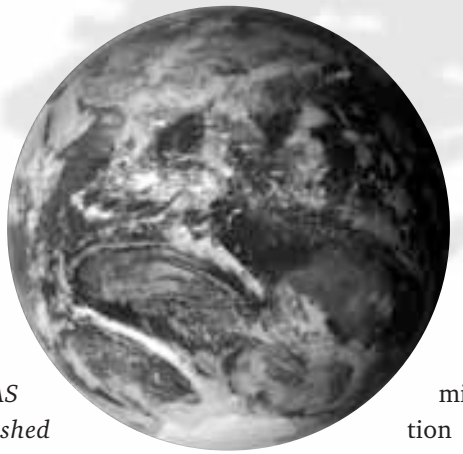
A NEW CLIMATE FOR CHANGE

WHAT WILL CLIMATE CHANGE MEAN FOR THE DEVELOPING WORLD, AND WHAT STEPS NEED TO BE TAKEN TO MITIGATE THE IMPACT OF CLIMATE CHANGE AMONG THE WORLD'S POOREST PEOPLE?



In the following article, Jagadish Shukla and Daniel Schaffer describe the current state of scientific knowledge on climate change and explore a range of measures that might be taken to meet the complex challenges that it poses to the Earth's well-being. Shukla (TWAS Associate Fellow 1995), Distinguished University Professor of Climate Dynamics at George Mason University and president of the Institute of Global Environment and Society, USA, is one of the world's foremost climate modelers. He recently served as a lead author for the Intergovernmental Panel on Climate Change (IPCC) Group 1 report, which examined the full range of scientific evidence that is driving our understanding of this critical global issue. Schaffer, the TWAS Public Information Officer, has written extensively on science and technology issues in the developing world.

Climate change issues have been in the news a great deal lately. And that's all for the good. The altering of the Earth's climate, after all, could be the most critical issue that the world has ever faced. As Albert Gore, who shared the 2007 Nobel Peace Prize with the Intergovernmental Panel on Climate Change (IPPC), noted in his Nobel address:

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

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

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

It is fair to say that a global consensus has now been reached on the risks that climate change poses for the global community. Australia joined the Kyoto

Protocol in December 2008. China and India have agreed that the risks created by global warming must be addressed now and not in the future (although not at the expense of economic growth), and even the current government in the United States, which has been the most skeptical and obstructive member of the global community when it comes to addressing issues related to climate change, has recently acknowledged that it is a problem that demands the world's attention.

The key question is no longer whether climate change should be a central global concern (indeed many now believe that it is a global emergency). Instead the key question now is how climate change will manifest itself regionally and what can we do about it.

FOLLOWING IPCC'S LEAD

IPCC has been the primary institution responsible for increasing public understanding of the climate change issues. The way in which IPCC has functioned provides a valuable model for others to follow when addressing global concerns of great consequence.

The principles of the IPCC are there for all to see: the creation of a broad international operational framework led by the world's top scientists; meticulously prepared, peer-reviewed publications; clear and concise demarcations between various aspects of the problem (scientific evidence, mitigation, adaptation); in-depth analyses of each issue based on the most current and well-respected scientific findings, accompanied by crisply written summaries designed for an educated lay audience. The latter are not dummy-downed versions of the scientific reports but comprehensive analyses of the nature of the problem intelligently written for the audience in mind.

Indeed the most important contribution of the IPCC has been to lay out, in an understandable and convincing way, what scientists know about the problem and what broad options, in its learned opinion, may be available to address this challenge – provided that society chooses to do so. And that's a key point: It's not up to the scientific community to act; it's up to society.

The IPCC may well represent a revolutionary strategy for presenting scientific findings of great import. But in most ways, its methodology – and, more generally, its way of operating – are as old as science itself: Conduct a thorough investigation; engage in careful and unbiased analysis; be assured that there is consensus within the scientific community on the issues for which you draw conclusions; and be prepared to

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The Earth has a fever, and the fever is rising.

revise, even change the assessment, if new data and information lead to a new conclusion.

QUESTIONS AND ANSWERS

As we approach this critical juncture in discussions on climate change – a time when both the global community and national governments seem poised to meet the challenges that rising levels of greenhouse gases pose to the planet's well being – it might be useful to look back and examine exactly what the scientific community knows about the issue (and what it doesn't know). It would, however, be even more useful to look forward, outlining the next steps that the scientific community needs to take to refine its knowledge and to determine the level of resources it will need to do so.

More generally, at this critical juncture in the discussion, we should take time to examine the questions and issues that the scientific community cannot answer, or that can only be answered by society itself.

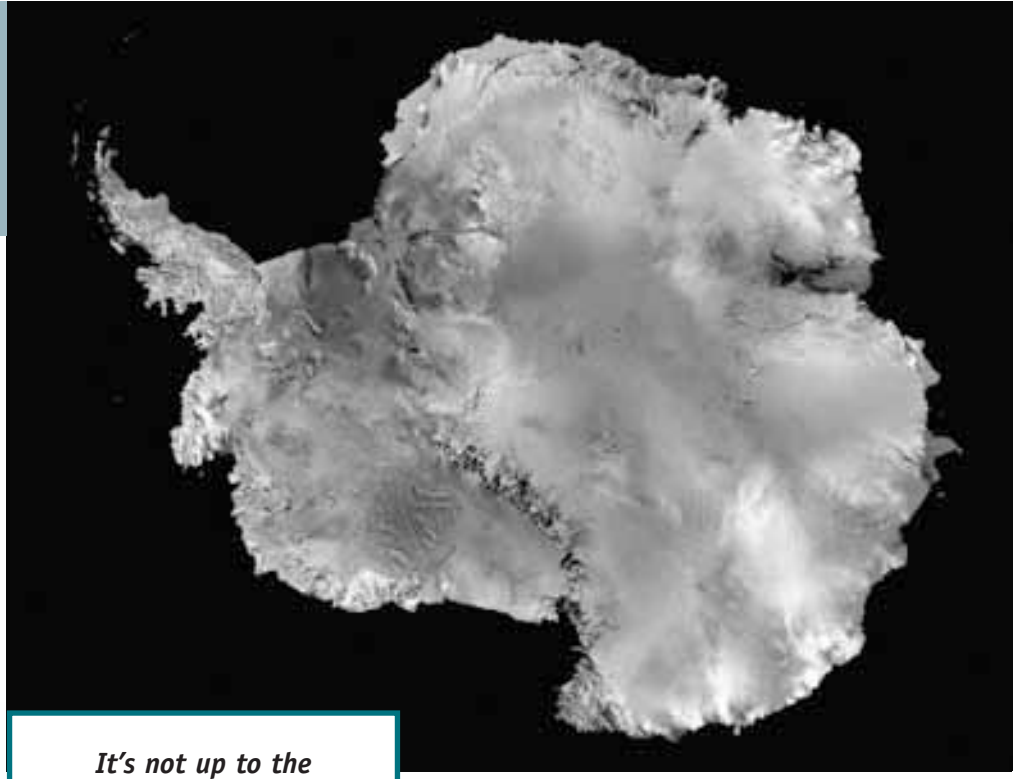
For example, what are the tradeoffs that exist between near-term economic development and long-term economic sustainability? What mechanisms should be put in place to ensure that those who have been least responsible for the problem are not the ones most burdened by climate change's anticipated impacts? What role should technology – new and old – play in efforts to combat global warming and its consequences, and at what costs financially? What role should societal reforms play (for example, broad efforts to change patterns of consumption and production) and at what costs to individuals and communities? And how can we devise an effective strategies for dealing with climate change issues when there is so much that we still don't know in terms of regional impacts, the pace of the change and the unsettling prospects for reaching tipping points from which there will be no turning back.

In a sense, then, it might be useful to create a research scorecard listing the knowns, the unknowns and the unknowables.

INSTITUTIONAL MANDATE

The IPCC was established in 1988 by two United Nations organizations: the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). Its mandate is to assess scientific, technical and socio-economic information relevant for the understanding of climate change. The IPCC is also authorized to examine potential impacts and possible options for adaptation and mitigation when dealing with climate change. Since its inception, it has produced four sets of 'assessment' reports – in 1990, 1995, 2001 and 2007.

Each series of reports has drawn its conclusions from a stronger base of scientific evidence and each has reached more convincing conclusions that human activities are the primary cause of the climate change, that the pace of change is accelerating, and that the impacts are becoming more troublesome and intractable. Indeed the last report concluded that the: "Warming of the climate is unequivocal, as is now evident from observations of increases in global aver-



age air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

Three separate working groups have been responsible for the work of the IPCC: the physical sciences (working group 1); impacts, adaptation and vulnerability (working group 2); and mitigation (working group 3).

KNOW THIS

IPCC's assessments have been able to draw a detailed portrait of atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the past 10,000 years, thanks largely to their ability to measure isotopes lodged frozen in ice cores.

What scientists have observed is that concentrations of these gases remained stable for thousands of years until about 1750 when the levels of gas began to rise in parallel with the industrial revolution. What scientists have also observed is that the level of carbon dioxide, the primary greenhouse gas, has risen more than 80 parts per million (ppm) or 25 percent since 1970, and that the levels of methane and nitrous oxide have also increased substantially during the same period. All told, in 2005 greenhouse gas concentrations in the atmosphere were at a level of about 380 ppm. In 1750, the figure stood at 280 ppm; in 1850, it still registered 280 ppm; and in 1950 it was 300 ppm.

At the same time, a rise in mean global surface temperature of about 0.7 degrees Centigrade in the last century has been observed. This rise in temperature followed on the heels of a slow, virtually imperceptible, increase in temperature during the previous 150 years. Thus it seems that the greenhouse gas buildup that began in 1750 took some time to gain momentum and exert its impact. However, as we have continued to emit these gases into the atmosphere at ever-higher levels, the pace of warming has accelerated.

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And there's more. Eleven of the past 12 years have been the warmest on record. And, in the past 500 years, the average warmest temperature for any 50-year period took place between 1951 and 2000.

Temperatures are not the only factor to consider. Ocean acidity is increasing. Scientists have found an annual 1.8 millimetre rise in sea levels since 1961. If we begin calculating the average in 1993, the annual rise in sea levels jumps to 3.1 millimetres. The ice mass floating on the Arctic sea has been reduced by 2.7 percent per decade since 1978, and in 2007 scientific surveys indicated that the Arctic's ice mass had shrunk to a record low level. Recently, scientists have observed even more alarming evidence of loss of Antarctic ice mass.

There have also been enhanced run-offs and an ever-earlier peaking of springtime discharges from many glacier- and snow-fed rivers. The number of hot nights has increased across climate zones while the number of days with frost has decreased. Flowers and trees now bloom earlier in spring and an increasing number of plant and animal species are moving into new habitats at higher elevations and closer to the poles – habitats that were once too cold, but are no longer. Algae and plankton seem to be thriving and

expanding their presence in global waterways, responding to the warmer temperatures and longer summers.

This is what the scientific community has assessed and accepted. Its efforts have provided irrefutable evidence that the levels of greenhouse gases in the atmosphere have increased substantially since 1750 and that the pace of the increase is now accelerating. The scientific community has also shown that surface temperatures are climbing, that ice packs and glaciers are receding; that sea levels are rising; and that both plants and animals are responding to the changing climate and ecological changes that inevitably result from altered temperature and changing patterns of precipitation. These are observed and irrefutable facts. Recording the changes in a systematic way, backed by scientific analysis, provides a vast storehouse of evidence that is beyond challenge.

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But is the relationship between rising greenhouse gas emissions and the world's changing climate a provocative but unusual coincidence or does it carry the weight of a proven scientific correlation?

Here's what scientific studies and modelling tell us. First, there is no scientific model that can explain the past 50 years of observed global warming without turning to the increased levels of greenhouse gases as the drivers of climate change. Put another way, there is no other mechanism known to scientists that can explain what is behind the warming of the atmosphere, ocean and land except the spilling of large amounts of greenhouse gas into the atmosphere. These gases are the only suspects and, according to the models, they stand guilty as charged.

But the models can help us look forward as well as backward, assisting us in anticipating the changes that lie ahead under different scenarios. Scientists agree, for example, that both global temperatures and sea levels will continue to rise for centuries regardless of whether current levels of greenhouse gas emissions are stabilized in the near future. That's because the gases continue to reside in the atmosphere long after they have been released. Indeed, we will live with the legacy of greenhouse gas emissions for centuries, and we will have to devise policies for this reality even if we succeed in significantly curbing the levels of future emissions over the next few years.

Scientists also agree that in addition to a rise in temperatures we can expect an increase in the frequency of heat waves and heavy rains. That is because a hotter atmosphere 'carries' more water, and more

water in the atmosphere will fuel more intense weather. And, finally, there is now a consensus that the Arctic sea ice will disappear in the late summer months by 2100 with a potentially significant ecological impact worldwide.

WHAT WE DON'T KNOW

The knowledge base is both impressive and growing. But there is plenty that scientists still don't know. For example, despite all of the evidence they have gathered about climate change, scientists cannot predict the occurrence of a single event. Put another way, scientists know that there will be changes in the frequency of storms and that these storms will be more intense, but they cannot tell where or when a hurricane with the clout of Katrina or a cyclone with the force of Vance will strike.

On a less dramatic note, scientists cannot predict the degree of climate change that is likely to occur at a regional scale. That's because today's computer models have a resolution of 200 square kilometres. Analysis at a regional scale will necessitate computers with a resolution of 20 or, preferably, 10 square kilometres. This can only be done with computers 10,000 times faster than those operating today.

Scientists, moreover, cannot predict if and when the Greenland ice sheet will melt. That's an important piece of information because if it happens, sea levels will rise on average by 7 metres, placing many coastal cities under water. Scientists do not yet know whether the Antarctic ice sheet is too cold to melt or whether, instead, it will gain mass due the additional snowfall that will accompany a wetter climate. Scientists do not know, as well, the level of species extinction that may occur as a result of global warming, although estimates suggest that a rise of 1.5 to 2.5 degrees Centigrade could cause a 20 to 30 percent loss in species and that a 4 degree rise could result in a 40 percent loss worldwide. And scientists do not know the reduction in the amount of carbon absorption that might take place in the oceans, a potentially aggravating factor that could intensify the impact of greenhouse gas emissions.

DELAY AND PAY

Some political leaders say that addressing the climate change issue too aggressively could impede economic growth. What the skeptics prefer not to talk about is this: Dithering in our response has adverse economic consequences too. Think of foregoing maintenance on the roof of your house. It may keep money in your pocket now, but it would likely cost you much more in the future as the slow leak spreads and leads to more serious roof and structural damages.

That is exactly the point of the 2006 Stern Review on 'The Economics of Climate Change.' Nicholas Stern, a scientist who served as economic advisor to the

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British government and who now holds the IG Patel Chair at the London School of Economics and Political Science, has warned that ignoring the impacts of climate change today will undermine economic growth in the future as the pace of global warming and the damages it inflicts on society accelerate and intensify. Damages, he asserts, could be on the scale of global conflicts such as World Wars I and II or comparable to the global economic depression of the 1920s and 1930s.

But unlike these past events, once the full force of global warming takes hold, Stern asserts that it will be difficult to reverse. In short, he maintains that the earlier we act, the less costly it will be. And since the most vulnerable citizens among us are likely to be those who suffer the most, mitigating global warming's impacts will help the people most in need. Stern even places a monetary value on efforts to act quickly and effectively. He estimates that measures taken to stabilize greenhouse gas emissions at 550 ppm by 2050 will shave 1 percent from the annual global GDP. If we procrastinate and do nothing, however, Stern counsels that economic losses due to climate change – as a result of storm damage, declining agricultural yields, population relocations and other factors – could slice annual global GDP by 5 percent over the same period.

Nicholas Stern

The lesson is this: Pay now or pay later. If we choose to pay later, we will pay more, a great deal more.

As we move into the future, the scientific community can help inform the public about the pace and risks posed by climate change. But like the rest of society, it must also operate in a world of unknowns.

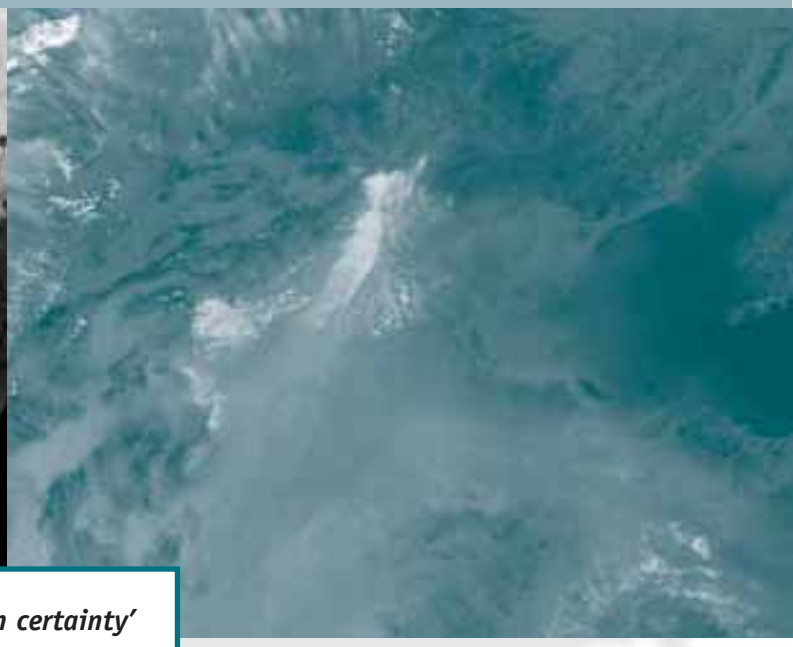
Scientists, for example, know that substantial adaptation and mitigation of climate change's impacts can be achieved with existing technology. But they cannot predict what breakthroughs in science and technology might take place in the future, leading, for instance, to viable alternative sources of 'green' energy or effective systems to capture and store carbon.

Scientists also know that important steps can be taken to relocate large numbers of people from coastal areas that are most vulnerable to rising sea levels. But they cannot predict if or when such measures will be taken.

Scientists know, as well, that abrupt and catastrophic changes are possible as a result of climate change but they cannot determine if or when such tipping points will be reached.

And, scientists understand the broad dynamics of climate change but they cannot say with any degree of specificity what the climate will be like in 2050 or 2100, especially at a regional or local level.

In a political world where decisions are often short-term and where leaders cherish detailed information providing a clear roadmap for action, the 'uncertain certainty' of climate change creates a serious handicap for devising initiatives that bring scientific findings into the policy arena.



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TALLYING UP

So here's the scientific scorecard as it stands today.

Is global climate being affected by human activities? The answer is an unequivocal yes.

Can it be mitigated and contained? Again, the answer is yes. But only if we act with the sense of urgency that the issue demands and only if we are able to get all of the main players – from both the developed and the developing world – on board.

Will we succeed in meeting the challenges of global warming? That is not an issue for the scientific community to answer. Scientists can inform. They can present and analyse trends and options. They can project the future based on the best scientific data and models available. But they cannot initiate action on their own; nor would society want them to.

Global climate change is a global problem that will require global action. Scientists have presented a compelling portrait of what is happening and have convincingly outlined what may unfold in the future. But society must ultimately shoulder responsibility for doing something about a problem that UN Secretary-General Ban Ki-Moon has called the "defining issue of our era".

So, will society act? That's an open question that remains to be answered.

The climate of opinion is changing for the better. The climate itself is changing for the worse. Humanity is in an unprecedented race in which we are competing against ourselves. The race is not 'we' against 'them'. It is a race of 'us' against 'us'. So the question is ultimately not which one of us wins, but whether we can work as one to successfully solve this problem together. ■

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