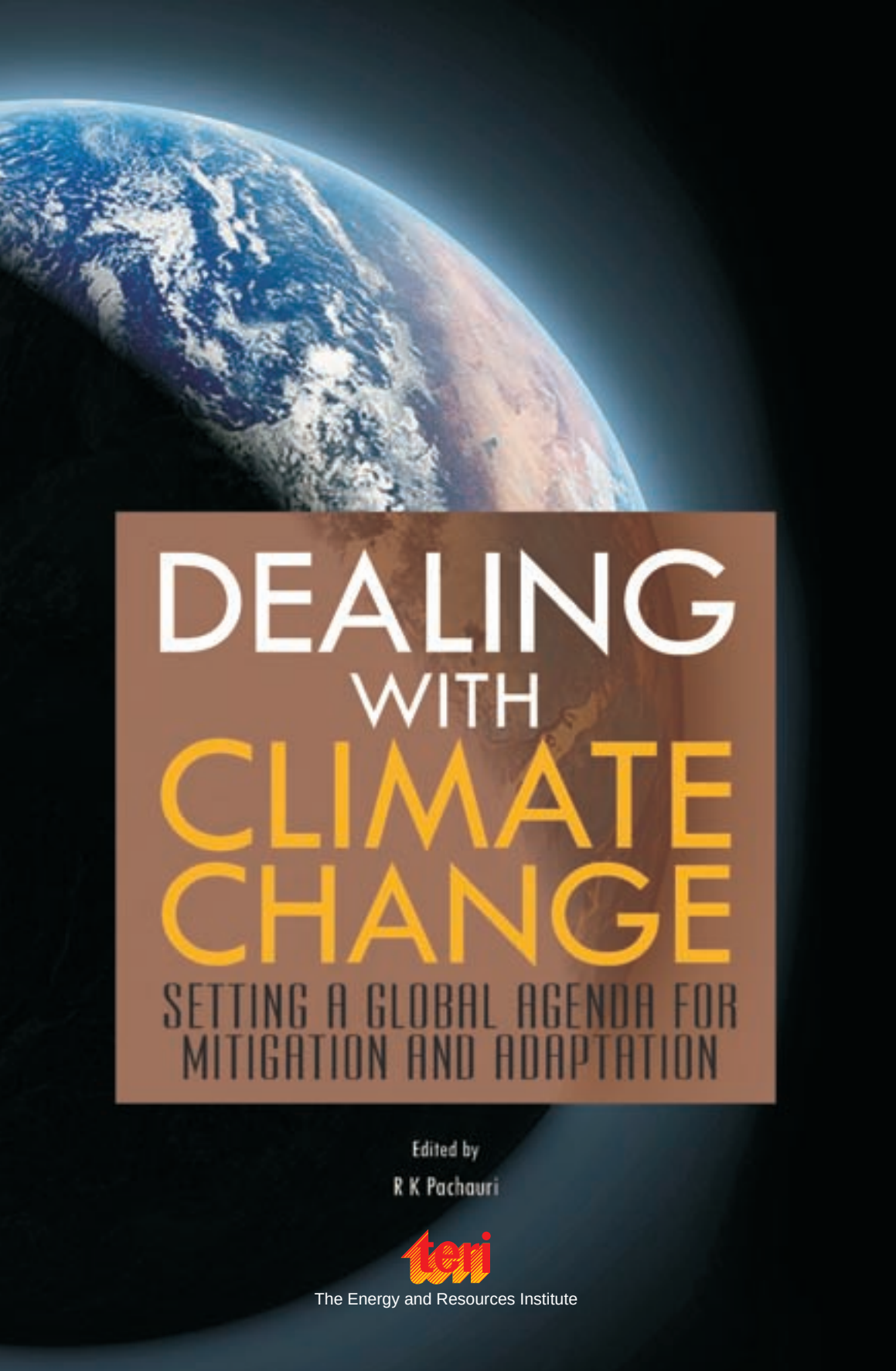

DEALING WITH CLIMATE CHANGE

SETTING A GLOBAL AGENDA FOR MITIGATION AND ADAPTATION

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The scientific assessment of climate change: new findings

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The *Fourth Assessment Report* (AR4) of the Intergovernmental Panel on Climate Change (IPCC) revealed a great deal of new scientific knowledge, which carries learning with a special value in a world where climate change has now come to occupy centrestage on contemporary global issues. But what has also been a major revelation is the learning that the world has been party to since the report itself was published. The major revelation of the period since November 2007, when the *Synthesis Report* of the last assessment was released, is the importance of information dissemination in a field that clearly has a major bearing on policies related to growth and development and every sectoral activity pursued by human society. Indeed, the IPCC has been motivated in its actions by creating reports that are policy relevant without being policy prescriptive. But what has been a remarkable advance in our understanding of the role of the IPCC has been the importance of spreading the major findings of the Panel's reports in order to establish the IPCC's policy relevance.

What has emerged from the experience since November 2007 is the fact that in democratic societies in particular, policy changes can only come about if the public desires them, and governments, therefore, sit up and take notice of what the public demands only when such a manifestation is widespread and strong. Such a shift in public perceptions and priorities, however, would come about only if they are

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informed of the rationale behind the choices that confront them. The scientific assessment of the IPCC, therefore, has to be translated into messages that the public can absorb and act on, creating a relevance on policy changes that leaders and governments will then accept and implement. Clearly, the ability and capacity of the IPCC to spread the message of its findings is limited, and therefore, there is a need for partners to work in the space of information dissemination, which the IPCC is neither equipped nor qualified to occupy arising out its own assessments.

The choice between action and inaction

The Energy and Resources Institute (TERI) has been engaged in research on climate change since 1988, and its very first piece of work in the field was carried out in preparation for a major conference that was organized in New Delhi in January 1989 with the title 'Global warming and climate change: perspectives from developing countries'. This conference was attended by leading scientists of the world, who for the first time focused on the specific conditions in the developing world and how considerations of equity, efficiency, and burden sharing needed to be evaluated in defining the role of the developing countries in meeting the global challenge of climate change, which has essentially been created by emissions that have taken place overwhelmingly in the developed world. Soon after the conference itself, TERI established a Centre for Global Environmental Research, the major focus of which was on climate change. This Centre not only conducted research but also ensured adequate attention to the dissemination of its results and the creation of awareness, which took place not only through spreading the message to the public and schoolchildren in particular, but also in advising governments and multilateral organizations on the basis of analysis that was carried out on a regular basis. Today, the world is clearly situated at the crossroads with choices that might tempt us to continue with business as usual, unwittingly creating a much greater and growing degree of climate change, the impacts of which will become progressively negative. The other choice is for us to evaluate the extent to which we must put in place adaptation measures and implement mitigation of greenhouse gas (GHG) emissions, so that the future does not impact on human society or other living species in a manner that creates unbearably negative or irreversible changes.

One guiding consideration in scientific assessment of climate change arises from Article 2 of the UN Framework Convention on Climate Change (UNFCCC), which clearly states *'The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.'*

Dangerous anthropogenic interference: the overwhelming evidence

The definition of what constitutes dangerous anthropogenic interference with the climate system is a matter that cannot be defined by science. It is an issue that involves value judgments that go beyond scientific facts and knowledge, but such a determination has to be based on science, and perhaps enabled by science. This means that the impacts of climate change cannot be evaluated on the basis of some vague average values that may define global conditions in general, but essentially these should relate to the impacts of climate change in perhaps the most vulnerable regions in the world. Clearly, what we need to do then is to see that we identify the most vulnerable regions, hypothetically speaking, and then define the conditions of climate change that would push such a location into the category of dangerous. Such an exercise can be problematic in practice both in respect of time and space.

Perhaps it is for this reason that policy-makers and, most certainly, negotiators working on the development of an agreement, both at the stage of drafting the Kyoto Protocol and an agreement for Copenhagen, have shied away from identifying the precise community or location that would be the first to face the danger from the impacts of climate change and defining what these impacts might actually be. There is, therefore, no reason to expect that the global community will come up with precision in applying knowledge to give substance to Article 2 of the UNFCCC. But we certainly need to map out the space on the global map that could be created as a result of unmitigated climate change if we continue to remain inactive in tackling the problem.

TERI has attempted to distil the information from the AR4 of the IPCC and recent developments, on the basis of which the public can be informed about where the world stands on the basis of existing knowledge in dealing with this enormous and unprecedented challenge. Consequently, it would be useful to look out where we are with scientific knowledge on the basis of work carried out by the IPCC and within the framework of what would be intelligible to the general public at large. First, we must understand the powerful findings that come out of the observational evidence that clearly provides substance to the IPCC's findings: '*Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.*' The summary of what has happened since the beginning of industrialization is best provided by Figure 1, reproduced from the IPCC's AR4.

What is significant is the fact that since the beginning of the industrial age, while global average surface temperature has fluctuated over the initial 100 years or so, the last five or six decades have clearly been marked by a clear trend of rising temperatures. This is clearly the result of human actions, which have contributed to a substantial increase in the concentration of GHGs in the atmosphere. Hence, while the previous fluctuations in temperature were the combined result of natural as well as human factors, the second half of the 20th century and the early part of this century have clearly seen the dominance of human actions over natural factors in determining temperature increase. Figure 1 also shows an increase in sea level, which during the 20th century amounted to around 17 cm. Correspondingly, northern hemisphere ice cover has gone down significantly during the second half of the 20th century.

Contributing to these changes are largely human actions, which have resulted in a substantial increase in global GHG emissions since pre-industrial times, with an increase of 70% between 1970 and 2004. This massive increase clearly highlights the ineffective nature of global action, which could have been expected to have had at least some marginal impact, particularly since the UNFCCC came into existence in 1992 and the Kyoto Protocol was ratified and came into official effectiveness in 2005. Human actions indicate a major aberration and departure not only within a time scale of the future decades but as a matter of fact, as the AR4 clearly observed: '*Global atmospheric*

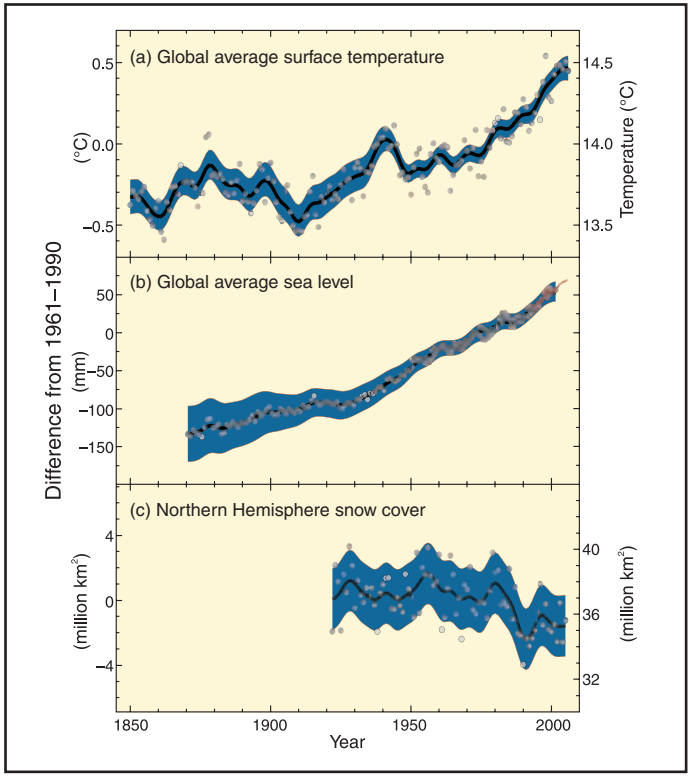

Figure 1 Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c).

Source IPCC Synthesis Report Figure SPM.1

concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.'

It is also interesting to highlight the fact that during the past 50 years, the sum total of solar and volcanic activities would likely have produced cooling. The actual observed patterns of warming and changes are simulated, as it happens only by models that include the

effects of human actions. Consequently, those who doubt the effect of the human hand in causing climate change must look at the evidence provided by the sophisticated and highly reliable models that are being used currently to simulate past actions with the inclusion of both natural as well as anthropogenic forcings. There should, therefore, be no cause for doubt that observed climate change is the result of both natural, as well as anthropogenic factors, with clearly anthropogenic forcings dominating what has happened in the last five or six decades. The importance of this finding is clearly brought out by Figure 2.

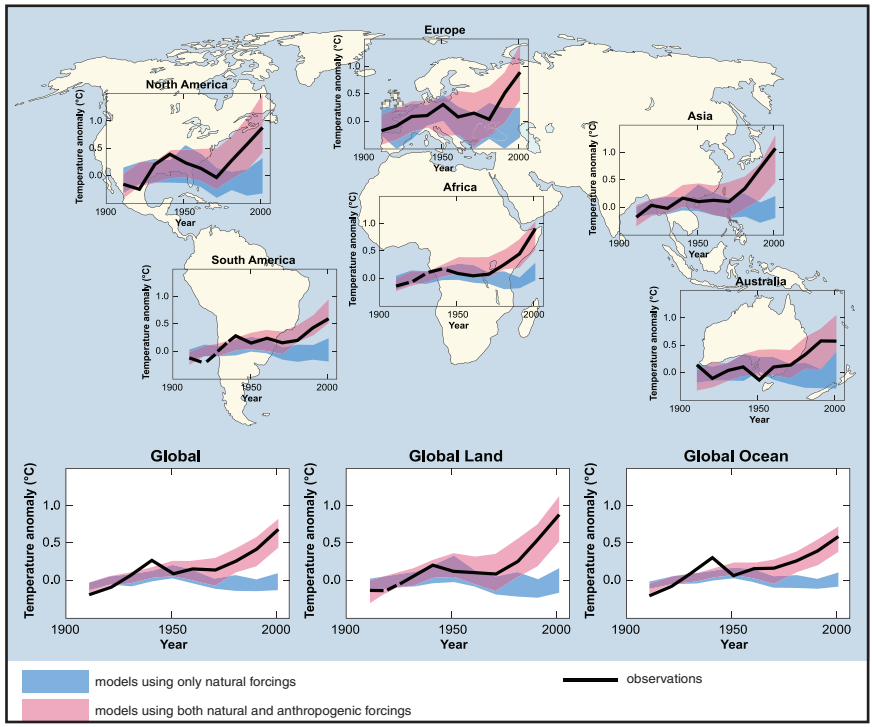

Figure 2 Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5% to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5% to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings.
Source IPCC Synthesis Report Figure SPM.4

Future projections

The IPCC has carried out projections of the future temperature changes based on a range of plausible scenarios. These are brought out by Figure 3.

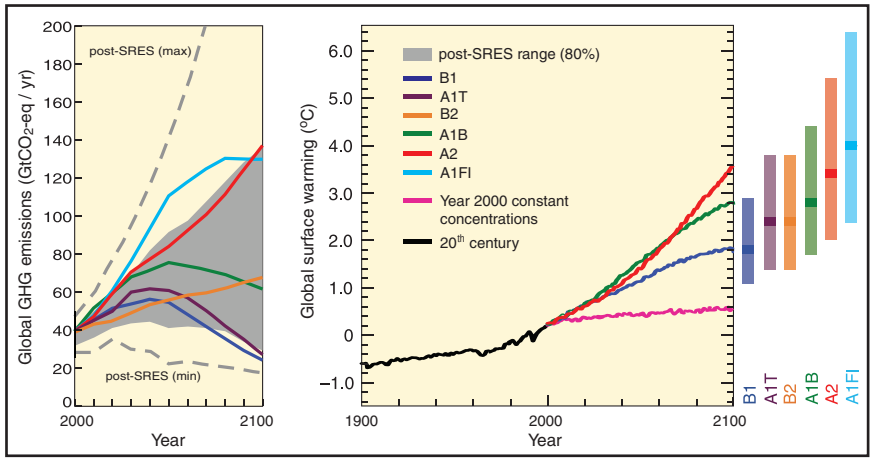

Figure 3 Left panel: Global GHG emissions (in $GtCO_2$-eq) in the absence of climate policies: six illustrative SRES marker scenarios (coloured lines) and the 80th percentile range of recent scenarios published since SRES (post-SRES) (gray shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions include CO_2, CH_4, N_2O and F-gases. Right panel: Solid lines are multi-model global averages of surface warming for scenarios A2, A1B and B1, shown as continuations of the 20th-century simulations. These projections also take into account emissions of short-lived GHGs and aerosols. The pink line is not a scenario, but is for Atmosphere-Ocean General Circulation Model (AOGCM) simulations where atmospheric concentrations are held constant at year 2000 values. The bars at the right of the figure indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios at 2090-2099. All temperatures are relative to the period 1980–99.
Source IPCC Synthesis Report Figure SPM.5

In essence, the projected increase in temperature by the end of the 21st century would likely be within a range of 1.1 °C to 6.4 °C. In order to help in focusing on what may seem a clear target for human society to work with, the IPCC pointed to a best scenario of 1.8°C at the lower end of the range and 4 °C at the upper end. It is important to understand that if we were to take even the lower end best estimate of 1.8 °C, we would reach a total increase of over 2.5 °C, given that the average increase during the 20th century has been 0.74 °C. The impacts

of climate change with this overall increase in temperature are likely to be serious for some key sectors and ecosystems. A useful understanding of the intensity and spread of these impacts is represented in Figure 4.

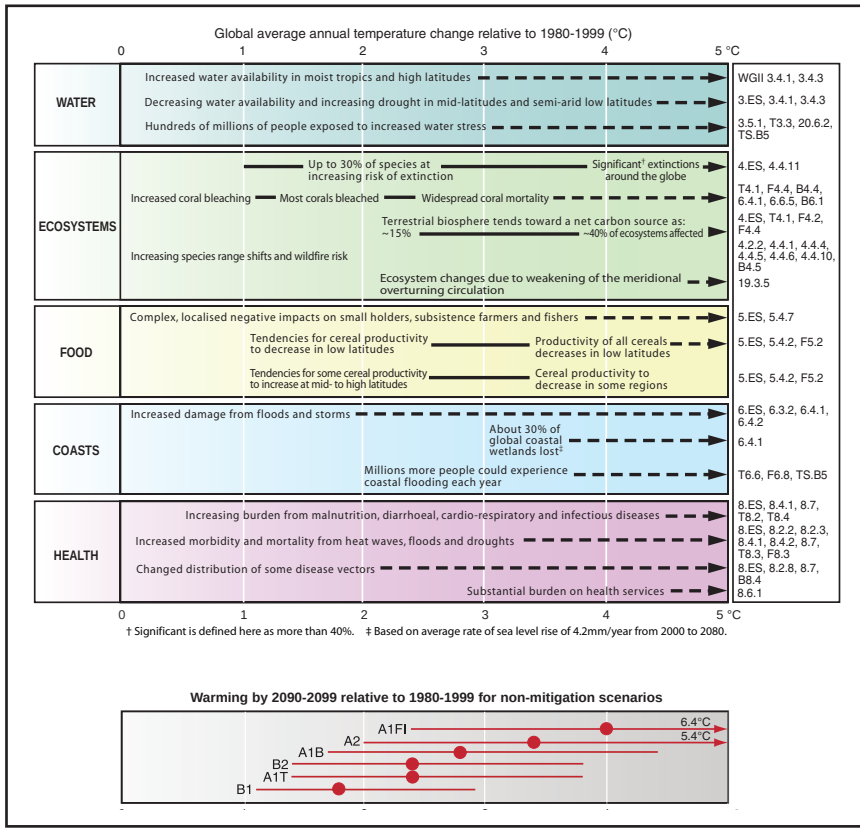

Figure 4 Examples of impacts associated with projected global average surface warming. Upper panel: Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric CO_2 where relevant) associated with different amounts of increase in global average surface temperature in the 21st century. The black lines link impacts; broken-line arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of text indicates the approximate level of warming that is associated with the onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of SRES scenarios A1FI, A2, B1 and B2. Adaptation to climate change is not included in these estimations. Confidence levels for all statements are high. Lower panel: Dots and bars indicate the best estimate and likely ranges of warming assessed for the six SRES marker scenarios for 2090-2099 relative to 1980-1999.

Source IPCC Synthesis Report Figure SPM.7

In some parts of the world, the impacts would clearly be far more serious than in other regions. For instance, the IPCC has identified the mega-deltas, which include cities like Shanghai, Dhaka, and Kolkata, as extremely vulnerable to coastal flooding. These are locations with high population density and substantial infrastructure, and given their low-lying nature and vulnerability to coastal flooding, the extent of damage and loss that could take place as a result of the current climate-related events could be very high. Other impacts of climate change include exacerbation of existing stresses such as in parts of Africa. It has been projected, for instance, that by 2020 there would be 75–250 million people living under conditions of water stress in Africa as a result of climate change. It must be kept in mind that there are communities and countries on that continent which are already under high levels of stress connected with poverty, malnutrition, widespread disease, and existing levels of water stress. In addition, as early as 2020 itself, some parts of Africa are likely to see a decline in agricultural yields for some crops by about 50%.

The Arctic region is also particularly vulnerable, with a substantial loss of see ice. This region in fact is warming at twice the rate of the rest of the globe. Particularly significant would be the possibility of abrupt and irreversible changes that could take place as a result of climate change. For instance, if any part of the Greenland or West Antarctica ice sheet were to collapse, the world would possibly face sea-level rise of several metres. This could result not only in large-scale destruction but also the problem of 700 million environmental refugees in different parts of the world.

Against this prospect of serious impacts of climate change based on the scenarios of unmitigated emissions growth in the future, two imperatives emerge very clearly. First, given the inertia in the system, and the fact that temperature increases and other changes in climate are inevitable over the next few decades, adaptation to the impacts of climate change has to be taken in hand with a sense of urgency. Second, the impacts would over a period of time reach a magnitude that would clearly exceed the capacity of communities and countries to be able to adapt. Consequently, mitigation of emissions has to be pursued with a sense of urgency and at a level that would bring about stabilization of the earth's climate.

As it happens, the cost of mitigation is so attractive and the co-benefits associated with it so important that a path of stringent

mitigation for global society is clearly an extremely attractive approach on scientific and economic grounds. For instance, to stabilize temperature increase between 2.0 °C and 2.4 °C, the extent of mitigation required would impose a cost of no more than 3% of the global gross domestic product (GDP) in the year 2030. If, however, we add the co-benefits from such a mitigation pathway – higher energy security, lower levels of air pollution and, therefore, commensurate health benefits, higher levels of employment and the benefits of avoiding negative impacts of lowered agricultural productivity – the world would incur in the aggregate negative costs related to such a path of mitigation. The IPCC AR4 also clearly concluded,

> *'Many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels. Delayed emission reductions significantly constrain the opportunities to achieve lower stabilization levels and increase the risk of more severe climate change impacts.'*

Another important conclusion that the AR4 provides was the fact that if the world wants to stabilize temperature increase between 2.0 °C and 2.4 °C, we have very little time to embark on the preferred trajectory of mitigation. In essence, global emissions will have to peak no later than 2015. This clearly emphasizes the importance of early action and the significance of an agreement that provides substance to the Bali Road Map and ensures firm commitments for reduction in GHG emissions by 2020. The Bali Road Map drawing on the findings of the IPCC *Synthesis Report* clearly states,

> *'The Conference of the Parties,*
> *Recognizing that deep cuts in global emissions will be required to achieve the ultimate objective of the Convention and emphasizing the urgency*[1] *to address climate change as indicated in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

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[1] Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Technical Summary, pages 39 and 90, and Chapter 13, page 776.

> *Decides to launch a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision at its fifteenth session.'*

Against this background, the decision by world leaders, including President Obama of United States, Prime Minister Lars Løkke Rasmussen of Denmark, and President Hu Jintao of China, among others, not to adopt a binding agreement at Copenhagen, by which the developed countries of the world would reduce GHG emissions is disappointing. In effect, this decision has been postponed to the next Conference of the Parties, to be held in Mexico. While prior developments had been pointing to such an outcome in Copenhagen, the decision by key world leaders to postpone any binding agreement in Copenhagen has been a source of disappointment for those who understand the imperatives of early action to meet the challenge of climate change.

Need for a mass movement on climate

Since 1992, when the UNFCCC came into existence, the global community has really not acted in keeping with expectations that are based on the knowledge and the scientific assessment brought out by the IPCC. In this respect, global action and even initiatives by nation states have proved inadequate and much too late. Such performance by the governments of the world raises questions on whether the nation state is really capable of taking action in adequate measure in the field of climate change. It almost seems that Mahatma Gandhi's approach of creating a mass movement through non-violence and civil disobedience may be the only possible approach for global action in the field. But such a response at the global level would require a 'global Gandhi', who is nowhere in sight today. Several years ago, there was a movement in Europe against a particular oil company, asking for a boycott of its products. Such small splinter movements have surfaced from time to time, but to get a consumer-based global response that could really help to fill up the vacuum created by the inaction of governments is an issue that cannot be treated as a likelihood in the coming years. However, if people across the globe are aroused, perhaps

this may be the only means to achieve a major global response that could make a difference towards addressing the problem of climate change, which we see becoming larger and becoming more serious in the coming years. Perhaps the following chapters of this book would help readers across the globe understand not only the nature of the problem but also some of the institutional responses that are required for the world to move on and tackle the challenge adequately and on a timely basis.

It is important for global society to accept and appreciate the inevitability of lifestyle and other changes, so that timely and adequate action can be mounted for stabilizing the earth's climate and ensuring that suitable adaptation measures are taken in hand in response to that component of climate change which has now become inevitable as a result of emissions and increase in concentration of GHGs, which have occurred in the past. The world, therefore, faces a dilemma. On the one hand, there is urgency in responding to the challenge of climate change, so that its impacts do not overwhelm the ability of human society to function on a stable and secure basis. On the other hand, there is a certain social inertia in the system, which favours the continuation of existing lifestyles and patterns of production and consumption that have built up over several decades. As would be expected, continuation of business as usual has the support of a large range of vested interests, who would indulge in widespread advertising and the services of lobbyists to ensure that action is thwarted or delayed for as long as possible. What we are seeing today is perhaps a combination of these factors. The issue really is one that requires individuals going against the tide of social pressures and practices, which have become deeply ingrained in most societies across the globe. Grassroots actions to mitigate climate change on a sizeable scale would require almost a revolutionary fervour, more or less similar to what a leader like Gandhi or his great follower Martin Luther King was able to achieve. We need to ask whether another Gandhi might emerge on the scene to provide direction to the current generation, which is still young and would face the real consequences of climate change. Perhaps, action by civil society, businesses, research and academic institutions and government at all levels would create the conditions for several Gandhis to emerge in due course, and take up this challenge in different parts of the world.