

Keynote Address

RAJENDRA K PACHAURI
CHAIRMAN OF THE
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INTRODUCTION

Prof. Obasi, Chairman of this inaugural session, Excellencies, distinguished ladies and gentlemen. It is a great privilege for me to participate in this event, and I am indeed happy that preceding my address, we have just heard a moving story which brings in the human dimension into a subject which most of us evaluate only in terms of numbers and statistics. Indeed the human aspect of the harmful impacts of climate change are difficult to quantify and, therefore, generally ignored. I am even happier to see that the distinguished ministers who have spoken before me have displayed great knowledge on the subject of climate change, energy and water. I would not be remiss in assuming that much of this knowledge has come from the work of the IPCC, and I would like to pay tribute to my predecessors for having led such an outstanding effort which has resulted in the high credibility and usefulness of the IPCC. This also convinces me how important it is for the IPCC to reach out to decision makers and the public at large.

Water is a fundamental resource, vital for the survival of people and ecosystems, and the growing scarcity of this resource in several parts of the world is already reaching crisis proportions. Even since the world became aware of the climate change issue, it has been widely recognised that changes in the cycling of water between land, sea, and air would have significant impacts across many sectors of society, the economy, and the environment.

In the IPCC's Third Assessment Report (the TAR), it is concluded that:

“Increasing global surface temperatures are very likely to lead to changes in precipitation and atmospheric moisture, because of changes in atmospheric circulation, a more active hydrological cycle, and increases in water holding capacity throughout the atmosphere”. (Section 2.5.1 of the WG I report)

Of course this trend in precipitation change due to global warming will not be uniform across the globe.

Analysis of the trends in annual precipitation over the last century, based on historical data, shows decreases in a number of sub-tropical areas, particularly the Sahel, the Middle East, China, and western Australia, and increases in the mid- and high-latitudes and in certain tropical areas, most notably the east coast of Africa and India. (TAR, WG I Figure 2.25(ii))

But these are historical data – what of possible future trends in a warming world? What are the likely changes that would occur in the hydrological cycle due to global warming, and how best do we plan to adapt to these changes since it is now well accepted that under the most optimistic Kyoto outcomes a significant level of climate change is inevitable?

The TAR, Working Group II Report: “Impacts, Adaptation and Vulnerability” (Chapter 4), describes our current assessment of these issues.

USING CLIMATE MODELS

This assessment, of the likely changes to the hydrological cycle from global warming, is largely derived from published studies of the use of General Circulation Models (GCMs) coupled with smaller, catchment scale, hydrologic models.

GCMs are based on physical laws represented by mathematical equations that are solved on a three-dimensional grid over the globe. The solutions are obtained using high-powered supercomputers. Generally speaking, the greater the power of the supercomputer the finer the grid and/or the more complex the model that can be integrated forward in time to provide an estimate of the climate when greenhouse gas concentrations (for example) are increased according to some pre-specified scenario.

There are a number of major drawbacks in using these models.

The first relates to scenarios.

Any projection of future climate change is based on scenarios. These scenarios are idealisations of the rates at which greenhouse gases will be emitted in the future and there are, of course, widely varying estimates of just what these emission rates will be.

Secondly, when studying the impacts of changes in the hydrological cycle there is a scale mismatch between the GCMs, that might only have a grid point every 200 km or so, and the catchment scale hydrologic models, where the entire catchment might fit within three, or less, grid points of the GCM.

Thirdly, there is a temporal scale issue. Generally, GCMs provide monthly mean data, whereas catchment scale models require hydrologic data (rainfall or streamflow) on daily or hourly time scales.

Nevertheless, the TAR WGII report summarises the trends in precipitation due to global warming, as assessed from published reports of combined GCM/hydrologic model studies. According to these, there is likely to be:

- (1) an increase in annual precipitation in high- and mid-latitudes and most equatorial regions;
- (2) a general decrease of annual precipitation in the sub-tropics;
- (3) small changes in annual precipitation, even by 2080, when compared with natural multi-decadal variability;
- (4) increased frequency of heavy rainfall events as the world warms;
- (5) a smaller proportion of precipitation may fall as snow (decreasing snow pack), thereby increasing winter run-off, but diminishing spring (snow-pack melt) run-off commensurately.

RIVER FLOWS

There have been many studies of historical data to determine trends in river flows.

The results of these studies vary substantially between geographical regions, with increased flows in some catchments, decreases in others. Where trends are identified it is often difficult to separate out those caused by global warming from those caused by natural climatic variability, or from changes to the catchment (e.g. land clearing, urbanization, altered drainage systems, etc.).

What is clear, however, is that the data records used to analyze changes in river flows are generally poor (with some notable exceptions) and not widely exchanged. Furthermore, the TAR notes that river monitoring stations are continuing to be closed (WG II Section 4.3.6.1, pg. 202).

There is a critical need to improve our assessment of river flows, as the impact of climate change on river flow goes beyond the issue of water supply. Changes in river flow or even its regime have the potential to affect hydropower generation, which in turn has developmental implications. This aspect is highly relevant for countries, which have large share of hydro electricity. Most of the power generated in several countries in Africa such as the Republic of Congo, Ethiopia, Mozambique, and Zambia comes from hydropower. In Paraguay and Brazil, about 99% and 87% of the electricity is from hydroelectric sources respectively. In the Indo China region, where vast hydropower potential exists, altered river flow characteristics could hinder the development of this source of energy. Such impacts could be critical for small countries like the Lao PDR, which earns significant amounts of foreign exchange through the export of electricity generated from hydro sources.

If we are to detect climate change and its economic and ecological impacts, and respond appropriately we will need to monitor the earth's systems, particularly those in the hydrologic cycle, properly. We cannot afford to reduce our monitoring efforts.

CRITICAL IMPACTS

Two particular aspects of the hydrologic cycle are of particular importance: floods and droughts.

Floods

It was clear at the time of preparation of the TAR that GCMs could not simulate with acceptable accuracy short duration, high intensity, localised heavy rainfall events that would give rise to floods.

To date, changes in the frequency of floods have been inferred by assuming that all amounts of rainfall in a month change in proportion to the change in monthly mean. That is, when a GCM shows an increase in rainfall over a catchment on a monthly mean basis, the frequency of heavy rain/flood events is assumed to increase proportionately. For monsoon-affected catchments such as the Brahmaputra, Ganges, and Meghna one GCM study, using this assumption, indicates the flood discharge for these rivers would increase by 6%, 15%, and 19%, respectively, for a 2° C global warming.

Drought

Modelling studies of drought, as reported in the TAR, are less extensive than for floods.

Using the same assumption as before, that climate variability remains constant and a reduction in mean rainfall will lead to a proportionate increase in periods of both hydrological drought (river or ground water levels are low) or water resources drought (when low river or ground water levels impact water usage) enables some tentative conclusions to be drawn about drought in a warmer world. Apart from the shift in mean precipitation, studies have also projected increases in interannual as well as inter seasonal variability of the Asian summer monsoons under increased greenhouse gas concentrations. The increased variability would increase the probability of flood and drought incidences in the region covered by this monsoon system.

Generally, the areas likely to experience more droughts are those where rainfall is expected to diminish – that is, in the sub-tropics such as the Sahel, the Middle East, China, and western Australia. Such changes in global rainfall patterns would have serious implications for various sectors. Climate change induced changes in the hydrologic cycle would have serious consequences for the agricultural sector in most developing countries, which also holds at stake the livelihood security of the poorest sections of the population in these countries relying on agriculture. For instance, in Africa alone about 70% of the population depends on farming, and crop production and livestock husbandry accounts for about half of household income. Under these circumstances, climate change impacts on agriculture are projected to be significant, particularly as much of the agriculture is rainfed. This holds true for several other developing regions of the world such as South Asia.

LESSONS FROM THE TAR

In summary then, the TAR highlights that there are major uncertainties associated with the current studies of the impact of climate change on the hydrologic cycle. Furthermore, it noted that by 2025 about 60% of a larger world population is expected to be living in such water-stressed countries.

It is becoming increasingly clear that many societies will have to adapt to the impact of climate change on the hydrological cycle. They will have to adapt to an increase in drought in some areas, and to an increase in floods in others.

Since our predictive capability in this area is not particularly high, it is useful to examine our adaptive capability.

There is a long history of successful adaptation, by water system managers, to changing circumstances relating to:

- (1) the availability of water;
- (2) the technologies available to deliver water to users; and
- (3) the demographics of those using water.

The options in such adaptation fall broadly into two classes:

- (1) supply-side management: adapting the water supply infrastructure of dams, pipelines, etc., to adjust to the changed circumstances. We have just heard His Excellency Mr Kasrils who gave us extremely valuable information and data on the gaping disparities between the developed and the developing countries in terms of storage capacity of water per capita. His figures are extremely compelling and provide a substantial basis for action in the developing world to enhance water storage capacity for the purpose of flood control and even distribution across time and space.
- (2) demand-side management: changing the incentives faced by water users so as to change their pattern and extent of demand for water.

This means that we would need to adopt technologies that minimise the use of water without adversely affecting the activities for which it is used. This would be particularly true of agriculture, but even in the industrial sector those processes which require water would need to be improved to manage with lower consumption of water in the future.

It seems clear that the existence of climate change exaggerates the pressures currently being experienced by water managers, and, additionally adds a new level of uncertainty. The most crucial aspect of the climate change uncertainty is the possibility that climate-induced effects may be non-linear, carrying potential surprises beyond those already considered and modelled.

The TAR identifies those factors internal to a country that affect its capacity to adapt to changes in the hydrologic cycle due to global warming (WG II Section 4.6.4):

- (1) The overall capacity, including the depth and range of skills of the staff of its water-related institutions, and authority of these institutions to act in response to changing circumstances
- (2) The legal framework for water administration. To what extent does it slow a response to changing circumstances? To what extent does it call for a sustainable management regime for water? To what extent does it give national policy makers control over the nation's water resources?
- (3) The wealth of the nation in terms of eco-systems, human capital (eg trained personnel), and human-made capital (eg water control systems)
- (4) The state of technology and the framework for the dissemination of technology
- (5) The mobility of populations to change residential locations and economic activities in response to severe climate events or climate change
- (6) The complexity of national management arrangement - in general, the fewer the number of agencies involved in water management the more rapid the response to change can be
- (7) The availability of accurate and timely hydrologic data within a framework that enables managers and policy makers to assess hydrologic system changes and to develop proper policy responses.

It is a challenge for all of us to assist developing nations to build their capacity to adapt to that amount of global climate change that is already inevitable. The TAR points to the areas of need, the challenge is to meet these needs where there are identified national deficiencies. His Excellency Mr Kasrils has talked about the "polluter must pay principle" being applicable at the global level. Prof. Obasi has given us the startling estimate of an 11.6% drop in GDP in Mozambique as a result of the floods that took place in that country. This raises the question of global equity in the context that one set of countries has created a global

problem, the ill effects of which are suffered by another set of countries. Should the polluter not pay for the damage thus caused?

THE FOURTH ASSESSMENT REPORT OF THE IPCC

To conclude this address let me tell you how I believe the IPCC's Fourth Assessment will help reduce some of the uncertainties that confront decision makers involved in water management.

I expect by the time the Fourth Assessment is well underway, in say 2005 or 2006, Regional Circulation Models would be developed to resolve catchment scale features with higher confidence and are capable of providing daily data and simulate weather events that give rise to floods and hydrological droughts.

I hope that the literature provides studies where these RCMs have been validated using both paleo-climate data and improved streamflow, run-off, and precipitation data sets.

I would hope that the scenarios for these studies have been developed such that they are not only consistent with the global emission scenarios used by the IPCC, but also on a regional or catchment scale.

I expect that these scenarios, and the GCM and associated hydrologic model outputs, will be used in a variety of formal risk assessment models to give decision makers a scientifically sound basis for assessing policy options in the face of the considerable uncertainty that will still exist. I would, therefore, like to put forward a plea on this occasion that much greater research should be initiated in the area of climate modelling which can also shed some light on its impacts on vital resources such as water.

I anticipate that in developing policy options, a mix of supply- and demand-side solutions will become available, which can be assessed more accurately.

This raises the issue of the importance of socio-economic implications of climate change which I hope the Fourth Assessment Report will be able to do adequate justice to.

And finally, I expect that in its Fourth Assessment the IPCC will be able to evaluate and report on the various legislative, economic, and technological tools available to decision makers so that they are able to properly respond to changes in the hydrologic cycle resulting from global climate change.

I have had the privilege of meeting the greatest leader of our time, Mr. Nelson Mandela, and when he came to New Delhi on one occasion he reminded us that we had sent a young lawyer to South Africa and that South Africa sent back to India 'a great leader and the father of the nation, Mahatma Gandhi'. It would be appropriate for us to remind ourselves of Mahatma Gandhi's emphasis on 'Antyodaya' which in Hindi means the benefit of the last. In all that we do we must pay adequate attention to the impacts of global phenomena on the lives of the dispossessed and the most underprivileged, that is, the time has come for us to concern ourselves with the welfare of the last.

Thank you.
