235-256.



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GLOBAL MEAN TEMPERATURE CHANGES OVER 1880-1980



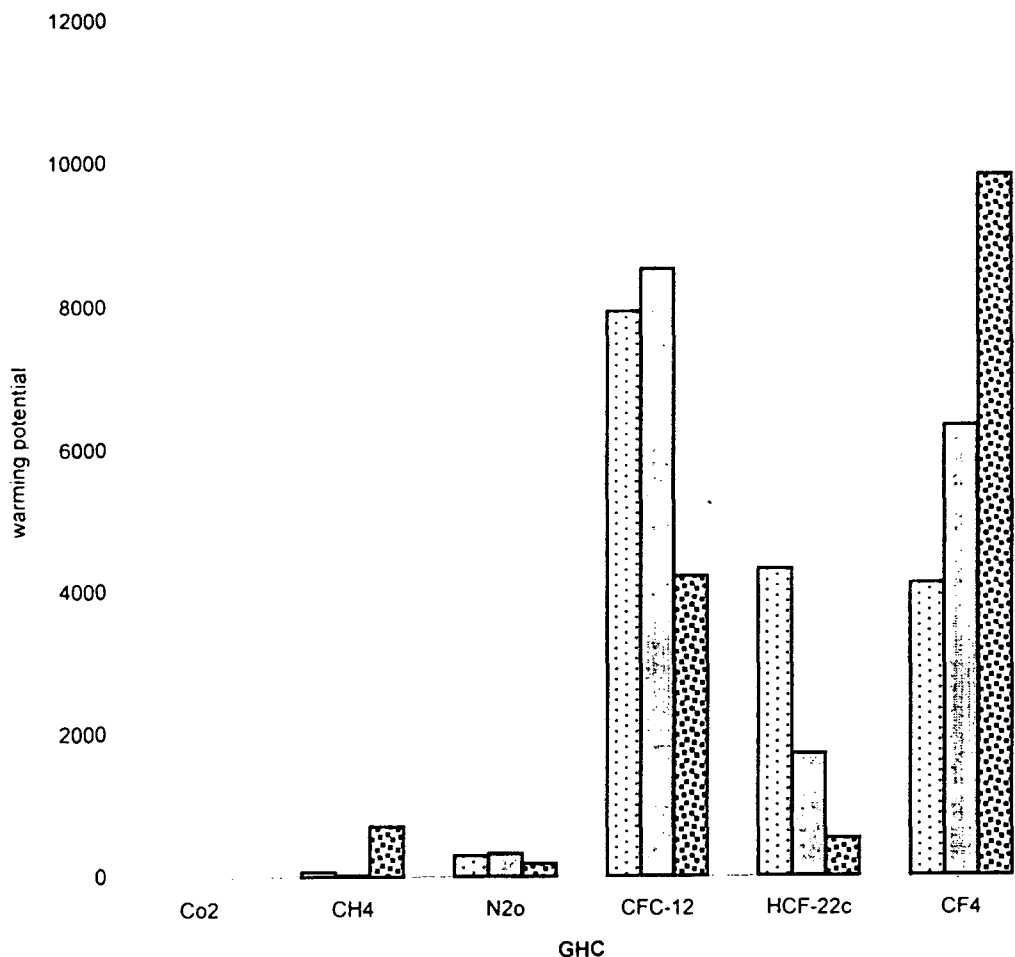
- Figure no.1.1
- Source : from Houghton et al.(1996) ,based on the IPCC Scientific Assessment Report Cambridge University press

atmosphere and the long lead time for its removal by natural sink. *Figure no. 1.1 shows the growth of observed CO₂ concentration in the atmosphere for the past century. And the table no. 1.1 shows the concentration of different green house gases in the atmosphere at the pre and post industrial revolution level.* On the other hand the total annual flux of methane to the atmosphere is between 400-600 million tonnes a year. Half of this amount is due to rice cultivation in China alone. Human activities add about 0.1 to 2.7 million tonnes of nitrous oxide per year from burning biomass¹⁶ and fossil fuels. The atmospheric nitrous oxide concentration is increasing at a rate of about 0.2-0.3 percent per year. Since 1750; atmospheric concentration of CO₂, CH₄, and N₂O have risen by about 30 percent, 100 percent and 15 percent respectively and are continuing to increase steadily. *Figure no 1.2 shows the relative global warming potential of different green house gases.*

Carbon dioxide in the atmosphere provides the key link in the global carbon cycle. The cycle had reached equilibrium over the past millennia until the dawn of the industrial revolution. The atmosphere has been the main absorber of carbon, while the terrestrial biosphere shifted from being a net source to a net sink for carbon after about 1940. Scientific enquiries indicate that global mean temperature changes have been closely synchronized with the level of carbon dioxide in air. UNFCCC identified carbon dioxide as the most

¹⁶ Bio mass means the total weight of a given substance in a volume of 1 m³. Hobbs, P.V., S. Reid, and R.A. Kotchenruther (1997). 'Direct radiative forcing by smoke from biomass burning'. *Science* 275: 1776-78.

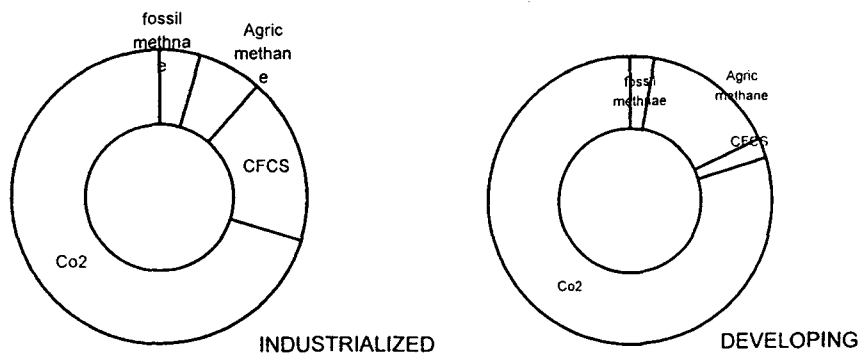
RELATIVE GLOBAL WARMING POTENTIAL OF MAJOR GHG



Note Series 1 depicts radiative global warming potential in 20 years
 Series 2 depicts radiative global warming potential in 100 years
 Series 3 depicts radiative global warming potential in 500 years
 source: Houghton et al. (1995)



CONTRIBUTION OF GHG IN RADIATIVE CHANGE DURING THE 1980S



source : UNCTAD paper 1992, Geneva

important GHG, having contributed about 60 percent of the total warming. At the same time the total additional effect of GHG depends on a several factors including its concentration, global warming potential (GWP) ¹⁷and atmospheric lifetime.

Table 1.1 indicates, while the concentration of carbon dioxide is much higher than that of other GHG, smaller increase in the concentration of latter gases could be as dangerous, because their GWPs are tens to thousands times greater relative to carbon dioxide. For example, methane is far less abundant in the atmosphere than carbon dioxide, still contribute about one- fourth as much as carbon dioxide does to global warming. Table 1.1 indicates the principal human activities that give rise to GHG. A number of sophisticated statistical tests show that the observed spatial variation in temperature is consistent with the pattern of increasing human intervention over time.

¹⁷ GWP indicates the cumulative warming effect caused by a unit mass of gas from the moment of emission upto some distant time in future. It is expressed as an index relative to the reference gas CO₂.

Main Green House Gases

GHG	Concentration		Main source	Relative global warming potential		
	PIL	level in 1992		20years	100 years	500 years
Co ₂	280 ppmv	335ppmv	Natural and anthropogenic	1	1	1
CH ₄	700ppbv	1714ppbv	Natural and anthropogenic	62	24.5	705
N ₂ o	275ppbv	311ppbv	Natural and anthropogenic	290	320	180
CFC-12	0	503pptv	Entirely anthropogenic	7900	8500	4200
HCF-22c	0	105pptv	Anthropogenic	4300	1700	520
CF ₄	0	70pptv	Anthropogenic Very long life	4100	6300	9800

Table NO 1.1

Abbreviation : ppmv, parts per million by volume; pptv, parts per trillion by volume;

Co₂ carbondioxide, CH₄-methane, N₂o-nitrous oxide, CFC-chlorofluorocarbon, HCF-22c, CF₄- perfluorocarbon

HCFC- hydro clorofluorocarbon

PIL : pre Industrial level

Source: Houghton et.al,1995

A range of climate indicators show that the twentieth century is probably warmer than any other century since 1400, before which sufficiently reliable data were not available. Even within this century, some areas have recorded the warmest decades that have occurred in the past millennium. The world average surface temperature has increased 0.3- 0.6°C over the past hundred years. Moreover, the warming has not been uniform- for example, night time temperature over land has increased more than day time temperature. The mean sea level has risen between 10-25 cm over the same period, primarily due to the retreat of glaciers. In 1992 IPCC made a series of projections up to 2100 of emissions of the principal GHGs that would most likely occur if no measures were taken to limit GHG emissions. The global average surface temperature is projected to go up by 1.4°C to 5.8°C by 2100. The highest projection that yields a sea level rise of 110 cm by 2100 corresponds to the worst emission scenario and the ice melt sensitivity level. In ecological terms this is a very rapid change.

Calculating and assessing the effects of global warming is not simple, as there is a lack of general consensus among the scientists. Moreover, different models yield differing results about the geographic variation in expected global warming and its impacts. The problem of global warming is one aspect of climate change and is likely to produce multi-dimensional repercussions. The Asian Development Bank's report on the impact of climate change gives an indication of the complex ecological and socio-economic situation in relation to adaptation to the effects of climate change. *The diagram*

CAUSE AND EFFECTS OF ANTHROPOGENIC GLOBAL WARMING

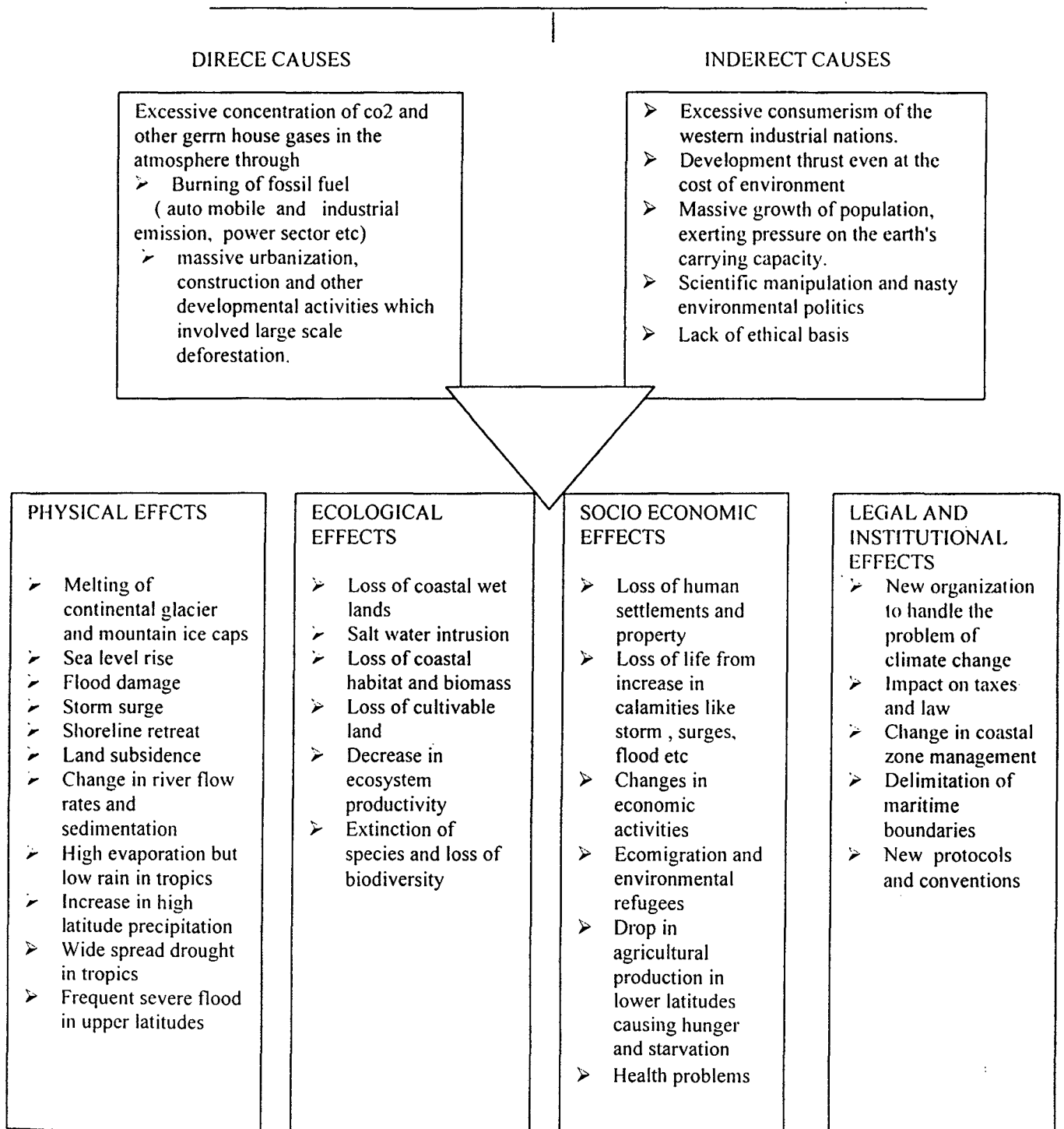


Figure No. 1.3

no 1.3 seeks to explain the causes and the probable consequences of the warming up of earth and its atmosphere.

A Spatial Overview

Asia is the largest continent in the world, covering almost one-third of the earth's total land surface. The Asian region spans polar, temperate, and tropical climates and is home to over 3 billion people. As the climate warms, many mountain glaciers may disappear, permafrost will thaw, and the northern forests are likely to shift further north. Rapid population growth and development in countries like China and India will put additional pressures on natural ecosystems and will lead to a rapid rise in the release of greenhouse gases into the atmosphere unless steps are taken to curtail emissions. Some cases of Asian region are-

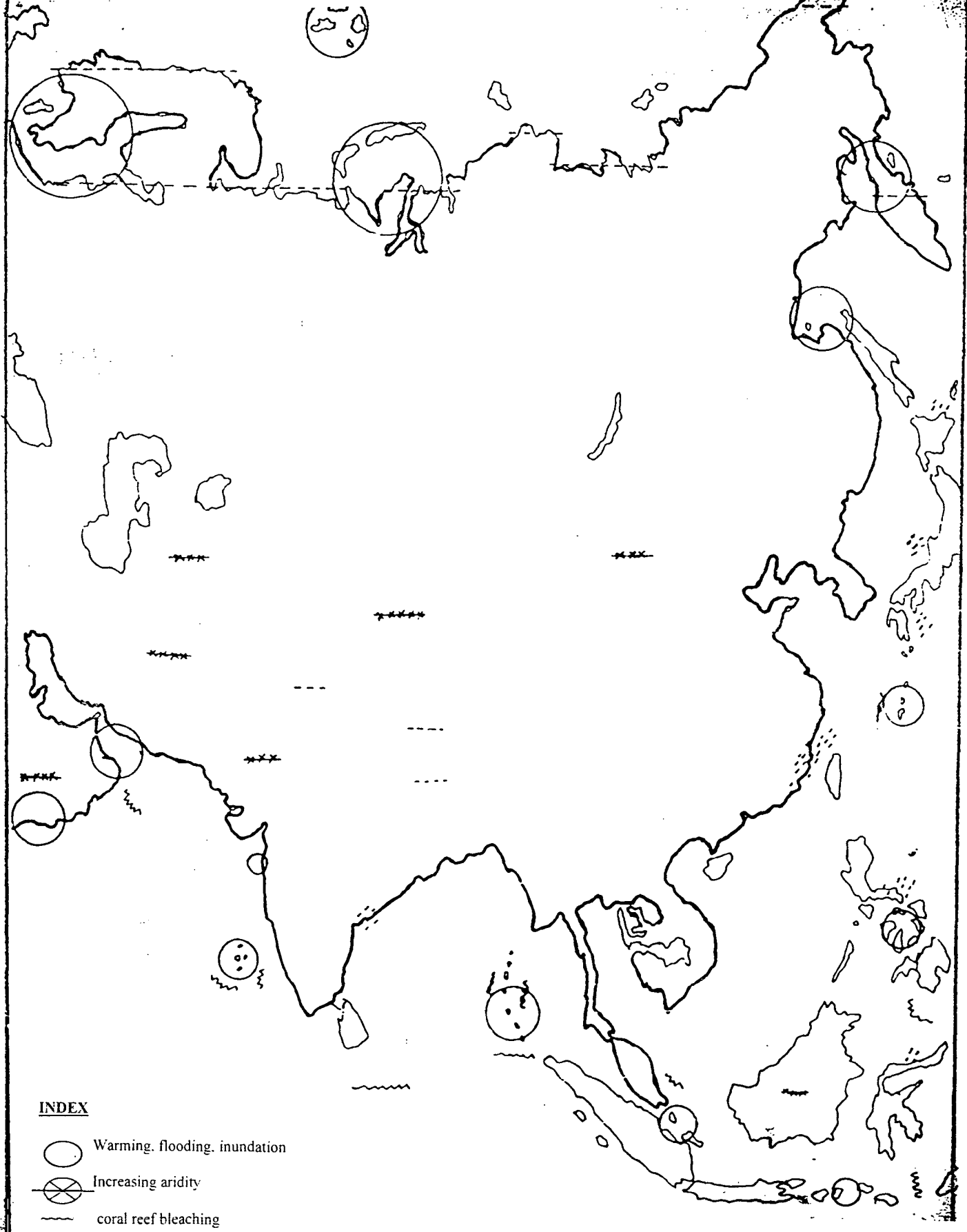
- *Tibet* -- Warmest June on record, 1998. Temperatures hovered above 77 degrees Fahrenheit for 23 days.
- *India* -- Glacial retreat at record pace in 1998 despite a severe winter. The Pindari Glacier is retreating at a rate of 13 meters a year. The Gangotri glacier is receding at an annual rate of 30 meters. At this rate scientists predict the loss of all central and eastern Himalayan glaciers by 2035. In recent decades, extreme rainfall events during the summer monsoon have increased over the northwest. The coastal states of Orissa was hit by two successive cyclones in 1999 which, affected nearly 15 million people. In 2000, heavy rains and flash flood devastated 11 districts of northeastern and eastern states, including Assam,

Bihar, WestBengal andhrapradesh. In 2001,Gujarat experiences heavy rains at the beginning of the monsoon season preceded by a severe drought. It has been estimated by the '*centre for Atmospheric Science' IIT, Delhi*¹⁸that high yield states like Punjab, Haryana and Uttarpradesh will suffer a decrease of 10 percent wheat yield if winter temperature increases by 0.5°C. On the other hand with rising sea level, salt marshes and mudflats in the Rann of kutch, the habitat of the Greater Flamingo in Asia may be submerged. Even the wild asses could lose their only habitat in India.Goa, Sundarban in WestBengal stand to lose 4 percent of its total area due to sea level rise. A one-metre sea level rise may displace approximately 7.1 million people in India. The entire population of Lakshadweep is at risk due to sea level rise. India's energy consumption is increasing and it is likely to grow as efforts to provide better living standards to her population are made. Thus, during the last decade, India's energy consumption more than doubled from 91 million tonnes of oil equivalent (mtoe)¹⁹in 1980-81 to 189 mtoe in 1991, reaching 219 mtoe in 1994-95. Most of the increased energy consumption has been contributed by coal and oil, the fuels that are also associated with emissions of greenhouse (GHG) gases. As a signatory to the Framework Convention on Climate Change that was adopted at Rio by the international community, India needs to pursue environmentally sound energy development. Since fossil fuel use contributes the largest share of GHG emissions in the atmosphere,





¹⁸ also refer Nadkarni Manoj,' Deep Impact, Shallow Response': Down To Earth; (October 31,2001), pp 28-53.

¹⁹ mtoe denotes metric tonnes of oil equivalent

THE IMPACT OF GLOBAL WARMING IN ASIA (PROJECTED)



INDEX

-  Warming, flooding, inundation
-  Increasing aridity
-  coral reef bleaching
-  Deglaciation

Source: J. Houghton (1997) 'Global Warming: The complete briefing', (2nd ed.)
Cambridge University Press and Jepma and Munasingh (1998) *Climate Change Facts,
Issues and Analysis*, www.noaa.org.

efficient production and use of energy can reduce emissions and put India on a low energy intensive growth path

- *Indonesia* -- Malaria spreads to high elevations. Malaria was detected for the first time as high as 6,900 feet in the highlands of Irian Jaya in 1997. Burning of rainforest, 1998. Fires burned up to 2 million acres of land, including almost 250,000 acres of primary forest and parts of the already severely reduced habitat of the Kalimantan orangutan.
- *Indian Ocean* -- Coral reef²⁰ bleaching (includes Seychelles; Kenya; Reunion; Mauritius; Somalia; Madagascar; Maldives; Indonesia; Sri Lanka; Gulf of Thailand; Andaman Islands; Malaysia; Philippines; Oman; India; and Cambodia). During 1997-98, reports of coral bleaching from all the major tropical oceans of the world suggested that this time period had seen the most geographically widespread bleaching ever recorded, with some areas (e.g., Singapore, and the Andaman Islands) witnessing extensive bleaching for the first time in recent history. The bleaching response represents a loss of symbiotic algae and their pigments such that the coral may pale in color to a varying extent, or turn starkly white. The response has been exceptionally severe with a large number of corals turning completely white and subsequently dying. Mass bleaching normally occurs when

²⁰ coral reefs are organically constructed calcareous marine topographic feature, developed by the activities of the carbonate secreting corals. Coral reefs are part of the exotic marine environment. Refer Wilkinson C, Linden O, Cesar H, Hodgson G, Rubens J, Strong AE (1999). 'Ecological and socioeconomic impacts of 1998 coral mortality in the Indian Ocean: An ENSO impact and a warning of future change?' *Ambio* 28, 188-196.

seasonally maximal sea-surface temperatures (SST) are exceeded. Not only hard and soft corals, but also sea anemones, giant clams, foraminifera and many other zooxanthellate invertebrates are also affected. Links have been made between the widespread incidence of coral bleaching in 1997/98 with one of the strongest El Ninos of this century. For some of the tropical oceans significant increases in SST have been observed over the last 50 years. While corals display impressive acclimation processes to changes in some environmental parameters, it is not known whether they are able to adapt or acclimatize at rates which match the projected rates of background seawater temperature increase. The 1997-98 episode of worldwide bleaching is a major cause for concern., although sea temperatures have returned to normal in many tropical areas of the world.

- *Tien Shan Mountains, China* -- Glacial ice reduced by one quarter in the past 40 years.
- *Korea* -- Heavy rains and flooding. Severe flooding struck during July and August, 1998, with daily rainfall totals exceeding 10 inches
- *Khabarovsk, Russia* -- Wildfires threaten tiger habitat, 1998. Drought and high winds fueled fires that destroyed 3.7 million acres of taiga and threatened two important nature reserves that are habitat for the only remaining Amur tigers.

The vast North American continent ranges from the sub-tropical climate of Florida to the frozen ice and tundra of the Arctic.

Within these extremes are two wealthy industrialized countries the United States and Canada, with diverse ecosystems. The United States and Canada are also two of the largest global emitters of the greenhouse gases. This has resulted in large scale environmental changes including polar warming in Alaska, coral reef bleaching in Florida, animal range shifts in California, glaciers melting in Montana, and marsh loss in the Chesapeake Bay etc.

The overall geographic distribution of the global warming hotspots is skewed towards North America. In part this is because this region has more readily accessible climatic data and more comprehensive programs to monitor and study environmental change. Some of the recorded cases of the impacts of global warming are as follows

- *Edmonton, Canada* -- Warmest summer on record, 1998. Temperatures were more than 5.4 degrees Fahrenheit higher than the 116-year average.
- *Glasgow, Montana* -- No sub-zero days, 1997. For the first time ever, temperatures remained above zero degrees Fahrenheit in December. The average temperature was 10.9 degrees Fahrenheit above normal.
- *Texas* -- Deadly heat wave, summer 1998. Heat claimed more than 100 lives in the region. Dallas temperatures were over 100 degrees Fahrenheit for 15 straight days. Besides this region has also seen record downpours in 1998. Severe flooding in southeast Texas

from two heavy rain-storms with 10-20 inch rainfall totals caused \$1 billion in damage and 31 deaths.

- *Florida* -- June heat wave, 1998. Melbourne endured 24 days above 95 degrees Fahrenheit; nighttime temperatures in Tampa remained above 80 degrees Fahrenheit for 12 days. Worst wildfire in 50 years has also been recorded in 1998. Fires burned 485,000 acres and destroyed more than 300 homes and structures. Florida, Texas, Louisiana also have seen the driest period in 104 years in April-June 1998. San Antonio received only 8 percent of its normal rainfall in May. New Orleans suffered its driest and hottest May in history.
- *Eastern USA* -- July heat wave 1999. More than 250 people died as a result of a heat wave that gripped much of the eastern two-thirds of the country. Heat indices of over 100 degrees Fahrenheit were common across the southern and central plains, reaching a record 119 degrees Fahrenheit in Chicago. Eastern USA was also observed the driest growing season on record in 1999. The period from April-July 1999 was the driest in 105 years of record keeping in New Jersey, Delaware, Maryland, and Rhode Island. Agricultural disaster areas were declared in fifteen states, with losses in West Virginia alone expected to exceed \$80 million.
- *New England* -- Double normal rainfall, June 1998. Rainfall in Boston on June 13-14 broke a 117-year-old record, closing Logan Airport and two interstate roads. Vermont, New Hampshire, Rhode Island, and Massachusetts each received more than double their normal monthly rainfall.

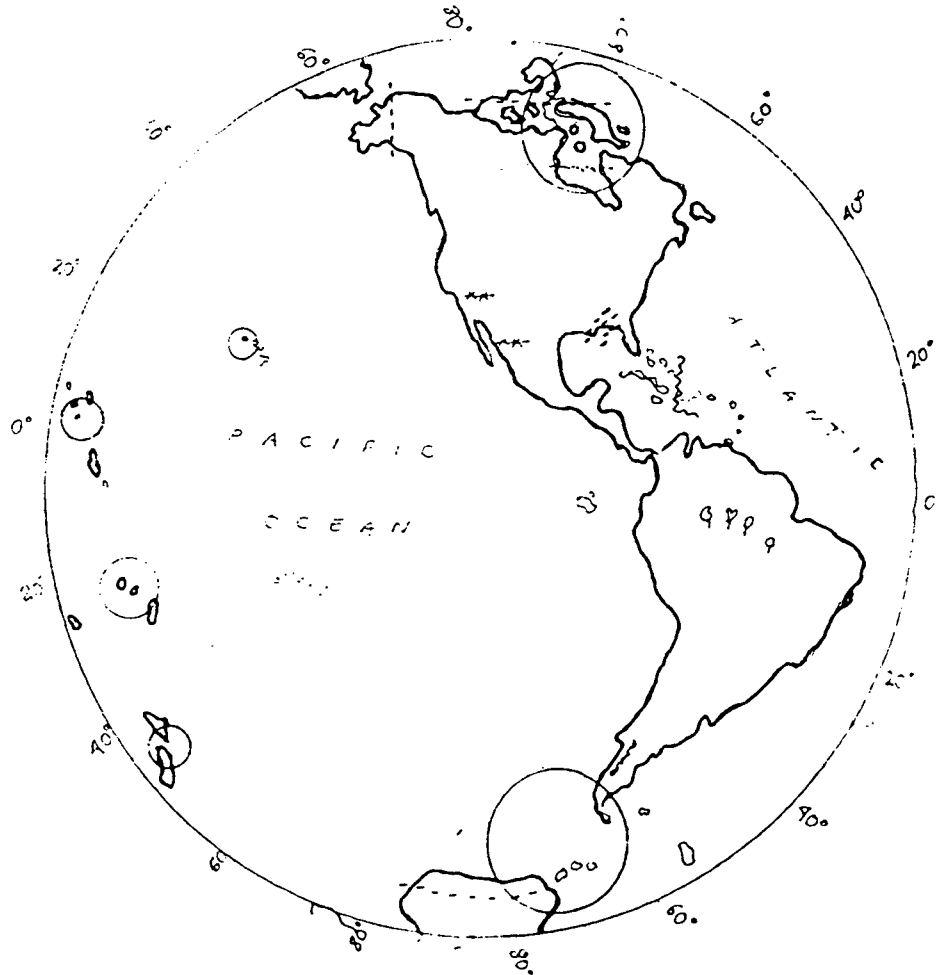
- *Mount Baker, Washington* -- World record snowfall, 1999. 1,140 inches of snow fell between November 1998 and the end of June 1999, a world record for most snowfall in a single winter seasons.
- *California* -- Butterfly range shift. Edith's Checkerspot Butterfly has been disappearing from the lower elevations and southern limits of its range. In Monterey Bay, California the shoreline sea life shifting northwards. Changes in invertebrate species such as limpets, snails, and sea stars in the 60-year period between 1931-1933 and 1993-1994 indicate that species' ranges are shifting northwards, probably in response to warmer ocean and air temperatures.
- *Chesapeake Bay* -- Marsh and island loss. The current rate of a sea level rise is three times the historical rate and appears to be accelerating. Since 1938, about one-third of the marsh at Backwater National Wildlife Refuge has been submerged.
- *Bermuda* -- Dying mangroves. Rising sea level is leading to saltwater inundation of coastal mangrove forests.
- *Hawaii* -- Beach loss. Sea level rise at Waimea Bay, along with coastal development, has contributed to considerable beach loss over the past 90 years.
- *Interior Alaska* -- Permafrost thawing. Permafrost thawing is causing the ground to subside 16-33 feet in parts of interior Alaska. The permafrost surface has warmed by about 3.5 degrees Fahrenheit since the 1960's. Nana, Alaska has also shown early river thaw. During 82 years on record, four out of the five earliest

thaws on the Tanana River occurred in the 1990's. The Sea bird population has declined drastically. The black guillemot population is declining from 1990 levels because melting sea ice has increased the distance the birds must fly to forage for food and reduced the number of resting sites available.

- *Bering Sea* -- Reduced sea ice. Sea-ice extent has shrunk by about 5 percent over the past 40 years.
- *Arctic Ocean* -- Shrinking sea ice. The area covered by sea ice declined by about 6 percent from 1978 to 1995.
- *Mexico* -- Dengue fever spreads to higher elevations. Dengue fever has spread above its former elevation limit of 3,300 feet and has appeared at 5,600 feet. Mexico has also recorded worst fire season ever, 1998. 1.25 million acres burned during a severe drought. Smoke reaching Texas triggered a statewide health alert.

The climate of Central America strongly affects social and economic conditions in the region through its impacts on agriculture, tourism, and human health. The impacts of the 1997-98 El Niño in Central America provide examples of what future global warming may bring. During that year, forest fires raged out of control and high sea surface temperatures “bleached” corals in adjacent seas. Future changes in the frequency of extreme events such as hurricanes, floods, and droughts may damage important export crops such as bananas, threaten human settlements on unstable hillsides, and facilitate the outbreak of diseases such as malaria and dengue fever. Dengue fever had spread to higher elevations. Dengue fever is

IMPACTS OF GLOBAL WARMING IN AMERICA (PROJECTED)



INDEX

- Warming, flooding, inundation
- ⊗ Increasing aridity
- ~ coral reef bleaching
- - - Deglaciation

Source: J. Houghton (1997) 'Global Warming: The complete briefing', (2nd ed.) Cambridge University Press and Jepma and Munasingh (1998) *Climate Change Facts, Issues and Analysis*, www.noaa.org.

spreading above its former limit of 3,300 feet and has been reported above 4,000 feet.

- *Monteverde Cloud Forest, Costa Rica* -- Disappearing frogs and toads. A reduction in dry-season mists due to warmer Pacific ocean temperatures has been linked to disappearances of 20 species of frogs and toads, upward shifts in the ranges of mountain birds, and declines in lizard population.
- *Pacific Ocean, Panama, Caribbean, Bahamas* -- Coral reef bleaching.
- *Nicaragua* -- 2.2 million acres burned in 1998 and the blazing acreage included protected lands in the Bosawas Biosphere Reserve.

The people of South America are heavily dependent on the continent's natural resources from the woodlands at the foothills of the Andes, to the plants and animals of the Amazon rainforest, to the fisheries off the coast of Peru. The region's ecosystems are particularly vulnerable to the changes in water availability. Higher global temperatures along with more frequent El Niños may bring increased drought and melting glaciers in the Andes threaten the future water supply of mountain communities. Signs of a warming climate have already appeared both at high elevations in glacial retreat and shifting ranges of disease and along the coast -- in rising sea level and coral bleaching.

- *Recife, Brazil* -- Sea level rise. Shoreline receded more than 6 feet per year from 1915 to 1950 and more than 8 feet per year from

1985 to 1995. The dramatic land loss was due to a combination of sea level rise and loss of sediment supply following dam construction, harbor dredging, and other coastal engineering projects.

- *Andes Mountains, Peru* -- Glacial retreat accelerates seven-fold. The edge of the Qori Kalis glacier retreated 13 feet annually between 1963 to 1978. By 1995, the rate had stepped up to 90 feet per year.
- *Andes Mountains, Columbia* -- spreading of *Aedes aegypti* mosquitoes that can carry dengue and yellow fever viruses were previously limited to 3,300 feet but recently appeared at 7,200 feet.
- *Galapagos* -- Coral reef bleaching

Europe is the second smallest continent in the world. The most northerly areas of the European region lie in the cold, snowy bosom above the Arctic Circle. Much of the central Europe is a plain with warm summer and cold winter. In the west the climate is milder, affected by rain bearing winds and Warm Ocean current. Southern Europe is divided by the mountain ranges of pyrenees, Alps and Carpathians. The lands around Mediterranean sea enjoy mild winter and warm summer. This region supports a wide variety of wildlife.

- *United Kingdom* -- Birds laying eggs early. From 1971 to 1995, 31 percent of 65 bird species studied in England showed significant trends towards earlier egg laying, moving up the date by an average of 8.8 days. Projected 20 percent increase in peak flows

in the River Thames, which flows through London, would put Tower Bridge and other parts of the British capital at severe risk. 50 to 90 percent of Europe's glaciers could disappear by the end of the 21st century, if current trends continue.

- Southern England -- Early leafing of oak trees. The four earliest leafing dates occurred in the past decade, a response to increasing temperatures during January to March over the past 41 years. Butterfly ranges have shifted northward. 22 of 35 butterfly species studied have shifted their ranges northwards by 22 to 150 miles, consistent with a 1.4 degree Fahrenheit warming over the past century.
- *Germany* -- Mollusc range shift. 20 percent of 40 mollusc species in a national park have changed their distribution in response to warming.
- *France* -- Severe storms hit Britain and France in November 2000, adding new urgency to the climate-change debate. The worst flooding claim in 400 years claims lives as the River Ouse surged 18 feet above normal. Some 10,000 people had to be evacuated from their homes. Atlantic salmon is disappearing fast from the River Loire.
- *Scandinavia* -- is experiencing increasingly heavy rain and more severe flooding.





The Oceania region ranges from the lush tropical rainforests of Indonesia to the interior deserts of Australia. The climate is strongly influenced by the ocean and the El Niño phenomenon. This region



IMPACTS OF GLOBAL WARMING IN ASUTRALIA (PROJECTED)



INDEX

-  Warming, flooding, inundation
-  Increasing aridity
-  coral reef bleaching
-  Deglaciation

Source: J. Houghton (1997) 'Global Warming: The complete briefing', (2nd ed.) Cambridge University Press and Jepma and Munasingh (1998) *Climate Change Facts, Issues and Analysis*. www.noaa.org.

mainly includes small island nations. Much of the population is concentrated in the coastal plains, vulnerable to increasing coastal flooding and erosion due to rising sea level. Warming sea temperatures in recent years have damaged many of the region's spectacular coral reefs, threatening one of the world's most diverse ecosystems.

- *Christchurch, New Zealand* -- Warmest February on record, 1998. Daily temperatures averaged near 67 degrees Fahrenheit.
- *Fiji* -- Sea level rise. Reports from local inhabitants at 16 sites indicate that the island's average shoreline has been receding half a foot per year over at least the past 90 years.
- *Western Samoa* -- Land loss. Western Samoa has experienced shore recession of about one and a half feet per year for at least the past 90 years.
- *Papua New Guinea, Australia, Great Barrier Reef* -- Coral reef bleaching
- *New South Wales, Australia* -- Wettest August on records, 1998.

The African continent has a rich mosaic of ecosystems, ranging from the snow and ice fields of Kilimanjaro to tropical rainforests to the Saharan desert. Although it has the lowest per capita fossil energy use of any major world region, Africa may be the most vulnerable continent to climate change because widespread poverty limits countries' capabilities to adapt.

Signs of a changing climate in Africa have already emerged: spreading disease and melting glaciers in the mountains, scorching heat in drought-prone areas, sea-level rise and coral bleaching along the coastlines.

- Cairo, Egypt -- Warmest August on record, 1998. Temperatures reached 105.8 degrees Fahrenheit on August 6, 1998.
- Southern Africa -- Warmest and driest decade on record, 1985-1995. Average temperature increased almost 1 degree Fahrenheit over the past century.
- Senegal -- Sea level rise. Sea level rise is causing the loss of coastal land at Rufisque, on the South Coast of Senegal.
- Kenya -- Mt. Kenya's largest glacier disappearing. 92 percent of the Lewis Glacier has melted in the past 100 years. Deadly malaria outbreak in summer, 1997. Hundreds of people died from malaria in the Kenyan highlands where the population had previously been unexposed to this disease.
- Tanzania -- Malaria expands in mountains. Higher annual temperatures in the Usambara Mountains have been linked to expanding malaria transmission.
- Seychelles Islands -- Coral reef bleaching.

Global warming in Antarctica: Scientists concerned about global warming are especially troubled by dramatic signs of climate change in Antarctica from rapidly melting glaciers to unexplained declines in penguin populations. Records show that average winter

temperatures today are 10 degrees higher in parts of Antarctica than 50 years ago. If that warming trend continues, the vast Antarctic ice sheets could melt, causing catastrophic coastal flooding as the world's oceans rise. However, the new geologic evidences unearthed from deep-sea mud deposits strongly suggests that Antarctica experienced periods of extreme warming and cooling long before the invention of the automobile. Sedimentary record reveals very significant changes in water temperature and ice melt during the past 7,000 years. Therefore it is now argued that the cause of Antarctic climate changes is still a mystery. Though many of the scientists are of the view that the most pristine continent on Earth is heating up primarily because of increased greenhouse gas emissions from cars, power plants and other human endeavors elsewhere on the planet.

The impacts of warming temperatures in Antarctica are likely to occur first in the northern sections of the continent, where summer temperatures approach the melting point of water, 32 degrees Fahrenheit. Some ice shelves in the northernmost part of Antarctica, the Antarctic Peninsula are on the verge of collapsing in recent years. Scientists are also concerned about future changes in the large West Antarctic ice sheet on the main continent because its collapse could raise sea level by as much as 19 feet. In the single largest event in a 30 year series of ice retreats, 1260 square miles of the Larsen B ice shelf, an area greater than the size of Rhode Island and the thickness of a 60 story building, disintegrated in the span of just 35 days from February to March, 2002. Scientists attribute the retreats to strong regional warming of about 4.5 degrees Fahrenheit since the late 1940's. Penguin population is rapidly declining. Adele Penguin

populations have shrunk by 33 percent during the past 25 years in response to declines in their winter sea ice habitat

- *Antarctic Peninsula* -- Since 1945, the Antarctic Peninsula has experienced a warming of about 4.5 degrees Fahrenheit. The annual melt season has increased by 2 to 3 weeks in just the past 20 years. The 770 square mile Larsen A ice shelf disintegrated suddenly in January 1995.

Green house damage will probably manifest in many different ways. However researchers differ significantly with respect to their appreciation of the differences in the contribution of various categories of damages to the over all damage. *Table no.1.2 depicts an over view of the damages in terms of physical quantities - the forest area lost in square kilometers, the number of habitat lost, the number of hurricane casualties and so no, assuming a bench mark average global warming of 2.5°C associated with a doubling of atmospheric carbon dioxide concentrations.* The chart shows that China's agriculture would suffer drastically at the assuming average global warming of 2.5°C. Though China is the world's largest agricultural producer (FAO report 2000) with 19 percent of the world's agricultural production, the share of agriculture to total GNP is likely to fall sharply than any other country as an adverse response to global warming. Besides the vast tract of amazon forest and the high latitude coniferous forests are under the threat of destruction because of increasing dryness, forest fires and land degradation. Among the OECD countries Canada's paper industries would receive a great

**Damage in Physical Units in Different Regions (At 2.5^oc
Warming)**

TYPE	INDICATOR	EU	USA	CHINA	NON- OECD	OECD	WORLD
Agriculture	Welfare loss (%GNP)	0.21	0.16	2.10	0.28	0.17	0.23
Forestry	Forest area lost (km ²)	52	282	121	334	901	1235
Fishery	Reduced catch (1000t)	558	452	464	4326	2503	6829
Energy	Rise in demand(Twh)	54.2	92.0	17.1	142.7	211.2	353.9
Water	Reduced availability(km ²)	15.3	32.7	32.2	168.5	62.2	230.7
Coastal protection	Annual capital costs(m\$ per year)	133	176	24	514	493	1007
Dryland loss	Area lost (1000 sq km)	1.6	10.7	0	99.5	40.4	139.9
Wetland loss	Area lost (1000 sq km)	9.9	11.1	11.9	291.1	33.9	253
Ecosystem loss	Number of protected habitat lost	16	8	4	53	53	106
Health/ mortality	Number of deaths (1000)	8.8	6.6	29.4	114.8	22.9	137.7
Hurricanes	Number of deaths(1995)	0	72	779	7687	313	8000
Damage	M\$ annual	0	115	13	124	506	630

Table NO 1.2

Source: Pearce et al(1996).-contribution of the working group III to the second assessment report of the IPCC., after Fankhauser(1995).

Shock. The productivity of the north Atlantic and south Pacific-fishing grounds would decrease due to the rise in sea surface temperature. Countries like Chile, Peru, Norway, Japan, China are likely to experience reduced catch. Both dry land and wet land loss in terms of area would be highest for tropical countries due to sea level rise and related submergence. The coastal areas of Middle east and south East Asian countries including many islands of this region are at the verge of annihilation. Therefore these countries have to bear high cost of coastal land protection. With lower level of development, maintaining health standard and food security would become a serious challenge for the non OECD countries specially the developing countries of Asia and sub Saharan Africa. The region lying between 20-40°N, surrounding the Atlantic and pacific coast has been predicted to be the worst sufferer of hurricane damage and casualties than any time in history.

The UN Intergovernmental Panel on Climate Change (IPCC) believed that the poorest and least adaptable parts of the world would suffer the most from climate change over the next 100 years. It will bring perceivable changes in the weather patterns, water resources, seasonal rhythm, and in ecosystems productivity. The review report of IPCC accepted by more than 160 delegates from different nations who met from February 13 to 16, 2001 to consider the new information on how global warming could impact civilization and the natural environment. The full report, which runs some 1,000 pages, represents nearly three years of work by 426 authors from around the world. The report went through extensive review by several governments and experts. Klaus Toepfer, the executive director of

United Nations Environment Programme (UNEP), emphasized that Governments should consider these new conditions into their long term investment and planning decisions. The report by Working Group I of the IPCC has also confirmed the increasingly strong evidence for humanity's influence on the global climate.

End Note

- I. For comprehensive details about climate change impacts see R.T Watson, M.C. Zinyovera and R.H. Moss's 'Climate Change 1995: Impacts, adaptation and mitigation of climate change' (ed), CUP, 1996.
- II. Sensitive to climate change refers to the degree to which a system responds to the change. While vulnerability to climate change refers to the extent to which it may damage a system. Vulnerability depends on a system's sensitivity and adaptability to change.

Chapter III

**GLOBAL WARMING AND THE PROBABLE
CONFIGURATION OF THE COMING CENTURY'S
POLITICO GEOGRAPHICAL SPACE**

The Thermodynamics of a Divided World

Global Warming is relatively new to the Pantheon of geo-political issues. Nations are still confused about how ecology and climate relates to the issues of trade, security, economic development or other matters of state. Some of the countries, mostly the developed nations of the 'north' are of the view that if the predicted warming could be induced it would probably provide net benefits to mankind. On the other hand Most of the tropical countries are in the fear of the widespread risk of the warming and politicians are responding to it. The past was never the same, not that of the present for the northern developed nations to that of the developing countries of Asia, Africa and Latin-America. It was the western industrial Nations who have degraded the environment beyond the level of replenishment and are largely responsible for causing global Warming. Yet when it comes to the time of compensation the Third World nations being abide by the geo-political pressure, have to pay for it for the sake of the Global community. The World is now experiencing a new geo-political impetus arising out of the issues of environmental politics. In recent times the issue of global warming seems to be most potential in shaping the future of geopolitical studies.

It is also argued that the activists are misusing science in demanding draconian restrictions to avert global warming. In fact, there is no consensus among the scientists that uncontrolled, human-induced warming threatens the planet or the kinds of measures being discussed in Bonn would avert such a disaster. The climate has long been a favorite of apocalyptic. Two decades ago there were fears of a

new ice age. Many publications in *National Geographic* and *Time*²¹ reported shorter growing seasons, summer frosts, and advancing glaciers and found that the atmosphere has been growing gradually cooler for the past three decades in the higher latitudes. There were also books, including *"The Weather Conspiracy: The Coming of the New Ice Age and Ice: The Ultimate Human Catastrophe"* and so on. The latter, written by Fred Hoyle and published in 1981, proclaimed: "It is 12,500 years since the last ice age ended, which means the next one is long overdue. When the ice comes, most of Northern America, Britain, and Northern Europe will disappear under the glaciers."

Many prominent scholars of the developed nations tends to argue that the global warming proponents are accepting a good financial income from the global warming scare and have become global warming propagandists to promote their interests. These include some researchers who obtain research grants and some environmental organizations that need donations. They are making a living by promoting fear of man-made global warming. Therefore, the global warming propaganda has induced a conspiracy that has created the fear of imagined risk in the public's perception. The origins of the scare are political and have resulted in political policies that now threaten serious economic damage for the entire world. On the other hand, global warming proponents call for reduced Carbon Dioxide emissions and this equates to a call for cuts in the use of energy. They encourage the use of renewable energy²² sources to replace fossil fuels. The critiques have labeled this call as 'a call for a return to pre-

²¹ Thompson Dick: 'Melt Away Future' ,*Time*, November 1997. pp 38-45

²² Renewable energy comes from an apparently inexhaustible sources and can be renewed if the rate of consumption is less than the rate of regeneration.

industrial society'. The industrial revolution occurred when fossil fuels replaced biomass and wind-power. It is physically impossible for wind and solar energies to supply the energy needs of the developed world. Therefore it was quite expected that the response of the developed nations would not be smoother when it harms their interests.

The hypothesis of man-made global warming existed since the 1880s. At that time it was an obscure scientific hypothesis that burning fossil fuels would increase Carbon Dioxide in the air to enhance the greenhouse effect and thus cause global warming. Before the 1980s this hypothesis was usually regarded as a curiosity because the nineteenth century calculations indicated that mean global temperature should have risen more than 1°C by 1940. Then, in 1979, Mrs Margaret Thatcher²³ became the Prime Minister of the UK, and she elevated the hypothesis to the status of a major international policy issue. Many of the experts and politicians of the United States of America put the following allegations against United Kingdom.

Allegations against United Kingdom by a section of the political thinkers of the United States

Firstly, There is a famous story of how Mrs.Thacher gained prominence in the world affair . It is said that Mrs Margaret Thatcher desired to be taken seriously by political leaders of other major countries. This desire seemed difficult to achieve because her only

²³ In 1979, Mrs Margaret Thatcher became the Prime Minister of the UK. She gave her political party (the Conservative Party) victory in three General Elections, resided over the UK's conduct of the Falklands War, replaced much of the UK's Welfare State with monetarist economics, and privatized most of the UK's nationalized industries.

experience in government had been as Education Secretary in the Heath administration that collapsed in 1974. Sir Crispin Tickell,²⁴ UK Ambassador to the UN, suggested a solution to the problem. He pointed out that almost all-international statesmen are scientifically illiterate, so a scientifically literate politician could win any summit debate on a matter, which seemed to depend on scientific understandings (Mrs.Thatcher had a B.Sc. degree in chemistry). It was thought that if a 'scientific' issue were to gain international significance, the UK's Prime Minister could play a prominent role, and this could provide credibility for her views on other world affairs. He suggested that Mrs.Thatcher should campaign about global warming at each summit meeting. Mrs.Thatcher rapidly gained the desired international respect and the UK became the prime promoter of the global warming issue.

Secondly, the USA is the world's most powerful economy and is the most intensive energy user. If all countries adopted 'carbon taxes', or other universal proportionate reductions in industrial activity, each non-US industrialized country would gain economic benefit over the United States. So, many politicians from many countries joined with Mrs.Thatcher in expressing concern at global warming and a political bandwagon began to roll.

Thirdly, following the General Election of 1979, most of the incoming Cabinet had been members of the government which lost office in 1974. They blamed the National Union of Mineworkers for

²⁴ see Crispin Tickell's (1986) '*Climate change and world affair*', Harvard University Press. Second ed.

their 1974 defeat. They, therefore, desired an excuse for reducing the UK coal industry. Coal-fired power stations emit Carbon Dioxide but nuclear power stations don't. Global warming provided an excuse for reducing the UK's dependence on coal by replacing it with nuclear power. Besides the Conservative Party wanted a large UK nuclear power industry for another reason. That industry's large nuclear processing facilities were required for the UK's nuclear weapons programme and the opposition Labour Party was then opposing the Conservative Party's plans to upgrade the UK's nuclear deterrent with Trident missiles and submarines. Unfortunately, the Three Mile Island and Chernobyl accidents had damaged public confidence in nuclear technology. Then, privatization of the UK's electricity supply industry exposed the secret that UK nuclear electricity cost four times more than UK coal-fired electricity. Global warming became the only remaining excuse for the unpopular nuclear power facilities needed for nuclear weapons.

Fourthly, early in the global warming campaign - the UK's Hadley Center for Climate Prediction and Research was established, and the science and engineering research councils were encouraged to place priority in funding climate-related research. The Hadley Centre sustained its importance and is now the operating agency for the IPCC's scientific working group. In 1992 - at the height of the global warming scare - Greenpeace International (an NGO) conducted a survey of the world's 400 leading climatologists. Greenpeace had hoped to publicize the results of that survey in the run-up to the Rio summit, but when they completed the survey, they gave very little publicity to its results. In response to the survey, only 15

climatologists were willing to say that they believed in global warming, although all climatologists rely on it for their employment.

Fifthly, the press is interested in selling papers and the TV companies want to gain viewers. Threat of worldwide disaster makes a good story, and the statements and actions of politicians together with great increase in scientific publications gave global warming an apparent authority. The media began to proclaim the worst imagined horrors. For example, massive floods were predicted due to melting of polar ice. and one UK TV programme went so far as to assert that the polar bears would die out because their habitat would melt. Public rely on the media to provide them with their information, so they came to believe the global warming scare because they were only given one side of the story. Politicians respond to public concern, so the politician's actions began to gain popular support.

Sixthly, the UK Government lost interest in global warming when John Major replaced Mrs. Thatcher as Prime Minister. The flow of Government money began to stop for conduct of global warming research. UK scientists then began to speak out in denial of the global warming hypothesis. It seemed that the issue was dying a natural death. Then the 'coal crisis' arose in October 1992 when the public protested at the scale of pit closures. This gave the UK Government a new need to find an excuse for its policy of closing coalmines. Global warming fitted this need and so the Government committed £16,000,000 to an advertising campaign which scaremongers about global warming, and re-established the funding priorities for climate research. Later, at the start of May 1997, the Conservative Party lost

office to the Labour Party and Tony Blair became UK Prime Minister. The UK had initiated the global warming issue and a change of UK policy may have had a significant effect on the widespread imagined risk, but by then the global warming issue had become important in its own right. Many countries had a stated global warming policy, 122 of them had signed a declaration of intent to reduce Carbon Dioxide emissions at the Rio Summit, and the Kyoto Summit was scheduled. The UK was one of the very few countries that had reduced its Carbon Dioxide emissions since the Rio Summit because the UK had replaced coal-fired generating capacity by gas-fired generating capacity. This provided the UK with a position of authority in international affair to strict action to cut Carbon Dioxide emission.

There should be no controls without genuine consensus. The basic theory is that pollutant and the greenhouse gases-- are accumulating in the atmosphere, holding in the heat, and causing the world's temperature to rise. It remains just a theory for many years. Unfortunately, the debate has become highly political. Past polls have found that most climatologists do not believe human-induced warming has occurred. Disputes begin over data collection and temperature trends. The best evidence suggests far less warming so far this century than predicted by the models. Moreover, 90 percent of the warming occurred before 1940, when emissions of supposed greenhouse gases began to climb dramatically. In fact, John Shanahan a research scholar of the Alexis de Tocqueville Institute points out that the satellite data and balloon measurements over the last 18 years show a very slight cooling. Like this there is dozens of studies that

suggest good reasons to avoid burdensome treaty commitments. Since the United States is already one of the globe's most efficient energy consumers, massive emission cut would mean fewer jobs, less production, and a lower standard of living. A Heritage Foundation study estimates the cost of proposed controls from 2001 - 2020 to be \$3.3 trillion. Therefore, it obviously matters whether environmental activists are choosing scientific platform and honesty when making their claims. This requires facts, not rhetoric.

Who will suffer?

Man-made global warming has become a major international political issue. Many of the proposed government policies seek to inhibit Carbon dioxide emissions. The Rio Summit in 1992 proposed actions to constrain the emissions and the Kyoto Summit in December 1997 has been intended to establish binding agreements that will commit the nation states to the constraints. The Kyoto Protocol, which was negotiated in 1997, laid down a target of a five percent reduction in GHG (green house gases) by 38 developed countries by the year 2010. More than 80 countries have signed Kyoto pact. Though it is widely argued that the effects of the constraints would probably cause real and severe economic damage. All industrial and economic growth requires an abundance of available energy supply. Anything that inhibits energy supplies reduces economic activity. At Kyoto, governments have been pressured to reduce carbon dioxide emissions to far below their 1990 levels. This requires cutting fuel supplies and, therefore, economic activity. The effects would be a drastic increases in energy

costs. The US Department of Energy (DoE) estimated that the US domestic energy prices would increase between 80 - 90% and in response to this the coal price would hike to the US consumers by 300%, if US sign the Kyoto pact. Also, the DoE study determines that the Energy intensive industries would be forced to move from the US to places where the emission constraints did not exist or were not enforced. The DoE study goes further by saying that its findings are not specific to the US but apply to every industrialized country. The US DoE study is supported by a similar study commissioned by the German government. That determined the cost to Germany for fulfilling the Berlin Mandate²⁵ would be about US\$500 billion and the loss of 250,000 jobs.

The economy of every country is affected by the performance of the world economy. The economic disruption in the developed world would harm economic activity everywhere. The largest affects would be in the developed countries because their economies are largest. But the world's poorest peoples (people who are near to starvation) would suffer the worst effects. A rational assessment of appropriate policies would include cost/benefit analysis. All the proposed responses to the risk of man-made global warming would increase starvation and poverty. One of the recent studies of the International Institute of Applied System Analysis (IIASA) in Laxenburg, Austria have shown that global warming and increased

²⁵ In April 1995, in the Conference of the Parties Involved in UNFCCC (United Nation Frame work convention of climate change) issued the Berlin Mandate at the conclusion of their first meeting. In the mandate, many industrial countries agreed to negotiate binding commitments to reduce their emissions of green house gases by the year 2000.

Carbon dioxide level will increase global food production in the next 70 years. At the same time it may lead to drying up of food crops in some of the world poorest countries situated near the equator. This would threaten food security in many poor countries. An Indian scholar of IIASA, Dr. Mahendra Shah (Climate Conference in Amsterdam, 2000) in his paper '*Challenges of a changing earth*' came out with more or less the same findings. According to his article published in the journal '*Nature*', Brazil, India, Indonesia and many sub-Saharan countries would be the worst sufferers of global warming while Russia, China, Canada, Argentina and northern states of US will gain overall. Temperate areas will not only get hotter but also wetter allowing agriculture to spread further north. Equatorial zones will get hotter, making current crops harder to grow, inhibiting economic development throughout the entire world.

On face value global warming is an environmental issue. Many environmentalists joined the bandwagon to draw international attentions. In its intrinsic value the global warming issue is political. In practice, politicians are accepting the predictions of climate-models and are responding to it. However both the aspects of the global warming began to feed on each other. It induced the 'Earth Summit' that was attended by many of the Heads of States in Rio de Janeiro during June 1992 and is the reason for the Kyoto Summit in Japan in December 1997. Different nations have variety of motives for interest in global warming. Each government has its own special interests but, in all cases, the motives in wider sense are related to economic policies. The USA fears loss of economic power to other

nations while universal adoption of 'carbon taxes'²⁶, or other universal proportionate reductions in industrial activity, would provide relative benefit to the other nations. However, if a few nations adopt the changes they would increase their manufacturing, transportation and energy costs and thus lose economic competitiveness. Developing nations cannot afford technological and economic advances that would benefit them and also reduce increased carbon dioxide emissions as they develop. These nations are looking for gifted technology transfers and economic aid from developed countries. The issue of global warming has become a stimulus for the emergence of a divided politico-geographical space on the earth.

Years of consecutive climate related disaster have brought wide spread misery and huge economic loss in different parts of the world. Scientists are yet to be concluded that whether this is just a sheer coincidence or fallout of the global climate changes. A large section of the world scientific community has reached consensus that climate change is human induced, caused by emission of greenhouse gases that prevent heat from dissipating into space. The most obvious manifestation of climate change is the rising of the average worldwide temperature or global warming. Several studies indicate that tropical countries are particularly vulnerable to climate change and are likely to suffer damage to agriculture, food and water security human health and coastal areas. On the basis of the *World Bank classification of world economies*²⁷, most of these tropical countries

²⁶ refer UNCTAD/RDP/DPP/1 (1992) report on 'Combating Global Warming: *Study on a global system of tradeable carbon emission entitlements*', United Nations, New York.

²⁷ see appendix for World Bank classification of economies by region and income, 2001

are either LIC (low-income countries) or LMC (lower-middle income countries) and are largely dependent on natural resources. Thus any adverse impact on these natural resources will have repercussion on the nation's economy and will widen the gap between rich and poor. A general analysis of the cost -benefit aspect of the different nations is attempted in this paper. The variables considered for this purpose is as follows-

Demographic Indicators

- Density of population (people per sq.km)
- Urban population (as %of the total)

Socio-Economic Indicators

Gross National Income (on the basis of PPP in billion US\$)

- Human Development index (HDI rank)

Environmental Indicators

- Carbon dioxide emission
 - - Share of world total
 - - Per capita metric tons
- Ratification/acceptance/signature of Kyoto Protocol

Data source : World development Report 2001(World Bank), Human development Report 2001(UNDP)

All these data have been collected for some selected countries of different regions. Macro scale regions have been delineated into the following on the basis of the World Bank classification of world economies 2001.

- East Asia and Pacific
- Europe and Central Asia
- Latin America and the Caribbean
- Middle East and North Africa
- South Asia
- Sub-Saharan Africa
- High Income OECD
- Other High Income Countries

Countries from each region have been selected after taking account of the following aspects.

- Size of population
- To cover all economy type
- Country of regional importance (subjective)

Based on World Bank classification the economies of the world have been classified into the following income groups-

- Low Income (LIC) \$755 or less

Region	Economy type	HDI Rank 2001	Gross National Income (PPP)-per capita \$2000
East Asia and Pacific			
China	LMC	87	3940
Fiji	LMC	67	4500
Indonesia	LIC	102	2840
Korea.Rep.	UMC	27	17340
Malaysia	UMC	56	8360
Myanmar	LIC	118	NA
Papua New Guinea	LMC	122	2280*
Philippines	LMC	70	4200
Thailand	LMC	66	6330
Vietnam	LIC	101	2030
Europe and central Asia			
Armenia	LIC	72	2570
Azerbaijan	LIC	79	2760
Bulgaria	LMC	57	5530
Hungary	UMC	26	12060
Kazakhstan	LMC	75	5490
Latvia	LMC	50	6960
Moldova	LIC	98	2240
Poland	UMC	38	9030
Romania	LMC	58	6380
Russian Federation	LMC	55	8030
Turkey	UMC	82	7030
Uzbekistan	LIC	99	2380
Latin America and the Caribbean			
Argentina	UMC	94	12090
Bolivia	LMC	104	2380
Brazil	UMC	69	7320
Chile	UMC	39	9110
Colombia	LMC	62	5890
Costa Rica	UMC	41	8250
Dominica.Rep.	UMC	86	5720
Ecuador	LMC	84	2920
Guatemala	LMC	108	3770
Haiti	LIC	134	1500*
Jamaica	LMC	78	3500
Mexico	UMC	51	8810
panama	UMC	52	5700*
Peru	LMC	73	4720
Trinidad , Tobago	UMC	49	8340
Uruguay	UMC	37	8880
Venezuela	UMC	61	5750

Region	Economy type	HDI Rank 2001	Gross National Income (PPP)-per capita \$2000
Middle East and North Africa			
Bahrain	UMC	40	12130
Egypt	LMC	105	3690
Iran Islamic.Rep	LMC	90	5900
Jordon	LMC	88	4040
Lebanon	UMC	65	4530
Libya	UMC	59	NA
Oman	UMC	71	NA
Saudi Arabia	UMC	68	11050
Yeman(Rep)	LIC	133	780
South Asia			
Bangladesh	LIC	132	1650
India	LIC	115	2390
Nepal	LIC	129	1360
Pakistan	LIC	127	1960
Sri Lanka	LMC	81	3470
Sub Saharan Africa			
Angola	LIC	146	1230*
Botswana	UMC	114	7190
Burundi	LIC	160	580*
Cameroon	LIC	125	1570
Cingo.Dem.Rep	LIC	126	682
Ethiopia	LIC	158	660
Gabon	UMC	109	5430
Ghana	LIC	120	1940*
Kenya	LIC	123	1010
Madagascar	LIC	135	830
Mauritius	UMC	63	9940
Mozambique	LIC	157	820*
Nigeria	LIC	136	790
Rwanda	LIC	152	930
Senegal	LIC	145	1480
Sierra Leone	LIC	162	460
South Africa	UMC	94	9180*
Tanzania	LIC	140	530
Uganda	LIC	141	1230*
Zambia	LIC	143	750*
Zimbabwe	LIC	117	2590

Region	Economy type	HDI Rank 2001	Gross National Income (PPP)-per capita \$2000
High Income OECD			
Australia		2	25370
Belgium		5	27500
Canada		3	27330
Denmark		15	27120
France		13	24470
Germany		17	25010
Ireland		18	25470
Italy		20	23270
Japan		9	26460
Netherland		8	26170
Newzealand		19	18780
Norway		1	29760
Spain		21	19180
Sweden		4	23770
Switzerland		11	30350
United Kingdom		14	23550
United States		6	34260
Other high income Countries			
Bahamas		42	16490
Brunei		32	25320
Isreal		22	19320
Kuwait		43	NA
Qater		48	NA
Singapore		26	24970
Solvenia		29	17390
UAE		45	19430

Region	Density of people (persq.km,2000)	Urban population	Electricity consumption per capita(kilowatt-hours)1998
East Asia and Pacific			
China	135	31.6	746
Fiji	44	48.6	NA
Indonesia	116	39.8	320
Korea.Rep.	479	81.1	4497
Malaysia	71	56.7	2554
Mayanmar	69	27.3	64
Papua New Guinea	11	17.1	NA
Philippines	253	57.7	451
Thailand	119	21.2	1345
Vietnam	241	19.7	232
Europe and central Asia			
Armenia	136	69.7	930
Azerbaijan	93	56.9	1584
Bulgaria	74	69.3	3166
Hungary	109	63.8	2888
Kazakhstan	6	56.4	2399
Latvia	39	69	1879
Moldova	129	46.2	689
Poland	127	65.2	2458
Romania	97	55.9	1626
Russian Federation	9	77.3	3937
Turkey	85	74.1	1353
Uzbekistan	60	32.7	1618
Latin America and the Caribbean			
Argentina	14	89.6	1891
Bolivia	8	61.9	409
Brazil	20	80.7	1793
Chile	20	85.4	2082
Colombia	41	73.5	866
Costa Rica	71	47.6	1480
Dominica	177	64.4	627
Ecuador	46	64.3	625
Guatemala	105	39.4	322
Haiti	289	35.1	33
Jamaica	242	55.6	2252
Mexico	51	74.2	1513
panama	38	56	1211
Peru	20	72.4	642
Trinidad , Tobago	254	73.6	3478
Uruguay	19	91	1788
Venezuala	27	86.6	2566

Region	Density of people (persq.km,2000)	Urban population	Electricity consumption per capita(kilowatt-hours)1998
Middle East and North Africa			
Bahrain	1000	91.8	7645
Egypt	64	45	861
Iran Islamic.Rep	39	61.1	1343
Jordon	55	73.6	1205
Lebanon	423	89.3	1820
Libya	3	87.2	3677
Oman	11	82.2	2828
Saudi Arabia	10	85.1	4692
Yeman(Rep)	33	24.5	96
South Asia			
Bangladesh	997	23.9	81
India	342	28.1	384
Nepal	167	11.6	47
Pakistan	179	36.5	337
Sri Lanka	300	23.3	244
Sub Saharan Africa			
Angola	10	33.5	60
Botswana	3	49.7	NA
Burundi	265	8.7	NA
Cameroon	32	48	185
Congo.Dem.Rep	23	61.7	83
Ethiopia	64	17.2	22
Gabon	5	80.3	749
Ghana	84	37.9	289
Kenya	53	32.1	129
Madagascar	27	29	NA
Mauritius	584	41.1	NA
Mozambique	22	38.9	54
Nigeria	139	43.1	85
Rwanda	345	6.1	NA
senegal	49	46.7	111
Sierra Leone	70	35.9	NA
South Africa	35	50.1	3832
Tanzania	38	31.6	54
Uganda	111	13.8	NA
Zambia	14	39.5	539
Zimbabwe	31	34.6	896

Region	Density of people (persq.km,2000)	Urban population	Electricity consumption per capita(kilowatt-hours)1998
High Income OECD			
Australia	2	84.7	8717
Belgium	312	97.3	7249
Canada	3	77	15071
Denmark	126	85.3	6033
France	107	75.4	6287
Germany	235	87.3	5681
Ireland	55	58.8	4760
Italy	196	66.9	4431
Japan	337	78.6	7322
Netherland	469	89.3	5908
Newzealand	14	85.7	8215
Norway	15	75.1	24607
Spain	79	77.4	4195
Sweden	22	83.3	13955
Switzerland	182	67.7	6981
United Kingdom	247	89.4	5327
United States	31	77	11832
Other high income Countries			
Bahamas	30	87.9	NA
Brunei	62	71.7	7676
Isreal	302	91.1	5475
Kuwait	111	97.4	13800
Qater	53	92.3	13912
Singapore	6587	100	6771
Solvenia	99	50.3	5096
UAE	35	85.5	9892

DATA Region	<u>Co2 emission (metric tons ,1997)</u>		status in Kyoto protocol (in 2001)
	share of world total in %	per capita metric tons	
East Asia and Pacific			
China	13.9	2.7	o
Fiji	n	1	@
Indonesia	1	1.2	o
Korea.Rep.	1.8	9.4	o
Malaysia	0.5	6.2	o
Mayanmar	n	0.2	
Papua New Guinea	n	0.5	o
Philippines	0.3	1	o
Thailand	0.9	3.5	o
Vietnam	0.2	0.6	o
Europe and central Asia			
Armenia	n	0.8	
Azerbaijan	0.1	4.2	@
Bulgaria	0.2	5.9	@
Hungary	0.2	5.7	
Kazakhstan	0.5	7.5	o
Latvia	n	3.3	o
Moldova	n	2.4	@
Poland	1.4	9	o
Romania	0.4	4.8	@
Russian Federation	5.9	9.7	o
Turkey	0.8	3.1	
Uzbekistan	0.4	4.4	@
Latin America and the Caribbean			
Argentina	0.5	3.9	o
Bolivia	n	1.4	@
Brazil	1.2	1.8	o
Chile	0.2	4	o
Colombia	0.3	1.7	@
Costa Rica	n	1.3	o
Dominica.Rep.	0.1	1.6	
Ecuador	0.1	1.7	@
Guatemala	n	1.7	@
Haiti	n	0.2	
Jamaica	n	4.3	@
Mexico	1.5	3.9	@
panama	n	2.8	@
Peru	0.1	7.7	o
Trinidad , Tobago	0.1	17.2	@
Uruguay	n	1.6	@
Venezuela	0.8	8.2	

Region	Co2 emission (metric tons ,1997)		status in Kyoto protocol (in 2001)
	share of world total in %	per capita metric tons	
Middle East and North Africa			
Bahrain	0.1	25.5	
Egypt	0.5	1.7	0
Iran Islamic.Rep	1.2	4.5	
Jordon	0.1	2.3	
Lebanon	0.1	5	
Libya	0.2	8	
Oman	0.1	7.7	
Saudi Arabia	n	n	
Yeman(Rep)	0.1	1	
South Asia			
Bangladesh	0.1	0.2	
India	4.2	1.1	
Nepal	n	0.1	
Pakistan	0.4	0.7	
Sri Lanka	n	0.4	
Sub Saharan Africa			
Angola	n	0.4	
Botswana	n	2.2	
Burundi	n	n	
Cameroon	n	0.2	
Cingo.Dem.Rep	n	n	
Ethiopia	n	n	
Gabon	n	2.9	
Ghana	n	0.2	
Kenya	n	0.2	
Madagascar	n	0.1	
Mauritius	n	1.5	
Mozambique	n	0.1	
Nigeria	0.3	0.8	
Rwanda	n	0.1	
Senegal	n	0.4	
Sierra Leone	n	0.1	
South Africa	1.3	8.2	
Tanzania	n	0.1	
Uganda	n	0.1	
Zambia	n	0.3	
Zimbabwe	0.1	1.6	

Region	Co2 emission (metric tons ,1997)		status in Kyoto protocol (In 2001)
	share of world total in %	per capita metric tons	
High Income OECD			
Australia	1.3	17.3	o
Belgium	0.4	10.2	o
Canada	2	16.2	o
Denmark	0.2	10.7	o
France	1.4	5.8	o
Germany	3.4	10.2	o
Ireland	0.2	10	o
Italy	1.7	7.1	o
Japan	4.8	9.2	o
Netherland	0.7	10.4	o
Newzealand	0.1	8.3	o
Norway	NA	NA	o
Spain	1	6.2	o
Sweden	0.2	5.4	o
Switzerland	0.2	5.6	o
United Kingdom	2.2	8.9	o
United States	22.6	20.1	
Other high income Countries			
Bahamas	n	6	@
Brunei	n	17.5	
Isreal	0.2	9.7	o
Kuwait	0.2	28.9	
Qater	0.2	66.7	
Singapore	0.3	23.4	
Solvenia	0.1	7.5	o
UAE	0.3	34.5	

<p>INDEX</p> <p>NA- data not available</p> <p>n- negligible</p> <p>*- the estimates is based on regression, extrapolated</p> <p>@- ratification, acceptance, approval</p> <p>o- signature</p>

source of data

Human Development Report 2001, UNDP, Oxford University press

World Development Report 2001, World Bank, Oxford University press

-Lower middle income (LMC)\$756-2995

-Upper middle Income (UMC)\$2996-9265 and

-High income\$9266 or more

The adaptability of a country in adverse situation depends largely on its socio-economic conditions. The poorer the country, the more vulnerable it is. Strong economy generates power and developed society seeks to materialize human freedom and together brings about well being. In this paper gross national income (in terms of PPP per capita in dollar) has been taken as the indicator of economic performances. While the HDI rank is largely a comprehensive indicator of human welfare measured in terms of three important parameters: (a) A long and healthy life, as measured by life expectancy at birth. (b) Knowledge, as measured by the adult literacy rate with 2/3 weight and the combined primary, secondary and tertiary gross enrolment ratio with 1/3 weight. and (c) a decent standard of living as measured by GDP per capita.

Two demographic indicators-density of population and percentage of urban population to total indicate (at least theoretically) the population pressure on resources and the standard of living respectively. However the base indicator for this paper are the rate of Carbon dioxide emission and country wise its percentage share of emission to the world total in per capita metric tons.

Most of the East Asia and Pacific countries except the Asian tigers and Japan fall into the lower middle and low income group categories with medium range of human development according to

HDI rank2001. In south Asia all most all of the countries fall into low income and low human development category, except Sri Lanka with significant difference than the rest. In case of the continent of Africa especially Sub-Saharan Africa the condition is even worst. With the exception of Gabon, Botswana, Mauritius and South-Africa nearly all the countries are in the lowest economic and human development. Sierra Leone, Burundi, Rwanda, Mozambique are at the lowest end of the economic and social development, marked by abject poverty, hunger, starvation and disease.

In the early 1990s the poorest 10 percent of the world had less than 1/20 of the income of the richest 10 percent. This high-income inequality places millions in extreme poverty and severely limits the effects of equally shared growth. South Asian countries show low Gini coefficient while countries of East Asia and Pacific exhibit no clear pattern. Arab states show more variation. Many countries in Sub-Saharan Africa have high level of income inequality. Among OECD countries there is also diversity in income inequality, from the low level in Austria and Denmark to the relatively high levels in the United states and united Kingdom. Still, in global terms income inequality among these countries is relatively low.

Africa's challenge is how to develop their nations first to meet the basic minimum needs of the millions of poor people. After years of subjugation these nations are trying their best to achieve some sort of relief when their counterpart in the west is living in an unthinkable (for them) luxury. Having a very lower standard of living these

countries hardly contribute to the global Carbon dioxide emission. Therefore in negotiating any international protocol like Kyoto they could hardly play an effective role. On the other hand many of the countries of East Asia-Pacific and Caribbean regions have just put a leap on the growth escalator. At this moment cut their head by imposing several expensive controls in the name of environment would be injudicious. It would mean like restraining millions of people from having food just served at the table in front of them. For them green technology may be a possible solution but not at the cost of their budding economy. Unfortunately, Asia's giant populations, China, India and Indonesia have not yet attained the level of affluence that could bring environmental enlightenment- what the Asian Development Bank calls 'the turning point'. Until, they are apparently content to let ecological destruction proceed at full scale. Besides many of the Asian and African leaders generally believe that west is pursuing environmental concerns only to stifle the economic aspiration of the poor. Many of them still have to confront the politics of mass poverty, are single minded in the pursuit of wealth. Which demonstrates that a lack of political will is not the main problem; will is often strong but propelled in a wrong direction. Asia's challenge is to give its people the sweet taste of economic success with out the toxic side effects of the western industrial model.

The developing countries are relatively small players on the energy scene. In 1970 they accounted for only 15% of global demand for commercial energy. However over the intervening twenty years upto 1990, their commercial energy consumption nearly doubled and now accounts for 26% of the global total. These statistics do not

include non-commercial sources of energy. However, per capita energy consumption will continue to be substantially higher in the developed countries. For example in 1998 per capita electricity consumption for US was 11832 kilowatt hours which is about 500 times higher than Ethiopia, marked by only 22 kilowatt hours per capita electricity consumption.

It is quite important to recognize that more energy is required to facilitate economic growth in the developing world. These countries must rely on the energy sources available to them, not necessarily the most sustainable energy systems. In some of the developing countries, the energy policy framework favors the extension of energy supply in comparison to demand-oriented measures and policies. The bottom line is: strategies to mitigate²⁸ GHG emissions are not simply a function of resource conditions and cost effectiveness but include broad political and socio-economic factors.

On the other hand, data shows that most of the OECD and other high-income group countries are the highest emitter of carbon-dioxide in the atmosphere with the United States having 22.6% share of the total emission of carbon-dioxide in the world in 1997. Compare to this most of the South- Southeast Asian and African countries except India, China, Korea, Japan and South Africa show negligible percentages (below 1). However in terms of per capita emission rate these countries stands far below the high income group nations. For example Australia, Belgium, Canada, Denmark, Germany, United

²⁸ see *Appendix V on the estimates of the cost of Carbon dioxide mitigation*

States show per capita emission ranging above 10 metric tons in 1997. While China and India though their share in Carbon-dioxide emission in the world is quite high, show the per capita emission rate far below the developed nations; ranging below 3 metric tons in 1997. This indicates the nature of western consumerism. More than half of the world population lives in the developing nations of Asia and Africa with very low standard of living. Most of the high-income group countries of the north possess high density of urban population but low average density of population as a whole. For example, in Australia the average density of population is 2 people per square kilometer with 84.7 percent of the population live in urban areas. While in Rwanda where average population density is 345 per square kilometer shows only 6 percent urbanization rate. This comparison represents extreme inequality. Data shows that the density of urban population and the per capita carbon-dioxide emission rate are positively correlated with the value of **0.544189**. This indicates that the more is the density of urban of urban population, the higher is the rate of per capita carbon-dioxide emission. Therefore the way of life style and the standard of living are directly related to the release of Carbon dioxide to the atmosphere. No doubt, the rate of urbanization is much higher in the developed nations.

Environment has its own cost. The developed nations thus should pay the cost of environmental degradation to which they are responsible. The developing nations in general have a concentration of population. Therefore in cumulative way they possess high share of Carbon dioxide emission in the world. It is not the hedonistic life

style but the technology and developmental lag which is responsible for their tragedy.

The Gross national income and the ranking in the Human development index are negatively correlated with the value of - **0.86432**. This means the higher is the country income the higher is the status of human development (as the less is the numerical rank in HDI, the higher is the country's progress). Therefore, national income and human development is strongly correlated. Most of the developing nations fall into the category of low-income group. They don't have the capital strength to develop their human resources. For them the primary concern is to satisfy the basis human demands for their people in their '*struggle for existence*'²⁹

A multitude of complex and interacting causes are responsible for the increase in carbon dioxide emissions in developing countries. Quite often national policies are understandably influenced more by developmental priorities and less so by environmental concerns. Economic growth, social development and poverty eradication are the first and overriding priorities in developing countries and are themselves essential to meeting national and global sustainability objectives. These coupled with the underlying institutional weaknesses in the existing framework have to some extent led to the deterioration of the environment. This will call for a decisive change in world political and economic trends. A cross-

²⁹ The phrase was used by HarbertSpencer to signify the struggle for surviving in the society. However the term was originally coined by Darwin in his *theory of the evolution of species*(1859). Herbert Spencer is thus called the founder of social Darwinism

section of the developing world including Africa, Asia and South America move to greater economic liberalization and free market structure in recent years. Yet, the impact of such a move is not felt due to the structural obstacles, which still persist. Against these harsh economic realities some questions still remain unanswered, such as, how should the transition take place; under what time frames; and who will pay, etc.

The issue of global warming is receiving increased attention in every section of the society, following record warmth in a number of regions of the globe. Studies have been published indicating that the effects of global warming are manifold, and are already beginning to show themselves. While much of what appears in the press is merely speculation, it is becoming increasingly obvious that something must be done to halt the flow of heat-trapping gases responsible for warming, most importantly Carbon dioxide. The environmental effects of global warming include increases in sea levels and precipitation; more severe weather patterns and greater prevalence of illnesses. Potentially more devastating would be the effects of climate change on agriculture, especially in developing nations, which lack the technology that would help developed nations adapt to climate shifts. The immediate consequences of global warming, like the consequences of other natural disasters, will fall most heavily upon the poor. The oil and coal industries are major economic forces, and thus the environmental issue of global warming takes on an economic and political character. In order to understand the current and possible measures to reduce global warming, it is necessary to understand how the political and economic factors interact.

The leading cause of human-produced carbon dioxide comes from the combustion of fossil fuels, especially oil and coal. At present, oil and coal are essential energy sources. Thus, it is not possible simply to limit the consumption of oil and coal, as was done with ozone-depleting chlorofluorocarbons (CFCs). Indeed, as various countries such as China and India continue the process of industrialization, and with the increase in human population, more energy is demanded and consumed. In order to curb the process of global warming there must be a change in the means of energy production on a world scale, a shift from oil and coal to more efficient sources such as solar power, tidal power, wind power and so on. Already the basic technology exists that would allow for such a change. In a *capitalist society*³⁰, however, the main stimulus for change is not concern for human or environmental welfare, but rather the continual drive for profit.

The conflicts over global warming policy are for the most part fueled by the contrary interests of different sections. Certain sections of the capitalist class, most notably insurance industries, stand to lose a lot of money if the environmental effects of global warming are not prevented. There also exists a prominent group of corporations calling themselves the International Climate Change Partnership (ICCP), who have invested a lot of money on research in alternative energy sources.

³⁰ This is a Marxist approach to modern society where the state seeks to rule in the long term political interest of capital (R. Miliband, *The state in Capitalist society*, 1969). This raises the question of how the putative interest of capital is translated into state action.

Opposed to these groups stand the enormous oil, gas, mining and automotive industries. These industries can strongly influence political decisions. During the period of 1995-96, oil and gas companies donated \$20.8 million to candidates for the United States Senate and Congress. During the same year, mining industries gave \$2.7 million, and auto industries \$3.8 million. All these sectors have a vested interest in seeing oil, coal and gas continue as the principal energy sources. Their enormous size and capital reserves put them in a position to spend large amounts of money to contribute to politicians, hire scientists, and inundate the public with media campaigns supporting their practices and interests. Oil and coal play a much larger role in the economy of nations than other commodities, and that the effect of these commodities on political processes extends far beyond the lobbying of interest groups. All countries must have a source of energy in order to survive. Moreover oil and coal—to a greater extent are localized commodities; they exist only in certain portions of the globe. Thus, the ability to access these areas is a major measure of world power. Those nations that control oil can assert themselves on a global scale. The United States has fought two wars in the past 10 years—in Iraq and in Yugoslavia—in which access to oil was a major factor. On the international scale, competition for market exists not only between individual corporations, but also between individual nations. Those nations who currently and potentially have control over oil and coal reserves have a vested interest in maintaining the energy status quo.

Given these facts it is not surprising that every attempt to institute carbon emission reduction measures has proved ineffective.

The Kyoto treaty signed in 1997 was full of loopholes such as "emissions trading," whereby the industrial nations can buy carbon dioxide credits from other nations whose emissions were below the level stipulated in the treaty. In addition, a viable means of enforcing such treaties does not. Nevertheless, the treaty failed ratification in the United States and has proved ineffective on an international level.

Political decisions are organically linked with business interests in a capitalist society. The collision between economic and political interests is not, however, secondary. The national governments are not autonomous, but function as the representatives of the "national" interests. The continuing struggle for world power among capitalist nations will have a profoundly disastrous effect on the environment. Within the capitalist system, there is hardly any possibility of dealing seriously with problems of the environment.

Increase efficiency of oil consumption and redistribution of wealth internationally is needed so that developing nations can acquire development stimuli without destroying their economies. This is prescribed as some of the major economic solutions to cope with the problem of global warming. More than simply ethical maturity, the solidarity of the international working class and true goodwill of the nations are required in the struggle for an internationally planned economy to address the crisis of global warming and other environmental problems in a rational manner.

Inequality exists in its all forms between the developed nations of the north and the developing nations of the south. The gap is wide

and it is the duty of the developed nations to help in reducing the gap (if we agree to the concept that the polluter-pay approach). Other wise the gravitational pulls with in the nations will be disrupted and the world would be fragmented into the pieces of conflicting complexes. On this matrix the problem like global warming imposes a severe threat to the civilization as a whole. Thesis and antithesis on this aspect are actually the part of politically motivated responses. What we have failed to realize is that despite all the hue and cry, it provides a great opportunity before the human society. That is the scope of collective reconciliation of the past error. This will help to channelise the accumulated human energy into the right path that is for the development of mankind. This energy otherwise would be wasted in the form of various conflicts. The notion of the development of mankind should be placed before the concept of the development of nations. This is only possible by replacing the notion of the mindless pursuit of wealth by the culture of sustainability. Sustainability should also mean a transformation of our values to build a society that will stand the test of time.

End notes

- I. *Gross National Income (GNI)* refers to the total of net incomes earned by the working people in different sectors and commercial enterprises. Income of both categories of people paying taxes and not paying taxes are added. In a broader sense, in this method national income is obtained by adding receipts as total rent + total wages + total interest + total profit.
- II. *Purchasing power parity (PPP)* the national income and the gross national product per capita is usually calculated by converting it to US dollars using the exchange rates as conversion factors. These estimates however, do not reflect the purchasing power of the currencies appropriately due to the relative prices of goods and services from one country to another. The use of PPP corrects this gap, therefore, provide a better comparison of average income.
- III. *Polluter-pay principle* refers to the idea that polluting emissions should be taxed in order that those who create them bear the cost of their actions. The principle derives from Pigou in 1932. It is an approach, which allows pollution within certain limits.

Chapter IV

INTERNATIONAL EFFORT TO NEGOTIATE ON
THE ISSUES OF GLOBAL WARMING

Global warming has gained wide credence among mainstream scientists over the past decade. Many of them believe that human activities are primarily responsible for the rise in greenhouse gases that may be causing the atmosphere to warm. With the world pretty much agreed that something needs to be done about it, there have been a number of attempts to tackle the issue of climate change and global warming. In 1968 Swedish government raised different environmental issues in the forum of the United Nations Economic and Social Council. In June 1972 at Stockholm, UN organized a conference on the Human Environment. It was here for the first time that countries around the world addressed the issues related to environment. 113 representatives attended the conference and the general assembly adopted a resolution that led to the creation of United Nations Environment Programme (UNEP). The Stockholm Conference clarified the link between development and the environment and suggested an approach that would recognize the socio-economic factors behind many environmental problems and to cure the effects by treating the causes. Stockholm Conference produced an *action plan*³¹ on the Human Environment. The 109 recommendations in the plan fell into three groups concerned with environmental assessment, environmental management and supporting system. Over the years specific goals were set up to implement these recommendations. *These goals*³² were revised and refined with the evolution and improvement of scientific knowledge on different issues.

³¹ The action plan was endorsed in GA resolution 2994 (XXVII) of 15 December 1972.

³² GA resolution, UN, 42/18 'Environmental perspective to the year 2000 and beyond' , 11 December 1987.

By 1980, environmental law and environmentally sound development had risen among the priorities of many countries. Many industrialized countries of Europe had adopted legislation to protect the natural environment. In 1981 at Montevideo, Uruguay an ad hoc meeting of senior government officials was convened by UNEP to establish a framework program for the development and review of environmental law. The Montevideo program initiated the evolution of the methods of environmental impact assessment. In 1986 a report by 150 scientists from 11 countries warns that the increased release of carbon dioxide may have fundamental effects on the atmosphere and may cause temperatures to rise by intensifying the Earth's greenhouse effect. However, the first stumbling block agreement on a framework has been hard. Planning for the Earth Summit began at the 1987 that produced the report *"Our Common Future."*³³ Norway's Prime Minister Gro Harlem Bruntland, who was also the vice president of the International Socialist Party, chaired the meeting. Prime Minister Bruntland freely acknowledged that the Earth Summit's agenda was based upon the International Socialist Party's platform. It was mentioned that-

"This theme-that nature has been irreparably damaged by industrialization and that the only remedy is to reduce progress and economic growth in the industrialized world -was one of the two underlying principles that guided UNCED. It was repeated over and over. The United States was singled out as the main culprit.

³³ GA of UN resolution 42/187, adopted the report of the World Commission on Environment and Development (WECD), also known as Bruntland Report. Refer Bruntland Report. World Commission on Environment and Development (1987), *Our Common Future*, New York: Oxford University Press.

Curiously, the other guiding principle for UNCED was the industrialized nations, accused of causing all the problems, must now pay for them by transferring large sums of money and technical know-how to the Third World." (WCED, 1987)

In 1988, James Hansen, an atmospheric scientist at the National Aeronautics and Space Administration's Goddard Institute of Space Studies, tells a Senate panel that the "evidence is strong" that man-made pollutants are causing the Earth to warm. Hansen is one of the first mainstream scientists to bring the issue of global warming to national attention. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to assess the scientific knowledge on global warming and concluded in 1990 that there was broad international consensus that climate change was human-induced. That report led way to an international convention for climate change, the United Nations Framework Convention on Climate Change (UNFCCC)³⁴, signed by over 150 countries at the Rio Earth Summit in June 1992. Delegates from 178 countries convene in Rio de Janeiro, Brazil for the United Nations Conference on Environment and Development, more commonly known as the Earth Summit. Delegates agree to set voluntary targets to stabilize the emission of greenhouse gases that are believed to contribute to global warming. The UNFCCC split the world into two halves: Developed countries, including the former Soviet Union, the countries of eastern Europe, and those belonging to

³⁴ see *appendix VI* for the summary of the conclusion of the IPCC working group I on science.

OECD including the United States were designated Annex-I parties. The remaining 129 developing countries, including China, Mexico, India, Brazil and South Korea were designated Non-Annex I parties. Delegates in Rio de Janeiro approved UNFCCC that called on countries to set voluntary targets to reduce carbon dioxide emissions over the next decade. Many environmentalists criticized the treaty for failing to set mandatory emission curbs, but countries such as the U.S. argued that the evidence of global warming was too inconclusive to merit any stronger commitments. To date, most countries are failing to meet the emission goals adopted at the conference, although a few countries, such as Denmark and Great Britain, may exceed planned emission curbs. United States as well as a few other countries, and many large corporations have been against this due to the fear of the threat to their economy and profits if they have to make substantial changes.

A mechanism suggested for tackling climate change and warming has been the idea of using "Carbon Sinks" to soak up carbon dioxide. To aid in this, reforestation and planting of new forests have been suggested. This is a popular strategy for the logging industry and nations with large interests in forests. While there may be some potential in this solution, it cannot be effective on its own. This is because it legitimizes continued destruction of old growth and pristine forests, which are rich ecosystem and have an established biodiversity base that naturally maintain the environment (at no cost). Creating new forest areas would require the creation of entire ecosystems. It is also criticized for being a quick fix that doesn't

tackle the root causes effectively and doesn't lead to, or promote actual emissions reduction.

A growing concern from developing countries and various NGOs is the public participation and the effect on populations and poor countries that these negotiations have, given that the effects of global warming affect poor people and poorer countries much more. In some cases, it already has affected some small island nations. Climate justice, equity, sustainable development, equal rights to the atmosphere for all human beings, equity within and between nations are all parts of this debate. This means for example, that reduction percentages and emissions allowances etc. should be based on a per capita basis; a view held by many developing countries and the European Union -- and a view that United States disagreed.

In April 1995, in the Conference of the Parties issued the Berlin Mandate at the conclusion of their first meeting. In the mandate, many industrial countries agreed to negotiate binding commitments to reduce their emissions of heat-trapping gases by the year 2000. Participants scheduled a series of negotiating sessions for the next two years so that they might reach an agreement by their third meeting in December 1997. The mandate also calls for the governments of industrial countries to analyze the economic and environmental effects of the policies and measures necessary to meet specific emissions-reduction objectives by 2005, 2010, and 2020. The Berlin meeting also saw the emergence of the Alliance of Small Island States as the moral conscience of the negotiations. Many of these countries, such as Jamaica, Trinidad and Tobago, and

Singapore, are only a few meters above sea level, and some are along well-defined tropical storm corridors. They worry that their very existence is threatened by possible increases in sea level and in the frequency of intense storms.

The US delegation acknowledged the need for a post-2000 aim for the global warming treaty, but was not prepared to commit to specifics. In addition, the United States called for expanding the effort to combat global warming to include unspecified actions by large developing countries that are industrializing rapidly, such as China and Indonesia. This raised fears among developing countries that the United States wanted to impose quantitative emissions commitments on them that would seriously impede their ability to industrialize. In the end, the Berlin conference addressed this issue by calling on developing countries to advance the implementation of their existing commitments under the treaty, but did not require binding emissions targets and timetables such as proposed for industrial countries.

In parallel, the United States and other industrial countries promoted the concept of joint implementation, which would allow industrial countries to meet part of their emissions-reduction commitments through public or private sector investments in developing countries. They argued that such investments are often more cost-effective than measures in the investing country itself. In an effort to build confidence in joint implementation, the Berlin conference established criteria for joint implementation projects to be initiated during a pilot phase, not to last beyond the year 2000. The emissions reductions from these projects cannot be credited against

existing commitments under the treaty. Post-2000 crediting rules will be the subject of intense negotiations. The IPCC released a second report on global warming. For the first time, the IPCC report concluded that global warming is already occurring and that the balance of evidence suggests that human activity is at least partly responsible. The report cited computer models of climate that predicted that average world temperatures would rise from between 1.8°F and 6°F if carbon dioxide concentrations doubled. Such concentrations were expected to be reached by the year 2100 if emission rates remained unchanged.

In July, 1996, at a U.N. meeting on climate change held in Geneva, Switzerland. The second Conference of the Parties, which met in Geneva moved the goal of a strong international global warming treaty. In the most important breakthrough since the Earth Summit, most of the world's environment and foreign ministers approved a strong ministerial declaration, signaling that there is now broad international support for legally binding targets to reduce emissions of heat-trapping gases. A major shift in the US negotiating position was key to galvanizing support among industrialized countries. With the United States agreeing to binding emissions-reductions targets and timetables, only Australia, New Zealand, the OPEC countries, and Russia dissented. The Geneva Declaration, as the document is known, advanced the treaty process beyond the 1995 Berlin Mandate in three important respects. First, it strongly endorses the conclusions of the Second Assessment Report of the Intergovernmental Panel on Climate Change. The report had been under concerted attack by fossil fuel industry lobbyists and OPEC

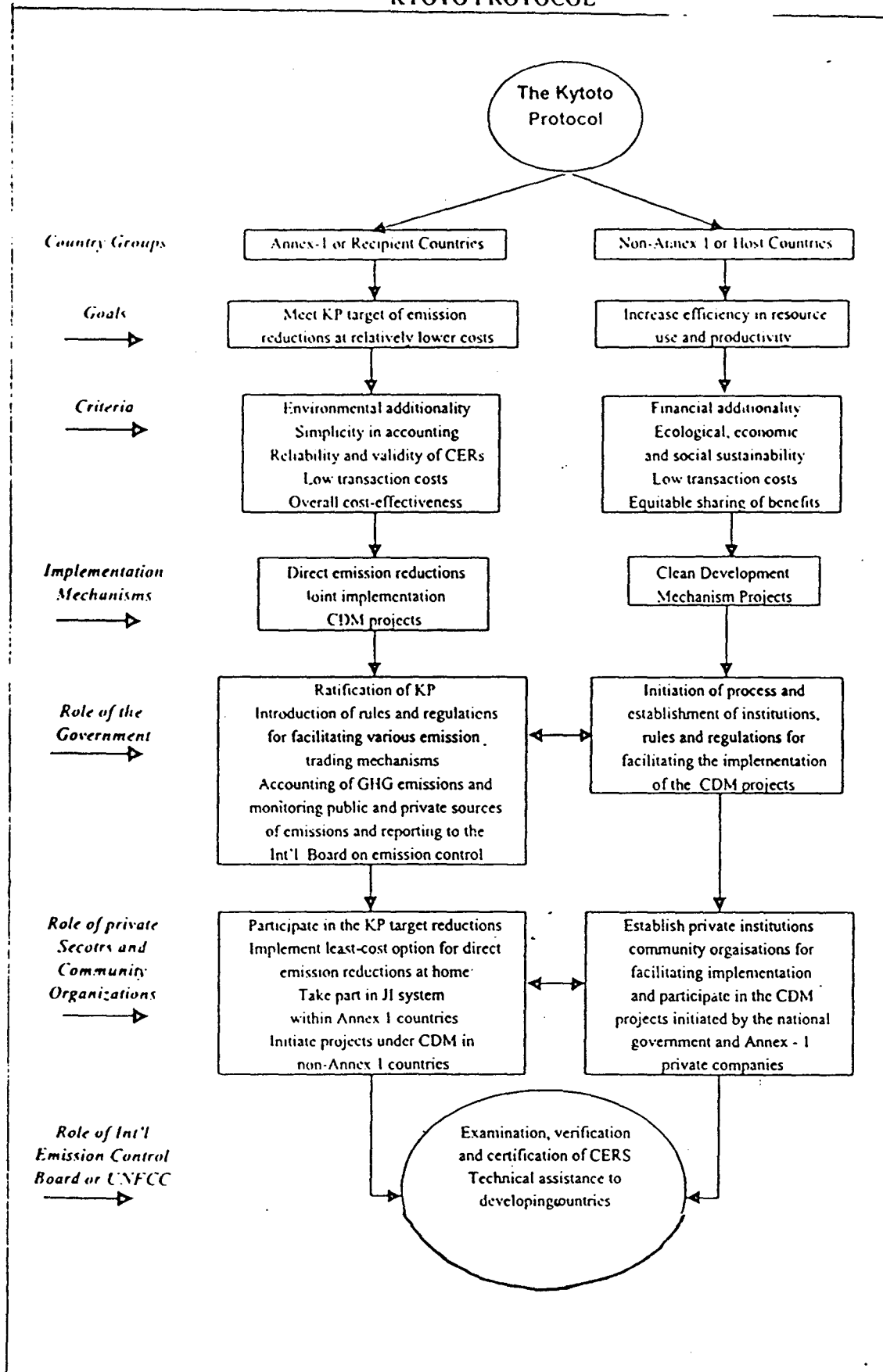
countries since it was released in late 1995. Second, the Geneva Declaration accepts the panel's assertion that the continued rise in atmospheric concentrations of heat-trapping gases "will lead to dangerous interference with the climate system." This is highly significant because the original treaty signed in Rio commits countries to the objective of avoiding adverse climate change. Third, the declaration calls on the negotiators to accelerate their work to complete a binding protocol, one that includes provisions for *legally binding* objectives and *significant reductions* -- that is, binding targets and timetables to reduce future greenhouse-gas emissions, to be signed at the third Conference of the Parties in Kyoto, Japan.

During the second Earth Summit, held in New York City in June 1997, the 15-nation European Union (EU) put forward an aggressive emissions proposal, signaling its willingness to take strong steps to prevent global warming. Business, political and social leaders in Western Europe have generally been more willing to agree to energy taxes and curbs on emissions to prevent global warming than their counterparts in the U.S. The EU proposal called for industrialized countries to reduce greenhouse emissions to 15% below 1990 levels by 2010. The Clinton administration rejected the plan, saying the emission targets were too aggressive and would blunt economic growth. In his own proposal, announced in October 1997, Clinton called for a more modest goal of capping emissions at 1990 levels by the year 2012. Despite key points of contention, negotiators approved a final accord in December 1997.

In July, 1997 the U.S Senate votes, 95-0, to pass a resolution stating that it would reject any international global warming treaty that does not require developing nations to cut greenhouse emissions if industrialized countries must abide by such reductions. Sens. Robert Byrd and Chuck Hagel, the co-sponsors of the resolution, argue that any treaty that does not involve developing nations would be ineffective.

In December 1997, at Kyoto, Japan, the Third Conference of Parties to the United Nations Framework Convention on Climate Change Conference (COP3), took place. Over 15,000 delegates from more than 150 nations attended Conference of Parties III (COP3) in Kyoto with an aim to approved the most sweeping and far-reaching global environmental treaty ever negotiated. Developed countries agreed to specific targets for cutting their emissions of greenhouse gases. A general framework was defined for this, which specifics to be detailed over the next few years. This became known as the *Kyoto Protocol*. The Kyoto Protocol marked the first international attempt to place legally binding limits not only on carbon dioxide but five other green house gases as well: methane, nitrous oxide, hydroflourocarbon, perflourocarbon, and sulfurhexafluoride. The protocol's specific goal is to reduce combined emissions among Annex I countries by approximately 5 percent from 1990 levels by a 2008-2012 time frame. Each Annex I country is assigned a specific emission reduction target. Under the adopted protocol, 38 industrialized nations were required to reduce their greenhouse emissions by 6% to 8% below their 1990 levels by 2010. The EU and Japan would be committed to reducing emissions by 8% and 6%,

RESPONSIBILITIES OF NATIONAL GOVERNMENT AND PRIVATE SECTOR UNDER THE KYOTO PROTOCOL



Source: Robert Mendelsohn and Dirgha Tiwari (2000) 'Two essays on climate change and agriculture: a developing country perspective' FAO/ ESDP

respectively. Under the Kyoto treaty, the U.S., the world's largest economy, was required to reduce its emissions of greenhouse gases to 7% below the total amount that it emitted in 1990. The accord in the U.S., has set off a firestorm of debate among environmentalists, business leaders and economists. In addition, many other nations that signed the treaty are unhappy with certain provisions. Many business leaders forecast economic doom if the U.S. ratifies the Kyoto treaty and enacts policies to curb greenhouse emissions. The treaty, they said, could mean higher energy prices, greater unemployment and social strife worldwide. It was also argued that the scientific evidence supporting the theory of global warming is still too weak and inconclusive to warrant sweeping policies. Environmentalists, meanwhile, predict environmental disaster if something is not done to limit emissions and avert global warming. Climatic changes could uproot many exotic ecosystems, cause widespread flooding in coastal areas and disrupt agricultural growing seasons, they claimed. It was argued that the evidences for global warming were strong and growing.

Much of the controversy focuses on three key questions. *Is global warming a real phenomenon? Which countries should be held primarily responsible for reducing greenhouse emissions? And what impact would the proposed reductions have on the economy?* Even the then U.S. President Bill Clinton, long a supporter of efforts to halt global warming, was later on influenced by the debate. He and many of his top advisers finally backed away from committing to highly aggressive plans to curb emissions. U.S proposed to just stabilize emissions and not cut them at all, while the European Union

called for a 15% cut. In the end, there was a trade off, and industrialized countries were committed to an overall reduction of emissions of greenhouse gases to 5.2% below 1990 levels for the period 2008 - 2012. As with the following COP meetings, there was enormous media propaganda by affected big businesses and by countries such as the U.S., who were openly hostile to the treaty. In fact one of the first things the American president George Bush did when he came to power was to oppose the Kyoto Protocol.

The Kyoto Protocol creates three innovative mechanisms designed to help the countries to reduce the costs of meeting their emission targets:

- joint implementation
- emissions trading
- the clean development mechanism

The Kyoto Protocol establishes a "Clean Development Mechanism" that will allow developing countries to voluntarily participate in projects that will reduce their greenhouse-gas emissions. The mechanism will foster two types of projects. The first, which is energy-related, is designed to transfer technology to developing countries so that they can achieve economic growth without the fossil-fuel dependency now typical of the industrialized countries. The technologies include energy-efficiency methods and equipment, and renewable energy technology, including wind and solar power. The second type of project will be forestry-related and will lead to forest restoration and preservation in developing countries. Properly

implemented, forestry projects have the potential to provide many co-benefits, such as conserving biodiversity and protecting watersheds and other ecosystems. The clean development mechanism aims to promote sustainable development in developing countries.

The Kyoto Protocol is just one step in the ongoing international effort to limit global warming. The developing countries have insisted that industrial countries make the first reductions, but most have agreed that all countries will ultimately need to accept emission limits in order to protect the planet from global warming. Flexibility mechanisms (fall into the following categories: Emissions Trading, Joint Implementation and Clean Development Mechanism) were defined in the Kyoto Protocol as different ways to achieve emissions reduction as part of the effort to address climate change issues. However, these have been highly controversial, as they were mainly included on strong US insistence and to keep the US in the treaty. One of the major areas of debate during the Kyoto talks was on the issue of deciding which countries ought to bear the greatest responsibility for reducing greenhouse gases. Developing countries maintain that the industrialized world is chiefly to blame for the build-up of carbon dioxide and therefore should be held responsible for emission cuts. They point out that cheap and abundant energy from fossil fuels is a primary reason why industrialized countries have become so rich. The industrialized world, thus has an obligation to use that wealth to pay to clean up the environmental problems that have resulted. At the same time, however, the effects of global warming will likely harm the developing world the most. Their economies are more heavily dependent on agriculture, which would

be severely impacted by climate shifts. In addition, global warming presents perhaps the greatest threat to small island nations, such as Malawi, and populous coastal nations such as Bangladesh. Since water expands as it is warmed, a global temperature increase could cause sea levels to rise. Millions of people could be displaced as low-lying areas are inundated. In an emotional appeal during the Kyoto conference, Kinza Clodumar³⁵, the president of Nauru, a small island nation in the Pacific Ocean, pleaded to take global warming seriously and to adopt aggressive emission targets. He said, -

"We submit respectfully that the willful destruction of entire countries and cultures, with foreknowledge, would represent an unspeakable crime against humanity," adding, "No nation has the right to place its own, misconstrued national interest before the physical and cultural survival of whole countries."

However, many U.S. critics of the treaty say that the accord will be ineffective unless the developing world also agrees to bind reductions in greenhouse gases.

"It is true that We; the industrialized world created the problem, but we can't solve it without cooperation from the developing countries," - says Jonathan Lash, president of the World Resources Institute. ('Nature' ,August 2000)

Lash and other observers note that developing nations will likely become the largest emitters of carbon dioxide within a few decades. Binding commitments from the developing nations such as India, China and Mexico, three most populous and fast-growing countries, are especially important since levels of greenhouse emissions from those countries are rising faster than levels in the

³⁵ Refer Najam. Adil ' Deal or no deal' Down to Earth, oct 2001, pp- 50-54

industrialized world. According to the estimates of the U.S Energy Department Carbon dioxide emissions from China, already the second-largest emitter of greenhouse gases, will surpass U.S. emissions within a few decades.

Famous U.S scholar Sen. Larry Craig³⁶ said that the Kyoto treaty is a failure because it is "*designed to give some nations a free ride, it is designed to raise energy prices in the U.S. and it is designed to perpetuate a new U.N. bureaucracy to manage global resource allocation.*"

Another area of contention is that many developing countries at the conference opposed a plan favored by the U.S. to allow trading in so-called emission permits. Under the plan, countries that lowered their emissions below the treaty's requirements would receive a permit, based on the amount of emissions reduction that the country achieved. Countries that do not meet their emission goals could then buy the permits, which they could use as credits to meet their own emission targets. The U.S. already uses a similar trading system domestically for controlling emissions of sulfur oxides, an air pollutant. Debate over permits nearly doomed the Kyoto talks. Developing countries argued that wealthy industrialized nations would exploit an emissions-trading scheme to shirk their obligations and buy their way out of the treaty. Others said that the scheme would be impossible to enforce worldwide. To break the deadlock that arose over the issue, Raul Estrada-Oyuela, the Argentinean delegate who chaired the Kyoto conference, persuaded countries to postpone

³⁶ refer C.W.Schmidt's ' Enough of hot air' , *Environmental health perspective*, V:108: 8 , August 2000 pp- A363-A365

discussion of permits until the conference's next meeting, to be held in November 1998 in Buenos Aires, Argentina.

November 2 - November 13, 1998 in Buenos Aires, Argentina the Fourth Meeting of the Conference of the Parties (COP-4) to the UN Framework Convention on Climate Change (UNFCCC) was held. It was the first major meeting to follow the Kyoto Conference on Climate Change. The meeting resulted in the Buenos Aires Plan of Action, which accomplishes two key things: Firstly, It strengthens implementation of major provisions of the original 1992 Rio climate treaty on technology transfer and assistance to developing countries in adapting to the impacts of climate change. Secondly,

It lays out a scope of work and sets a deadline in 2000 for decisions on unfinished business from Kyoto, particularly the rules and guidelines for the flexibility mechanisms (emissions trading, joint implementation, and the Clean Development Mechanism or CDM³⁷). While these actions went some way toward maintaining the momentum generated in Kyoto, much hard work remains to be done to decide a number of tough issues. Especially on the trading of Carbon emissions and equity between the rich and developing nations.

November 13 to November 24, 2000 saw the sixth session of the United Nations Framework Convention on Climate Change

³⁷ Article (12) of kyotoProtocol defines CDM , which was designed for extending the cooperation between the developing and developed countries for reducing GHG emission. Refer D. Tiwari and r.Mendelson's *Two essays on climate change and agriculture: Towards a framework for implementing the clean development mechanism in developing countries* FAO/ESDP, Rome 2000.

(UNFCCC) Conference of the Parties (COP6). Each COP meeting is where nations meet to evaluate the accords and compliance with meeting emissions reduction targets. This one was intended to wrap up three years of negotiations on the implementation of the Kyoto Protocol. The talks pretty much collapsed

The third IPCC assessment, Climate Change 2001, finalized at the group meeting in Shanghai in January 2001, released a brief "summary of policymakers". The major difference from the second assessment is in the projected temperature increase, which is now put 1.4C - 5.8C. The projected Sea level rise is slightly smaller, at 0.09 - 0.88 meters. There is also a strengthening of the statement on anthropogenic causes with new and stronger evidences to support that most of the (atmospheric) warming observed over the last 50 years is attributable to human activities. The report notes that even with stabilization of green house emission, there may be continuing effects beyond the Twenty-first century. One such effect is the weakening of ocean thermohaline circulation.

In March 13, 2001 Bush administration reversed a pledge to legislate limits on CO₂ emissions from U.S. power plants, saying such a rule would be too costly, in light of rising energy prices. U.S. vowed to require limits on CO₂ emissions, along with other power plant pollutants including sulfur dioxide, nitrogen oxides and mercury. In March 28, 2001, Christie Todd Whitman, head of the U.S. Environmental Protection Agency, confirmed that U.S. would not implement the Kyoto Protocol. Whitman's comments come two days after the European Union wrote to U.S. President George W. Bush,

seeking his commitment to the climate change treaty and calling on him to find political courage. The news³⁸ has been greeted with anger and disappointment from some quarters in the U.S. and overseas. European Environment Commissioner Margot Wallström responded to Whitman's announcement - *"George Bush's decision to rat on the Kyoto treaty is grim news. This ignorant, short sighted and selfish politician, long since firmly jammed into the pockets of the oil lobby. The talks in Bonn in July must now concentrate on world action independent of the U.S."*

Many critics argued that the Bush Administration's approach of explore for oil and ignore the science on global warming leaves the U.S. increasingly isolated from the rest of the world. By simply opposing the Kyoto Protocol rather than seeking to improve it, U.S would have effectively blocked the binding international agreement for fighting global warming, while offering hardly any alternative path to protect the planet. Moreover this move would have the potential to slow international action on climate change for many years. As the superpower, and the world's largest producer of greenhouse gases, the U.S. has a special obligation to lead on this issue. The Kyoto Protocol will not take any effect until it is ratified by 55 percent of the nations emitting at least 60 percent of the greenhouse gases - carbon dioxide (CO₂), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Countries disagree on how they should be allowed to meet their targets. Under the Protocol, the U.S. is supposed to cut its greenhouse gas emissions by seven percent. With four percent of the world's

³⁸ Whitman and Wallström's responses and reactions were published in Wall Street Journal on Web in March 29,2001.

population, the country accounts for about 25 percent of the Earth's greenhouse gas emissions.

July 16-27, 2001, representatives from more than 180 countries gathered in Bonn, Germany for a U.N. conference on global warming. The meeting was a follow-up to 1998 and 1997 meetings in Buenos Aires and Kyoto, Japan, respectively. Unfortunately, the political scenario suddenly changed as after assuming office in January 2001, President George W. Bush announced that the United States would withdraw from the Kyoto Treaty, although it would continue to participate fully in the international meetings that developed the treaty. Following his announcement, President Bush received a firestorm of criticism from political opponents at home and from Europe. Much of this criticism, however, was hypocritical in the extreme. Proponents of the treaty had already admitted that the treaty's provisions would not have the beneficial environmental impacts advertised, and that the costs of implementation would be much higher than the public had been told. Given the climate of criticism surrounding the Bush Administration on the issue of global warming, The National Center for Public Policy Research has published a list of the top charges being made on the Kyoto Protocol. It was argued that US president George W. Bush killed the Kyoto Protocol. However, in against of this charge the bush government argued that: President Bush did not kill the Kyoto Protocol. It was dead when he took office. *Senate Res. 98*, passed by a vote of 95-0 on July 25, 1997, states that the Senate will not ratify any climate treaty that would harm the U.S. economy or fails to require developing

nations to reduce emissions. President George W. Bush simply recognized these facts.

October 29 to November 9, 2001 saw the seventh session of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties. The purpose of the meeting was to agree legal text covering outstanding technical aspects of the political agreement reached in Bonn in July 2001 on how to implement the Kyoto Protocol. While an agreement resulted, there are still concerns that there will be little impact on emissions as a whole.

In May 29, 2002 - Developing countries have urged industrialized countries to ratify the 1997 Kyoto Protocol on global warming, with nongovernmental organizations (NGOs) urging Indonesia to take the lead in a final preparatory meeting for the World Summit on Sustainable Development 2002 to be held in Paris.

In June 3, 2002, Japan's Foreign Minister Yukio Takeuchi announced that Japan will submit its ratification documents for Kyoto Protocol to U.N. headquarters in New York. In June 4, 2002 on the basis of this announcement Japan ratified the Kyoto Protocol aimed at curbing global warming. (*June 5, Kyodo News, Japan*)

In June 2002 Environmental Protection Agency (EPA) has published a report indicating a major shift of focus on green house gases. It is for the first time, the Bush administration has admitted that man made global warming will inflict serious, permanent changes on America. The administration appears to have accepted the scientific case for global warming, adopting a section of a recent study on

climate change by the National Academy of science. The report *U.S Climate Action Report 2002* says for the first time that human actions are mostly to blame for global warming. (*The Hindu, Wednesday, June 5, 2002*). The report concludes that the changes are inevitable but does not recommend altering the administration's current policy on greenhouse gases. Instead the report says that if America's economic growth is to be protected the country will have to adapt to a climate that is between 5-9⁰F warmer. There was no doubt on the fact that the Bush administration has been under increasing pressure from environmental groups alarmed by reversals of environmental protections within the U.S. One of the country's oldest and largest environmental groups, the Sierra Club launched a series of radio ads criticizing the present U.S environmental policy. The recent response of the Bush administration represents an effort to reconcile the home crisis.

In June 6, 2002, Australian Prime Minister John Howard, a keen ally in the U.S.-led anti-terror campaign, has echoed Washington's concerns on two major international treaties repudiated by the Bush administration. On both the International Criminal Court (ICC) and the Kyoto Protocol on "global warming," the conservative Prime Minister has signaled that Australia is closer to American than European thinking (www.cnn.news.com). President Bush in March 2001 walked away from the Kyoto agreement, which he said would jeopardize U.S. industries and jobs Both decisions brought considerable criticism from foreign governments, led by the European Union, as well as from environmental and human rights campaign-groups.

Both Australia and the U.S objected to the fact that Kyoto does not demand emission reductions from countries like *India and China*³⁹ though the U.N. figures show both are major CO2 polluters. Australia maintains that ratifying Kyoto without the U.S. is pointless. Given that the largest polluter is no longer part of the signatories and the provision of more loopholes for sinks and trade of GHGs have been allowed, the protocols will now do even less than it was originally going to do in terms of reducing actual emission or concentrations. Moreover, the long term message it sends to the developing countries of the south -about what industrialized countries is actually committed to do and how developing countries might be eventually incorporated into global climate regime is more confusing than ever.

However, all 15 members of the European Union, as well as Canada and New Zealand and Japan have ratified the treaty. This is expected to create pressure on Australia and US in the near future. Despite of the fact that US's shadow on any international decision making is large and ominous, it no longer would remain the single most important player in the negotiations. Especially after the September 11, 2001 incident (terrorist strike on World Trade center) and with the launching of the 'global war against terrorism' the course of international relational has changed. Now the policy of domination has to replace by the policy of co-operation to fight against the recent crisis like terrorism, drug trafficking and so on. All these problems with large cross border spread require international co-operation and

³⁹ According to Human Development Report 2001 China ranks 2nd and India ranks 6th in carbon dioxide emission in the world.

goodwill to curb them out. On the other hand, globalization and the free market economy need what is known as 'trading of interests' for its sustenance. Therefore, being a part of the present 'net world' isolation from the rest is not likely to prove fruitful in the long run.

International cooperation is essential to achieve a globally coherent response strategy and could both significantly reduce the cost and increase the effectiveness of GHG mitigation measures. Efficient policies that provide correct economic signals through such policy instrument as carbon taxes, specific subsidies, quota scheme, tradable emission permits as well as international incentive programme like joint implementation schemes should be introduced to have required responses.

However, Unless the issues of mistrust, legal requirements and financial guarantees are resolved, the most carefully constructed environmental treaties and action plans may collapse. A new system of priorities based on global partnership must be established, involving full participation in decision making by every country on an equal footing in which every one should pay a fare share to combat environmental danger. These arrangements do not depend on technical or financial feasibility but on political good will.

End notes

- I. The basic criteria mentioned for implementation of Clean Development Mechanism (CDM) are-
 - Acceptable to both the host and recipient governments.
 - Satisfy the goal of sustainable development
 - Potential for increasing resource use efficiency
 - Less risk of potential leakage
 - Financial additionality

- II. Thermohaline circulation means the vertical movement of ocean water driven by density differences resulting from the combined effects of variation in temperature and salinity.

Chapter V

TOWARDS A SUSTAINABLE FUTURE

The Interface between Environment and Development

" Man can control the environment for good as well as illwisdom lies in seeking to preserve the balance of nature....the present generation has an obligation, above all, to secure the welfare of future generation"

George Perkins Marsh in his classic 'Man and Nature'. 1964.

Any environmental crisis including the problem of global warming poses a significant threat to future economic activities and human well being. The economic approach is to maximize the net benefit from the use of global resources. While, the rising concern is to maintain the stock of ecological assets at a level that ensures future benefits. To achieve this aim the underlying principle should be based on optimality and economically efficient use of resources to ensure stability and viability of the global ecosystem. This thrust led to the consideration of environment at the core of developmental issues.

Initially many countries were suspicious of 'environment' as a public issue on a global scale. While, some countries viewed the outcry over the issue of global warming and other ecological adversities as merely a diplomatic tactic; a mechanism of exploitation designed to keep the poor ones away from industrializing. Many of the leaders from developing countries argued that if pollution meant having industry, they would welcome it wholeheartedly while, the others wanted to avoid the mistakes already committed by the developed nations. A deadly combination of poverty, rapid population growth and unmanaged industrialization with the result of poor governance have turned the industrial development of many of the developing countries into an environmental nightmare. For instance, between 1975-1988 according to

World Bank estimates, toxic releases went up 500 percent in Indonesia, 800 percent in Philippines and 1200 percent in Thailand. Slowly people began to realize that the western industrial strategy with its heavy use of raw material and energy, is a highly toxic model. But it was feared that the additional expense on imported technology, damage to the export caused by newly adopted regulations and the diversion of foreign aid funds to environmental protection projects would cause a severe resistance to the process of development.

With the Stockholm Conference, a search began for a new, more rounded concept of development in which environmental consideration would play a central role still allowing opportunities for human activities. The Stockholm Conference somewhat modified the dire warning of the *Club of Rome* report⁴⁰. Concerns voiced at Stockholm and the subsequent international symposia have led to the evolution of the theory and practice of what is popularly known as sustainable development.

There is now almost unanimous agreement that doubling the expected greenhouse effect would raise the global average surface temperature. Discrepancies among the results of different modeling approaches are insignificant. And this is not simply an issue for the north. A clear scientific consensus has emerged on the range of warming to be expected during the twenty-first century, in spite of uncertainties about its precise regional distribution and its environmental consequences. However, the real test is just ahead: convincing the world

⁴⁰ in 1970s the prestigious Club of Rome released 'Limit to Growth', warning that the planet's ability to sustain industries and agriculture have being jeopardized, and that what for a relatively small human population had seemed infinite was actually alarmingly finite.

community of the reality of the global warming crisis, reducing the existing gaps and ambiguities in the new protocols, achieving its ratification in time -still continuing with the process of development specially for the millions of people thriving under acute poverty. To couple development with environmental responsibility, a concept that has to be called as 'Sustainable Development' is now the most rational way available before humanity.

The current models of economic development fail to consider the value of natural resources. Two centuries ago, Adam Smith⁴¹, in *The Wealth of Nations*, wrote, "Things which have the greatest value in use- such as water, air... have frequently little or no value in exchange." Although the environment is embodied in all goods and services exchanged it is not itself exchanged and therefore eludes a market price. The result is that natural resources are treated as 'gift of nature' rather than as productive assets. Economics has great difficulties assigning to any thing outside of mercantile activities (Mostafa.K.Tolba⁴², 1998). Putting a price tag on environment is not all to solve the present crisis. What is needed is a change in our perception of wealth.

The 1960s and 1970s were marked by an intensification of concern about environment. There was rising awareness that- environmental problems arise within the context of a complex interrelationship between humankind, the global resource base and the social and physical environments (Turner 1988). As a consequence,

⁴¹ He was primarily concerned with the factors which led to increase wealth in a community. To him skilled labour and free competition are the essential ingredients of efficient economy. Refer A.Smith's '*An Inquiry into the Nature and the causes of the Wealth of Nations*' 1776.

⁴² Tolba K. Mostafa, Iwona Rummel- Bulska (1998) ' Global environmental diplomacy. Negotiating environmental agreements for the world 1973-92'; MIT Press; Cambridge. Massachusetts, London, England; pp 3-96.

question about the acceptability of conventional growth objectives, strategies and policies were brought to the forefront of public debate. In 1980 the concept of sustainable development entered into the public arena. When the international Union for the conservation of Nature and Natural Resources presented the *World Conservation strategy* with the over all aim of achieving sustainable development through the conservation of living resources (IUCN 1980). A broader understanding of sustainable development was used by the United Nations Environment Programme, in the report *Our Common Future*, published by the World Commission on Environment and Development (WCED 1987). This report also known as Brundtland Report, after its president provided the widely quoted definition of Sustainable development - "*development that meets the needs of the present without compromising the ability of the future generation to meet their own needs.*" The report argued that the concept provides a framework for the integration of environmental policies and environmental strategies, thus breaking the perception that environmental protection can only be achieved at the expense of economic development.

Sustainable development is a multi-dimensional and many faceted objective. One, which is intrinsically linked to many other important, issues (environment, trade, cultural sustainability, urbanization, etc.). Sustainable development must be viewed with a broad perspective which incorporates five main elements: (*John Robinson ,Vice President, Policy Branch, Canada*)

- environmental sustainability.(maintaining ecosystem integrity and biological diversity)

- economic sustainability (efficient and equitable economic development and increases the productivity of the poor) .
- political sustainability(the political will and capacity of societies to respect the rights of all, and to govern effectively in a democratic manner. open, democratic and accountable systems of governance and respect for human rights, For example, good environmental decisions demand input from all concerned people - which presupposes an open and participatory process.)
- social sustainability (to promotes social well-being through gender equity, improved income distribution and basic social sector investment.
- cultural sustainability (ensures sensitivity to and recognition of cultural values conducive to development).

The UN Frame work Convention on Climate Change (UNFCCC) which seeks to stabilize the concentration of GHGs has recognized the emerging consensus on the economic, social and environmental dimensions of sustainable development explicitly in Article 2, which states that the stabilization of GHGs concentration "should be achieved with in a time frame sufficient to....enable economic development to proceed in a sustainable manner"(UNFCCC 1992). This consideration suggests that an integrated and comprehensive framework for analysing the problem of global warming is already in its way with the concept of the promotion of values that encourage consumption pattern that are within the bounds of the ecologically possible and to which all can reasonably aspire. Many scholar have suggested more specific decision

making objectives in this respect to meet the criteria for sustainable development that should be addressed by all humanity- Firstly determining the acceptable concentration of GHGs in the atmosphere at different times in future. Secondly, determining the target levels for reduction of GHG emissions. Thirdly, Identifying the combination of measures that will bring about the desired reduction of emission. Fourthly, allocating the appropriate distribution of emission reduction responsibilities among different nations, taking into consideration their past emission and future development needs. Fifthly, establishing mechanisms and institutions for making collective decision and implementing them effectively. And sixthly, developing measures to deal with special difficulties, especially the issue of uncertainty that may manifest in different forms. The collective decision-making process will provide 'equitable' solutions to problems associated with global warming. The process of collective decision making also involve the establishment of global environmental regimes, which requires some new concepts and principles to be invoked. These are (a) common concern for mankind. (b) Precautionary principle (c) polluter-pay principle (d) equitable global partnership. (e) Market bases approaches (f) common but differentiated responsibility.(g) intergenerational equity and (h) public participation. (Mostafa.K.Tolba 1998)

However there is no single blue print of sustainable development as economic, social and ecological conditions differ widely among countries. Thus each nations would have to work out the concrete policy implication for itself. Policy makers have the great tasks of translating the highly generalized and declaratory political statements into practice.

A Quest for Sustainability

A range of human activities characterizes that modern economic systems are leading to emissions of greenhouse gases. For some activities like the cultivation of paddy rice in flooded soils, there is reason to believe that there are no economically viable or practical alternatives to the current methods. However, there are several other areas of human activity ranging from the generation of electricity to the provision of passenger and freight transport, in which there clearly exists the potential for preparing the agenda for change, which would mitigate global warming.

Evaluation of costs and economic impacts of GHG mitigation strategies is generally carried out through the construction and simulation of quantitative economic models. There are a number of global top-down and bottom-up models used for this purpose. Some of the top-down models include CRTM: Carbon Rights Trade Model, ERM: Edmonds-Reilly Model, GREEN: OECD model, IEA: International Energy Agency Model, MR: Manne-Richels Global 2100 Model and WW: Whalley-Wigley model and so on. The major sets of bottom-up studies relating to GHGs mitigation involving several developing countries include the "Collaborative Study On Strategies to Limit CO₂ Emissions in Asia and Brazil" carried out by the Asian Energy Institute (AEI), "UNEP Greenhouse Gas Abatement Costing Studies", by the UNEP Collaborating Centre on Energy and Environment (UCCEE), Denmark. The developing countries are still seen as relatively small players on the energy scene. In 1970 they accounted for only 15% of global demand for commercial energy. From

1970 to 1990, despite the crippling effects of the oil price rises and heavy indebtedness, their commercial energy consumption nearly doubled and now accounts for 26% of the global total (These statistics do not include non-commercial sources of energy) Most scenarios foresee demand in developing countries at least doubling from 1990 to 2010, and doubling again to 2030, by which stage they would probably account for at least half of global energy consumption.(Grub.M.etal1990). However, per capita energy consumption will continue to be substantially higher in the developed countries. To expect the developing countries to cut down on fossil fuel consumption may seem unfair, given that there exist enormous disparities between their stages of development and fossil fuel consumption. Also, it would be inequitable and unfair to propose that the developing countries forego opportunities for bettering their standards of living in order to solve a global problem which in any case is not of their creation.

In a developing country like India, prices of all the major fuels (except firewood and other biomass) are administered; the stated purpose being to pursue certain social objectives. The prices do not, in general, reflect economic costs. For instance, kerosene is subsidized, it is viewed as the major commercial fuel used by low-income households, although it is well known that low-income households may not always get the intended benefits. Since the mid-1960s, the use of policy instruments to achieve stable, efficient and balanced growth of agriculture has been officially adopted by the Government of India. The electricity supply to this sector was, hence, subsidized. Electricity sales to rural farmers take place at tariffs which are the lowest (compared to

other categories of consumers), while the costs borne by utilities for supplying electricity to them are the highest. This has encouraged the inefficient use of electricity in the rural sector. In the process, the related environmental concerns are completely ignored. The production of foodgrains has increased from 50,825 thousand tonnes in 1950-51 to 211 million tonnes in 2001-2002. However, the difference between the average revenue realized and the average cost of supplying electricity to the agricultural sector in India has also been increasing. Similarly, in China, the use of its abundant coal resources is seen as the key to its industrial future. In China where with some exceptions, energy prices have also been kept well below world prices. The price structure for energy not only gives the wrong incentives as regards energy saving, but it has effects on production. Hence, quite apart from common market failures, the government has also failed to incorporate externalities.

A study conducted by *Tata Energy Research Institute* found that the markets worldwide fail to reflect the full economic and social cost of environmental problems. Market failures are further exacerbated by government actions or policy failures that encourage inefficient resource use such as the subsidized provision of electricity. Other policy failures are tied to inappropriate tax incentives, trade policies and exchange rates that lead to environmental problems. Related to policy failure is the inability of the existing institutions to formulate, implement, and enforce environmental policies. Institutional capacity is further weakened by jurisdictional complexity, insufficient information, and lack of broader participation. Further, in developing countries, institutional weaknesses are acute at the level of local governments and agencies that are responsible for monitoring and enforcement of the mechanisms. A

multiplicity of actors with overlapping, uncoordinated or poorly defined responsibilities aggravates institutional weaknesses and hampers the development and implementation of the environmental action plan. Environmental protection is also constrained by the lack of related information and analytical frameworks for understanding the problems. Furthermore, the lack of user participation usually results in inadequate support for mitigation activities.

A switch to renewable sources of energy or afforestation measures has many more environmental benefits. Energy conservation and improvements in energy efficiency through up-gradation of currently employed technologies- this option can be implemented in a short duration and the benefits could be expected to secure within a short term. However, it is also true that some countries in the developing world are quite skeptical about energy conservation. There is a huge, and still largely unexplored, role for personal initiative in a micro-enterprise in ensuring the success of the environmental policies.

Policies to promote energy efficiency include rational energy pricing for developing nations - and "full cost" of supplying energy for developed nations. Within the national developmental perspective, the aims of an integrated energy policy should be to: reflect the real costs including depletion costs; encourage energy conservation with a graded tariff structure; promote, inter-fuel substitution and renewable energy sources. To encourage the rational use of energy, substantial changes in goals and operations are frequently required. This could be achieved by evolving a set of standards that encourages the continuous upgradation and absorption of energy technologies in the most cost-effective manner.

This has had excellent results in the US where now some refrigerators use 55% less energy than in 1972. In the case of the renewable energy sector, the list of available innovative technologies for meeting diverse end-uses is impressive. However, some of them have not achieved the level of maturity or conversion. The fundamental problem is that this sector has been accorded a low priority. The resource allocation for this sector continues to remain insignificant.

Experience shows that providing financial incentives may prove costly and less effective. However, it has helped in promoting the use of energy efficient technologies. It also tends to inhibit up-gradation of the technology. However, financial incentives coupled with an improvement in the administrative process could prove effective. The shift from remedial to preventive technologies is seen as the basis of a primary strategy in response to global warming. Though green technologies, which are considered critical for reducing current level of emissions, there seem to co-exist a number of barriers to their deployment and diffusion on a pace and scale.

The experience of the international transfer of technology over the recent past has one striking feature. Much of the technology imported into the developing countries never reaches its design capacity, and its performance deteriorates significantly over its operational life. This goes to prove that for technology transfer to be effective it is required to look over and beyond the transfer, to concentrate on the development of 'human-endowed technological capabilities'. The challenges involved in this are critical, though often overlooked. The reason for this is largely economic - these capabilities need a long time to show results. Thus

there is no incentive to invest in these capabilities which, in turn, leads to decline in long-term performance.

Policies to promote technological development include technology evolution with a greater concern for environment. The policies for this need to be three folds:

- a. Create an awareness so as to feel the need for such technologies.
- b. Provide financial and human resources to be utilized for this purpose.
- c. Improve the scope and depth of technology transfer

Communications, education and training processes that can foster and institutionalize this ethic needed to be developed. The problem of a technology transformation is not primarily scientific and technical, it is one of policy end management.

A group of thinkers suggests adopting a much more primitive life style and giving up a large part of the industry. This sounds very seductive but just not practical. The world population is now over 6 billions, some six times what it was in 200 years ago and three times what it was in just 50 years ago. The world can not be adequately fed with out the modern method of food production and distribution. More over the scientific and technological development can not be frozen at a given point in history. Therefore, 'back to nature' viewpoint is neither balance nor sustainable. A balance has to be struck between the provision of necessary resources and the long-term need to preserve the environment.

Al Gore the ex-vice president of the United States in his book ⁴³'The Earth in the Balance' implied that there are balances in the environment, which need to be maintained. A small area of a tropical forest possesses an ecosystem, which contain some thousand of plant and animal species each thriving in its own ecological niche in close balance with the others. Balances are also important for larger regions and for the earth as whole. Al Gore has proposed a plan for saving the world environment, called 'A Global Marshall Plan'. Like the original Marshall *Plan* ⁴⁴ resources for the plan would need to come from the world's major wealthy countries. Five strategic goals were proposed for this-

- The stabilization of world population
- The rapid creation and development of environmentally appropriate technologies
- A comprehensive and ubiquitous change in economic 'rules of the road' by which the impacts of decisions on the environment can be measured.
- The negotiation and approval of a new generation of international agreement, which should be sensitive to the vast difference of capability and need between developed and developing nations.
- The establishment of a cooperative plan for educating the world citizen about global environment.

⁴³ Al Gore, (1992) *'Earth in the Balance'*, Houghton Mifflin company.

⁴⁴ Through Marshall Plan the United States assisted the western Europe to recover and rebuild their economies after second World War.

Global Marshall plan incorporates the idea of sustainability and provide a theoretical basis for the design and implementation of national and international policies to reconcile social, economic and environmental objectives of development. Thus sustainability is a part of integrated development planning which addresses the underlying causes of environmental degradation and lack of human development. Unsustainable lifestyle, unnecessary over-consumption and irresponsible use of scarce natural, human and financial resources disrupt the balances of nature. To quote John.Houghton⁴⁵, the co-chairman of the Scientific Assessment Working group of the IPCC - " It needs to be a balanced and harmonious relationship in which each generation of humans should leave the earth in a better state, or at least in as good a state as they found it. The word often used for this is sustainability-politician talks of sustainable development."

⁴⁵ Refer J.Houghton (1997) 'Global Warming: The complete briefing', (2nd ed) Cambridge university press pp- 142-145

Conclusion

The diplomatic activity concerning global warming might lead one to believe that it is the major crisis-confronting mankind in recent time. The point is that carbon dioxide is vitally central to industry, transportation, modern life, and life in general. It has been joked that carbon dioxide controls would permit us to inhale as much as we wish; only exhaling would be controlled. Dealing with the threat of warming fits in with a great variety of preexisting agendas--some legitimate, some less so: energy efficiency, reduced dependence on fossil fuel, dissatisfaction with industrial society, international competition, governmental desires for enhanced revenues (carbon taxes etc), and bureaucratic desires for enhanced power and so on.

The very scale of the problem as popularly portrayed and the massive scale of the suggested responses has their own appeal. The Working Group I report of the Intergovernmental Panel on Climate Change suggested, for example, 60 percent reduction in carbon dioxide emissions. Such a reduction would call for measures that would be greater than those devoted to national security and defense. And just as defense has dealt with saving one's nation, curbing "global warming" is identified with saving the whole planet.

Major agencies in the United States, hitherto closely involved with traditional approaches to national security, were earlier neglected the issue of environmental security. Notable among those agencies are NASA, the Department of Defense, and the Department of

Energy. Many scientists also feel that national security concerns formed the foundation for the U.S. government's generous support of science. With the urgency of national security, there is a common feeling that a substitute foundation to perform integrated research on global warming and other ecological problems must be established. The recent EPA report 2002 admitted for the first time after US has abandoned the Kyoto protocol that man made global warming will impose serious threat to global environment but unfortunately (till now) did not recommended altering the American Government's current policy on green house gases.

"Global warming" may be a tempting issue for many important groups to exploit. Some industries have become successful at profiting from environmental regulation. The most obvious example is the waste management industry. The environment, itself, qualifies as one of the major industries. If thesis³⁵ like Dr. Mahendra Shah of International Institute of Applied System Analysis (IIASA) and Prof. M Lal of Indian Institute of Technology (IIT) were correct, the major losers would be the ordinary people. Wealth that could have been used to raise living standards in the world would be squandered. Living standards in the developed world would decrease. Regulatory apparatuses would restrict individual freedom on an unprecedented scale. Public perceptions, under the influence of extensive, deceptive, and one-sided publicity, can become disconnected from reality.

³⁵ Refer M.Shah's '*Challenges of a changing Earth*', paper presented in climate conference in Amsterdam, 2000. Also see 'Deep impact shallow response', *Down to Earth*, oct. 31,2001. Pp- 28-51

On the other hand the issue of global warming has all potential to change the course of international relations already discussed in the previous chapters. There is growing awareness that transboundary pollution and transfer of GHG is a new source of international tension and may become a potential source of conflict in near future. Several groundbreaking agreements have been made to deal with the problem but hardly anything has been materialized due to clash of interests and mis-visioned diplomacy. The end of cold war did not bring about a peaceful era expected by many. Now there is another set of growing crisis like terrorism and national security, illegal migration, cyber crime etc to be confronted besides the old problems like poverty, hunger, unemployment, discrimination, and more severely the erosion of global resources. The vast amount spent annually on arms and nuclear stockpiles can not rebuild the economies of the Eastern Europe neither it can usher in development in the developing countries nor it can provide food for the poorest million in the continent of Africa. Rich nations like US can bear up huge unproductive defense expenditure in the name of national security but reluctant to spend on environment. While it has been widely recognized that close connection exists between environmental health and security and international cooperation is needed to protect the fragile web of life, rather than additional expenditure on arms. A quote from the UNDP's Human Development Report offers elaboration on this matter- *"The concept of security must change - from an exclusive stress on national security to a much greater stress on people's security, from security through armaments to security through human development, from territorial security to food, employment and, environmental-security"*.

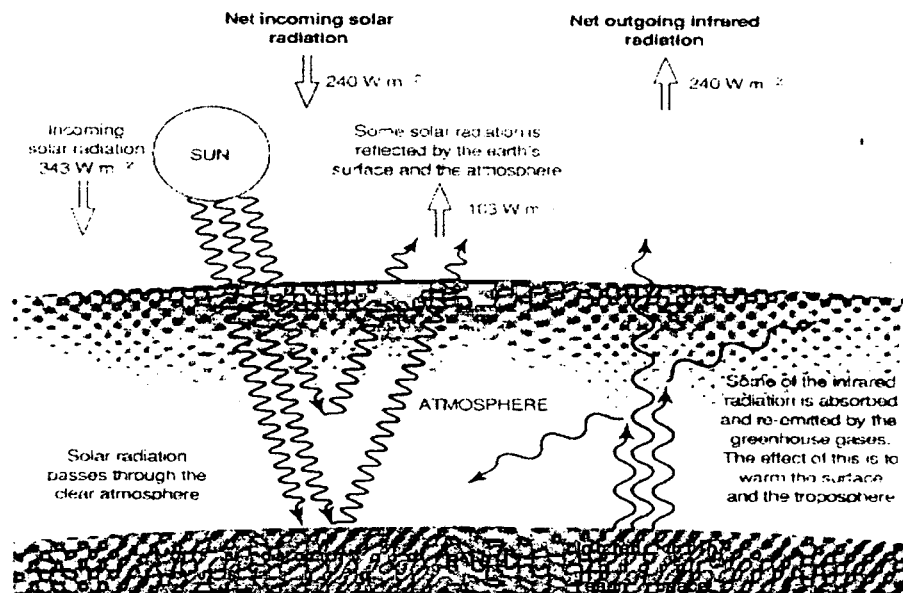
Structural shift in economic activity taking into account the comparative advantage of the region/countries now need to be placed in more holistic frameworks in response to global warming and climate change. If there exists a clear understanding of the linkages and relationships between different sectors in a region, it would be worthwhile to work towards a structural shift in the economic activity where production of a particular commodity in a particular country is undertaken because of its comparatively more advantageous energy endowments over the other countries in the region.

Policy to promote a structural shift in economic activity is fundamental to sharing a common future. The idea of building partnerships for action encompasses the search for new forms of international cooperation. The first step in this process is to building on some of the existing regional networks and alliances like ASEAN, SAARC, etc. Two major institutional changes required are Firstly, modification of the planning process: A more rational approach for planning which requires an integrated set-up. Secondly, consensual approach to decision making, made on political grounds should involve community participation. As with all forms of development initiatives will be successful only if they involve the local people.

Balancing growth with conservation is difficult even for the most economically powerful nations. It requires not only capital but also farsighted and effective governance - farsighted enough to appreciate emerging problems and effective enough to impose needed regulations. The trouble is that politicians all over the world continues to give greater importance to economy than to ecology. The result is

that most of the leaders of the developing countries feel they are being unfairly asked to share the economic burden of conservation even though such problems like global warming and ozone depletion are largely western creation. Global attitudes would change greatly if nations like US and other high income countries show green leadership back home first and then launch international programs to protect the environment. It is clear from the current scientific understanding that global warming poses a global challenge, which must be met by global efforts. So far as environment is concerned national boundaries are becoming less and less important.

Appendix I: Greenhouse Effect and the mechanism of global warming



Source : Jepma and Munasingh (1998) *climate change facts, issues and analysis*

Moderate levels of greenhouse gases in the atmosphere are essential for maintaining relatively constant temperature levels on Earth. In what is known as the greenhouse effect, the gases allow sunlight to pass to the surface of the Earth, much the same way that sunlight passes through a greenhouse's windowpanes. As sunlight warms the planet, the Earth reflects its own heat energy. However, greenhouse gases block much of that reflected energy from leaving the atmosphere. The "trapped" energy then heats up the surrounding atmosphere, enveloping the Earth in a cozy blanket of warm air that holds temperatures and climate patterns relatively constant. Without greenhouse gases, the Earth's heat would dissipate into space and the planet's surface would freeze over.

The largest greenhouse gas by far is water vapor, which accounts for about 98% of the total greenhouse gases in the atmosphere. Carbon dioxide comprises more than half of the remaining 2%. Other greenhouse gases include methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexachloride. Although water vapor contributes most to the Earth's natural greenhouse effect, human impact on its levels is considered inconsequential. For that reason, most measurements of greenhouse gases only include levels of those gases, such as carbon dioxide and methane, that are directly influenced by human activities.

Life as we know it would be unbearable without greenhouse gases, but what would happen if the gases steadily increased? That is the question that scientists currently face and the riddle that underpins the global warming debate. Excluding water vapor, levels of greenhouse gases, in particular carbon dioxide, have in fact increased about 30% since the mid-18th century when the industrial revolution began. Emissions of carbon dioxide rose as more and more coal, oil and natural gas were burned to power the factories, power plants and automobiles that helped shape the modern world. Currently, concentrations of carbon dioxide are about 360 parts per million, compared with 280 parts per million during pre-industrial times.

Appendix II - The chronology of events

Global Warming: The History of an International Scientific Consensus

1896: Arrhenius, a Swedish chemist, advances the theory that carbon dioxide emissions from combustion of coal would enhance Earth's greenhouse effect and lead to global warming.

1924: Based on 1920 coal use, Lotka, a U.S. physicist, speculates that industrial activity will double atmospheric CO₂ in 500 years.

1949: Callendar, a British scientist, speculatively links the estimated 10% increase of atmospheric CO₂ between 1850 and 1940 with the observed warming of northern Europe and North America which began in the 1880's.

1954: Hutchinson, a Yale biologist, first suggests that deforestation will increase atmospheric CO₂.

1957: Revelle and Seuss, scientists with the Scripps Institute of Oceanography, report for the first time that much of the CO₂ emitted to the atmosphere is not absorbed by the oceans, as some had argued, leaving significant amounts in the atmosphere which could eventually warm the Earth. They call carbon dioxide emissions "a large-scale geophysical experiment" with Earth's climate.

1958: Keeling, a scientist with the Scripps Institute, begins the first reliable and continuous measurements of atmospheric carbon dioxide at Hawaii's Mauna Loa Observatory. Keeling finds CO₂ concentrations to be 315 parts per million and rising.

1967: The first reliable computer simulation calculates that global average temperature may increase by more than 4 degrees Fahrenheit when the atmospheric CO₂ level doubles that of pre-industrial times.

1971: Some scientists argue that cooling of the atmosphere by particulates from coal burning could be more significant than warming by greenhouse gases. Uncertainties are too large to be sure which effect will dominate.

1976: Scientists at several research institutions identify chlorofluorocarbons (CFCs), methane, and nitrous oxide as greenhouse gases.

U.S. and Swedish scientists estimate that cooling by particulates from coal burning is a relatively small effect on a global average basis.

1979: The report of a National Academy of Sciences (NAS) panel on climate change advises that "A wait-and-see policy may mean waiting until it is too late" to avoid significant climate changes.

1983: An NAS report confirms that a doubling of CO₂ levels eventually would warm the Earth by 3 to 8 degrees Fahrenheit. The same year a U.S. Environmental Protection Agency (EPA) study called *Can We Delay A Greenhouse Warming?* states that as a result of warming, "agricultural conditions will be significantly altered, environmental and economic systems potentially disrupted, and political institutions stressed."

1985: A conference sponsored by the United Nations Environment Program (UNEP), the World Meteorological Organization (WMO), and the International Council of Scientific Unions forges a consensus of the international scientific community on the issue of climate change. The conference report warns that some future warming appears inevitable due to past emissions regardless of future actions and recommends consideration of a global treaty to address climatic change. Atmospheric CO₂ concentrations recorded at Mauna Loa Observatory show steady increase averaging more than 1 ppm/year .

1987: An ice core from Antarctica analyzed by French and Russian scientists reveals an extremely close correlation between CO₂ and temperature going back more than 100,000 years.

1988: The Intergovernmental Panel on Climate Change (IPCC), made up of leading climate scientists from around the world, is established by UNEP and WMO to assess the scientific and economic basis of climate change policy in preparation for the 1992 Rio Earth Summit.

1990: An appeal signed by 49 Nobel prize winners and 700 members of the NAS states, "There is broad agreement within the scientific community that amplification of the Earth's natural greenhouse effect by the buildup of various gases introduced by human activity has the potential to produce dramatic changes in climate ... Only by taking action now can we insure that future generations will not be put at risk."

The scientific working group of the IPCC, drawing on 170 scientists from 25 countries, publishes a report stating that human activity increasing greenhouse gas emissions "will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface." It calculates that an immediate 60% reduction in CO₂ emissions would stop the buildup of carbon dioxide.

747 participants from 116 countries take part in the Second World Climate Conference. The conference statement reports that "a clear scientific consensus has emerged on estimates of the range of global warming which can be expected during the 21st century. If the increase of greenhouse gas concentrations is not limited, the predicted climate change would place stresses on natural and social systems unprecedented in the past 10,000 years."

1992: The NAS publishes a study reporting that despite uncertainties, greenhouse warming poses a potential threat, "sufficient to merit prompt responses ... Investment in mitigation measures act as insurance protection against the great uncertainties and the possibility of dramatic surprises. In addition, the panel believes that substantial mitigation can be accomplished at modest cost. In other words, insurance is cheap."

A supplementary IPCC report updating its 1990 study finds that new research confirms the general conclusions of its earlier study. However, the report notes that reflection of sunlight by particulates may be offsetting some greenhouse warming in the Northern hemisphere.

The United Nations Framework Convention on Climate Change is signed by 155 nations at the Rio Earth Summit. The Framework Convention's stated objective is "stabilization of atmospheric concentrations of greenhouse gases at a level that would prevent dangerous anthropogenic interference with the climate system."

1993: The United Nations Framework Convention on Climate Change is ratified by more than 50 nations, putting it into effect.

1994: Mt. Pinatubo's cooling effect wanes, and Earth's temperature returns to high readings characteristic of the late 1980's; March through December 1994 are the warmest such period on record, according to the National Weather Service's Climate Analysis Center.

1995: The Intergovernmental Panel on Climate Change, representing the consensus of climate scientists worldwide, concludes that "... the balance of evidence suggests that there is a discernible human influence on global climate." The year 1995 matches 1990 as the hottest year on record.

1997: More than 160 nations, Parties to the Framework Convention on Climate Change, adopt the Kyoto Protocol, with legally binding obligations to limit emissions of industrialized nations for the years 2008-2012. The Protocol's emissions targets are hailed as important first steps toward the Framework Convention's objective of avoiding dangerous climate change, and as necessary if warming is to be limited to between 1°C-2°C (1.8°F-3.8°F).

1998: The year is the warmest of the last century based on thermometer data and the warmest of the last millenium based on proxy temperature data.

1999: New York City has its hottest July on record.

2000: Nations meeting in The Hague, Netherlands fail to reach agreement on the implementation rules that are prerequisites for most industrialized nations' ratification of the Kyoto Protocol. Atmospheric concentrations of CO₂ measured at Mauna Loa reach 368.37 ppm, their highest level in 420,000 years.

2001: The IPCC issues its Third Assessment Report stating that "most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations". IPCC points out a number of features of the climate system, like intensity of rainstorms, that have already changed and estimates that warming of the coming century will reach 1.4°C-5.8°C (2.5°F-10.4°F) if emissions are not limited. IPCC finds that warming of between 1°C-2°C (1.8°F-3.8°F) is likely to pose high risks to unique and threatened ecosystems, and to lead to increases in the risk of extreme climate events.

The U.S. National Academy of Sciences, at request of President George W. Bush, issues report analyzing climate science. NAS finds that "temperatures are in fact rising. The changes observed over the last several decades are likely mostly due to human activities NAS reports that IPCC's findings are "robust" and its work is "admirable." President George W. Bush declares scientific uncertainty too great to justify Kyoto Protocol's targets.

The two week UN Conference in Bonn (Germany) in July, 2001 has not been able to bridge the divide between U.S and the other developed nations over the accord of global warming.

2002: World Summit on Sustainable Development was held on May 15, 2002 in Paris, Releases the UNEP's over view report 10 years after Rio.

APPENDIX III

Classification of economies by region and income, 2001

East Asia and the Pacific		Latin America and the Caribbean		South Asia		High income OECD	
American Samoa	UMC	Antigua and Barbuda	UMC	Afghanistan	LIC	Australia	
Armenia	LIC	Argentina	UMC	Bangladesh	LIC	Austria	
China	LMC	Belize	LMC	Bhutan	LIC	Belgium	
India	LMC	Bolivia	LMC	India	LIC	Canada	
Indonesia	LIC	Brazil	UMC	Maldives	LMC	Denmark	
Kiribati	LMC	Chile	UMC	Nepal	LIC	Estonia	
Korea, Dem. Rep.	LIC	Colombia	LMC	Pakistan	LIC	Germany	
Korea, Rep.	UMC	Costa Rica	UMC	Sri Lanka	LMC	Greece	
Laos PDR	LIC	Cuba	LMC			Iceland	
Malaysia	UMC	Dominica	UMC	Sub-Saharan Africa		Ireland	
Marshall Islands	LMC	Dominican Republic	LMC	Angola	LIC	Israel	
Malronesia, Fed. Sts.	LMC	Ecuador	LMC	Benin	LIC	Italy	
Mongolia	LIC	El Salvador	LMC	Botswana	UMC	Japan	
Myanmar	LIC	Grenada	UMC	Burkina Faso	LIC	Luxembourg	
Palau	UMC	Guatemala	LMC	Burundi	LIC	Netherlands	
Papua New Guinea	LMC	Guyana	LMC	Cameroun	LIC	New Zealand	
Philippines	LMC	Haiti	LIC	Cape Verde	LMC	Norway	
Samoa	LMC	Honduras	LMC	Central African Republic	LIC	Portugal	
Solomon Islands	LIC	Jamaica	LMC	Chad	LIC	Spain	
Trinidad	LMC	Mexico	UMC	Comoros	LIC	Sweden	
Tonga	LMC	Nicaragua	LIC	Congo, Dem. Rep.	LIC	Switzerland	
Vanuatu	LMC	Panama	UMC	Congo, Rep.	LIC	United Kingdom	
Vietnam	LIC	Paraguay	LMC	Côte d'Ivoire	LIC	United States	
		Peru	LMC	Equatorial Guinea	LMC		
		Puerto Rico	UMC	Eritrea	LIC	Other high income	
Europe and Central Asia		St. Kitts and Nevis	UMC	Ethiopia	LIC	Andorra	
Albania	LMC	St. Lucia	UMC	Gabon	UMC	Aruba	
Armenia	LIC	St. Vincent and the Grenadines	LMC	Gambia, The	LIC	Bahamas, The	
Azerbaijan	LIC	Suriname	LMC	Ghana	LIC	Barbados	
Belarus	LMC	Trinidad and Tobago	UMC	Guinea	LIC	Bermuda	
Bosnia and Herzegovina	LMC	Uruguay	UMC	Guinea-Bissau	LIC	Breton	
Bulgaria	LMC	Venezuela, RB	UMC	Kenya	LIC	Cayman Islands	
Croatia	UMC			Lesotho	LIC	Channel Islands	
Czech Republic	UMC			Liberia	LIC	Cyprus	
Estonia	UMC			Madagascar	LIC	Faroe Islands	
Georgia	LIC	Middle East and North Africa		Malawi	LIC	French Polynesia	
Hungary	UMC	Algeria	LMC	Mali	LIC	Greenland	
Isle of Man	UMC	Bahrain	UMC	Mauritania	LIC	Guam	
Kazakhstan	LMC	Djibouti	LMC	Mauritius	UMC	Hong Kong, China	
Kyrgyz Republic	LIC	Egypt, Arab Rep.	LMC	Mayotte	UMC	Israel	
Latvia	LMC	Iran, Islamic Rep.	LMC	Mozambique	LIC	Kuwait	
Lithuania	LMC	Iraq	LMC	Namibia	LMC	Liechtenstein	
Macedonia, FYR	LMC	Jordan	UMC	Niger	LIC	Macao, China	
Moldova	LIC	Lebanon	UMC	Nigeria	LIC	Malta	
Poland	UMC	Libya	UMC	Rwanda	LIC	Monaco	
Romania	LMC	Morocco	LMC	St. Fomé and Principe	LIC	Netherlands Antilles	
Russian Federation	LMC	Oman	UMC	Senegal	LIC	New Caledonia	
Slovak Republic	UMC	Saudi Arabia	UMC	Seychelles	UMC	Northern Mariana Islands	
Tajikistan	LIC	Syrian Arab Republic	LMC	Sierra Leone	LIC	Qatar	
Turkey	UMC	Tunisia	LMC	Somalia	LIC	San Marino	
Turkmenistan	LMC	West Bank and Gaza	LMC	South Africa	UMC	Singapore	
Ukraine	LIC	Yemen, Rep.	LIC	Sudan	LIC	Slovenia	
Uzbekistan	LIC			Swaziland	LMC	Taiwan, China	
Yugoslavia, Fed. Rep.	LMC			Tanzania	LIC	United Arab Emirates	
				Togo	LIC	Virgin Islands (U.S.)	
				Uganda	LIC		
				Zambia	LIC		
				Zimbabwe	LIC		

This table classifies all World Bank member economies, and all other economies with populations of more than 30,000. Economies are divided among income groups according to 2000 GNI per capita, calculated using the World Bank Atlas method. The groups are: low income (LIC), \$255 or less; lower middle income (LMC), \$256-2,925; upper middle income (UMC), \$2,926-9,265; and high income, \$9,266 or more.

Source: World Bank data.

Appendix IV : Profile of the Kyoto Protocol

In December 1997, delegates from nearly 160 nations participated in a U.N. summit on global warming held in Kyoto, Japan. During the conference, officially known as the Third Conference of Parties to the United Nations Framework Convention on Climate Change, delegates approved a legally binding treaty for countries to reduce emissions of greenhouse gases, which many scientists believe are causing global warming. Listed below are some details of the treaty:

Emission Reductions	The treaty sets a goal for 38 industrialized nations to reduce their combined greenhouse emissions by 5.2% below 1990 levels between the years 2008 and 2012. To meet that target, some countries must reduce emissions by greater amounts than others. The 15-member European Union is committed to reducing its emissions by 8% below 1990 levels, while the U.S. is bound to a 7% reduction; Japan would be required to meet a 6% reduction target. The treaty exempts several nations that are considered developed but are in the midst of prolonged economic declines, such as Russia and Ukraine, from any reductions, while other countries, including Norway and New Zealand, have agreed to much higher emission reductions. Developing countries, such as China, India and most African countries, are not bound by emission mandates but are asked to set their own voluntary targets.
Gases Affected	The treaty covers six gases, including the major greenhouse gases of carbon dioxide, methane and nitrous oxide. Three other synthetic gases-hydrofluorocarbons, perfluorocarbons and sulfur hexachloride-were also included. Those latter three greenhouse gases have also been implicated in the depletion of the ozone layer, a thin blanket of ozone gas in the upper atmosphere that shields the planet from the harmful ultraviolet rays of the sun.
Ratification Process	The Kyoto Protocol was approved by a majority of the countries attending the conference. The treaty will take effect when 55 nations, representing those responsible for emitting 55% of the total carbon dioxide released in 1990, ratify the protocol.
Implementation and Enforcement	The treaty tentatively allows for a controversial system of emissions trading. Under the system, countries that fail to reduce their greenhouse gas emissions by their target amounts may buy emission credits from those nations that are able to reduce their emissions below targeted levels. Details of the system will be hammered out during the next climate-change summit, scheduled to be held in November 1998 in Buenos Aires, Argentina. Conferees at the summit will also decide how the emission targets ought to be enforced. To date, the treaty approved in December 1997 includes no punishments or sanctions for noncompliance

Appendix V ESTIMATES OF THE COST OF CO₂ MITIGATION

<i>Country/region</i>	<i>Investigator</i>	<i>Methodology</i>	<i>Time Period</i>	<i>Cost of control (per ton carbon equivalent)</i>	<i>Strategy characteristics</i>
Global	Whalley and Wigle (1991)	CGE model	1990-2030	\$430 for 50 per cent	Combination of six different regions that impose the same rate of carbon taxation
Global	Nordhaus (1991)	Dynamic mathematical programming		10-\$430 for 5-98 per cent	Incorporation of four end-use sectors, various fuels and potential production techniques
Global	Nordhaus (1991)	Survey of results of various estimates		5-\$342 for 10-80 per cent	Combination of reduction of CO ₂ , CFCs and forestry options
United States	Manne and Richels (1991)	Macroeconometric	2020 2040	\$600 for 20 per cent \$250	1 per cent autonomous conservation; carbon taxes and regional trade in emission rights
OECD (except United States)	Manne and Richels (1991)	Macroeconometric	2020 2040	\$200 for 20 per cent \$250	5 per cent autonomous conservation; carbon taxes and regional trade in emission rights
Soviet Union and Eastern Europe	Manne and Richels (1991)	Macroeconometric	2020 2040	\$600 for 20 per cent \$700	25 per cent autonomous conservation; carbon taxes and regional trade in emission rights
China and Rest of World	Manne and Richels (1991)	Macroeconometric	2020 2040	\$40 for doubling \$250	1 per cent autonomous conservation; carbon taxes and regional trade in emission rights
United States	Chandler (1990)	Direct estimation	2020	\$118 for 20 per cent	Energy efficiency and development of additional energy supplies
Soviet Union	Chandler (1990)	Direct estimation	2005	\$16 for emission control	Structural changes, energy efficiency and interfuel substitution
Poland	Chandler (1990)	Direct estimation	2005	\$8 for 20 per cent	Structural changes, energy efficiency and interfuel substitution
United Kingdom	European Community (1990)		2005	10-\$140 for 10-30 per cent	Reduction of CO ₂ emissions from the energy sector
(Eastern Europe, OECD)	Barbier <i>et al.</i> (1990)			\$60 for 50 per cent	Potential reduction in CO ₂ and CFCs
Sweden	Bodlund <i>et al.</i> (1989)			160-\$250 for 63-74 per cent	CO ₂ reduction in the electric power sector and the sectors using electric power
Netherlands	Kram <i>et al.</i> (1989)	Linear programming		\$40 for 28 per cent	
Egypt	Blitzer <i>et al.</i> (1990)		2002	\$200-\$3135 for 15-50 per cent	Substitution is restricted to oil and gas
Brazil, Indonesia and Cote d'Ivoire	Houghton <i>et al.</i> (1987)	Direct estimation		\$2/ton (Brazil) \$15/ton (Indonesia) \$8/ton (Cote d'Ivoire)	Curtalement of deforestation

Appendix VI

SUMMARY OF THE CONCLUSIONS OF THE IPCC WORKING GROUP I ON SCIENCE

We are certain of the following:

- There is a natural greenhouse effect which already keeps the earth warmer than it would otherwise be.
- Emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases (carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxide). These increases will enhance the greenhouse effect, resulting on average in an additional warming of the earth's surface.

We calculate with confidence that:

- Carbon dioxide has been responsible for over half of the enhanced greenhouse effect in the past, and is likely to remain so in the future.
- Atmospheric concentrations of the long-lived gases (carbon dioxide, nitrous oxide and the CFCs) adjust only slowly to changes in emissions. Continued emissions of these gases at present rates would commit us to increased concentrations for centuries ahead.
- The long-lived gases would require immediate reductions in the net emissions from human activities of over 60 per cent to stabilize their concentrations at today's levels; methane would require a 15-20 per cent reduction.

Based on current model results, we predict:

- The IPCC Business-as-Usual (Scenario A) emissions of greenhouse gases ... will result in a likely increase in the global mean temperature of about 1°C above the present value by 2025 and 3°C before the end of the next century.
- That land surfaces warm more rapidly than the oceans, and higher northern latitudes warm more than the global mean in winter.
- Regional climate changes differ from the global mean, although our confidence in the prediction of the detail of regional changes is low. For example, temperature increases in Southern Europe and central North America are predicted to be higher than the global mean, accompanied on average by reduced summer precipitation and soil moisture.
- An average rate of global mean sea-level rise of about 6 cm per decade over the next century.

There are many uncertainties in our predictions, particularly with regard to the timing, magnitude and regional patterns of climate change.

Our judgement is that:

- Global mean surface air temperature has increased by 0.3°C to 0.6°C over the last 100 years, with the five global average warmest years being in the 1980s ... These increases have not been smooth in time, nor uniform over the globe.
- The size of this warming is broadly consistent with predictions of climate models, but it is also of the same magnitude as natural climate variability.
- The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more.
- There is no firm evidence that climate has become more variable over the last few decades.
- Ecosystems affect climate, and will be affected by a changing climate and increasing carbon dioxide concentrations.

Note: The 1992 Update of the IPCC Studies reported that "Findings of research since 1990 do not affect our fundamental understanding of the science of the greenhouse effect and either confirm or do not justify alteration of the major conclusions of the first IPCC Scientific Assessment".

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- www.unfccc.org
- www.worldwatch.org
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