



Tackling Tomorrow's Challenges Today



Climate Change and Water



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Foreword



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In the last meeting of the Patrons of the WSDF (World Sustainable Development Forum), a suggestion was made that the Forum in its research activities should focus on sustainable development and water. A dialogue was initiated, as agreed, between the Earth Institute, Columbia University and the group dealing with Water Resources and Management at TERI. Some tentative plans were developed and efforts were made to seek support for a major activity in this area, which unfortunately, have not progressed sufficiently. One reason why we have not been able to take in hand a major global study is because the two research groups have been overtaken by other activities, which would ultimately strengthen any global study or assessment of water for sustainable development that is undertaken within the ambit of the WSDF. For instance, TERI has carried out a comprehensive exercise on watersheds in India for some specific industry groups that

depend directly on processing water in their production. The insights and knowledge created from these activities would provide invaluable insights and information for evaluating options for water supply particularly in rural areas of developing countries.

Another major development has been the release of the Fourth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change), which has provided projections of the impacts of climate change on water in several parts of the world. This would have profound implications for water availability and management in several parts of the globe. In addition, the IPCC is now bringing out a consolidated technical paper on climate change and water, which would provide valuable consolidation of knowledge on

the entire water cycle and its nexus with climate change.

All in all, therefore, considerable work has been done which could perhaps be brought together now in the form of a major global assessment that would be of value in policy making and management of water resources for sustainable development in different parts of the globe. This issue of the WSDF newsletter "*Tackling tomorrow's challenges today*", on the theme of Climate Change and Water is directed at creating a basis for such an activity beginning this year. The advice of the Patrons of WSDF and the readers of this newsletter would be of great value in taking this process forward.



Focus

In deep waters: climate change and sustainable development

TERI Research Team*

Water is one of the prime elements responsible for life on earth; it circulates through the planet transporting, dissolving, and replenishing nutrients and organic matter, while carrying away waste material. Freshwater resources crucial to human survival on earth, form only about 2.5 % of the total water resources on earth, with about two-thirds of this quantity present in the form of glaciers and snow cover. These resources are used by the earth's 6 billion people for drinking and municipal use, agriculture, industry, recreation and aesthetic purposes. By 2025, the freshwater demand globally is projected to rise by 25% or more (Appleton, 2002). Freshwater ecosystems also support the generation of hydropower, a renewable and more climate-friendly form of energy. However, while the world is not running out of water, many of its most vulnerable live in increasingly water stressed areas: approximately 1.4 billion people live in river basins in which water use exceeds recharge rates

(UNDP, 2006). Rivers are increasingly drying up, groundwater tables are falling and water-based ecosystems are being rapidly degraded in many water stressed regions in the world. Furthering the stress on water availability is changing climate. Spatial and temporal variations in water availability due to climate change are likely features in areas already marked by chronic water stress and more extreme weather patterns. Manifestations of climate change in the context of water include glacial melt and sea level rise. These have the potential to impact over one-sixth of the world's population who inhabit glacier or snow-fed river basins, and one-quarter of the global population living in coastal regions vulnerable to seawater intrusion. The impacts are likely to be particularly severe in developing countries where coping capacities are relatively limited.

About 700 million people in 43 countries fall below the water-stress threshold of 1,700 cubic metres per person. This figure is projected to reach 3 billion by 2025, with prominent

areas of concern lying in China, India and Sub-Saharan Africa (Kundzewicz et al, 2007). The water crisis often extends beyond the lack of physical availability of water: about 1.1 billion people in developing countries have inadequate access to water, and 2.6 billion people lack access to essential sanitation facilities (UN, 2006). Climate change would aggravate these existing disparities by impacting the hydrological parameters that govern the availability of water and also exacerbating the vulnerabilities of the poor to cope with the resultant changes in water availability, thereby limiting their capacities to utilize water as a resource. This in turn would have implications

Box 1 The Millennium Development Goals

- MDG 1: Eradicate extreme poverty and hunger
- MDG 2: Achieve universal primary education
- MDG 3: Promote gender equality and empower women
- MDG 4: Reduce child mortality
- MDG 5: Improve maternal health
- MDG 6: Combat HIV/ AIDS, malaria and other diseases
- MDG 7: Ensure environmental sustainability
- MDG 8: Develop a global partnership for development

The research for this article was undertaken at TERI by Ms. Sreeja Nair, with inputs from Dr. Sangeeta Nandi, and Ms. Prima Madan

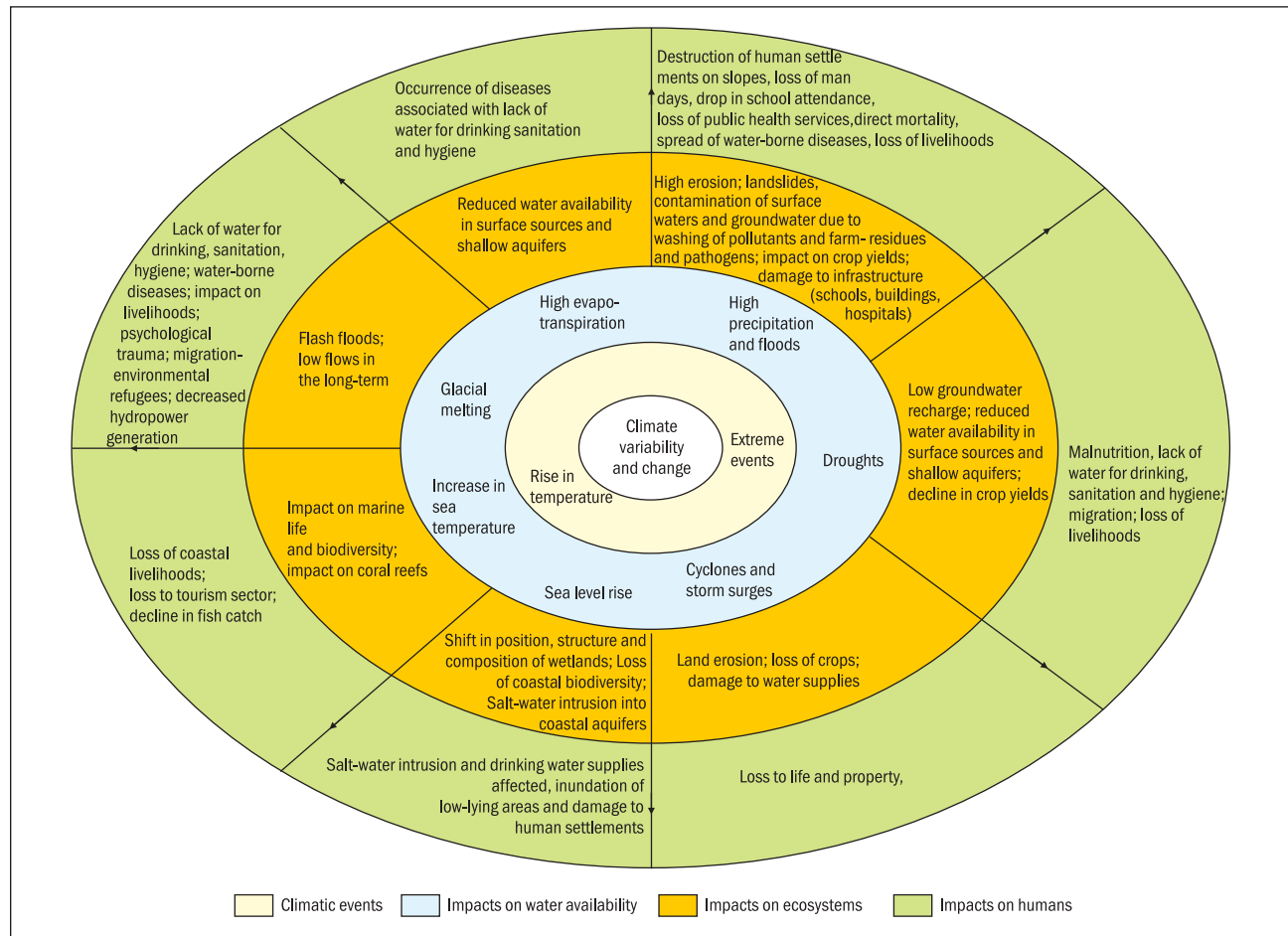


Figure 1 Impacts of climate change on water availability

on development objectives, including those enshrined in the Millennium Development Goals (MDGs) framework, agreed upon by the world community in 2000 (Box 1). The inter-linkages between climate induced water stresses and sustainable development are illustrated in Figure 1. These would mainly arise due to high precipitation and floods; droughts; cyclones and storm surges; sea level rise; increase in sea temperature; glacial melting; and high evapo-transpiration.

Climate change and water: major areas of concern

As illustrated in Figure 1, uncertainties and irregularities in climatic patterns can affect the hydrological cycle, with resultant consequences for human well-being. Climate induced water stresses can have direct and indirect impacts on issues of importance in the realms of the economy, the society and the environment, the three pillars in the paradigm of sustainable development. In this context, this section notes some important areas of concern, given the dynamic

inter-linkages governing the natural and socio-economic outcomes of climate variability and change and the underlying importance of stable water-based systems to support them.

The IPCC (Intergovernmental Panel of Climate Change) AR 4 (Fourth Assessment Report) confirms an average warming trend globally, over the past century, with regional variations. The trends are likely to continue along with an intensification of the hydrological cycle and consequent increase in the frequency and intensity of



extreme events such as droughts and floods impacting water availability and quality. With large parts of the world dependent on rain fed agriculture, the reduction in water availability and inadequate groundwater recharge coupled with unpredictable changes in rainfall could affect millions of farm-based livelihoods and jeopardize food security. All four dimensions of food security viz. food availability (production and trade), access to food, stability of food supplies, and food utilization (the actual processes involved in the preparation and consumption of food) are likely to be affected. Climate change will result in mixed and geographically varying impacts on food production and thus, access to food.

Reduced moisture retention in the soil can be expected to lower productivity and raise the risk of crop failure, even if average annual rainfall rises (Biemans et al, 2006). Low-income countries in the tropics are at particular risk due to climate variability and change as the rain-flow and stream-flow is concentrated over few months (UN, 2006). Many of these countries with poor land and water resources already face serious food insecurity, and are at higher vulnerability to climate change. For instance, Sub-Saharan Africa and Asia are characterized by both abject poverty and rain fed agriculture, with agriculture being the mainstay of several economies. Other semi-arid and sub-humid

regions of the globe, including Australia, Western USA and Southern Canada and the Sahel, have also suffered from intense and multi-annual droughts (Kundzewicz et al, 2007).

In arid and semi-arid regions, plagued by constant water scarcity, groundwater is a major source for meeting domestic and irrigation demands. Several regions across the globe are witnessing conflicting uses of water required for the agricultural sector, households, industry and to maintain other ecosystem services (Falkenmark and Galaz, 2007). Lack of proper regulatory regime coupled with climatic factors leading to reduction in surface water resources has led to over-extraction of groundwater resources in many parts of the world. Furthermore, several activities such as clearing the forest and vegetative cover for agrarian and commercial activities, construction of drainage etc. have altered the natural groundwater recharge and hydrological cycle.

Anthropogenic pressures as well as increasing frequency of severe droughts in Central Africa have resulted in the shrinkage of one of Africa's largest wetlands, Lake Chad, which supports a population of about 20 million) by about 90 per cent (Davis, 2007).

Higher temperatures and resultant high evapo-transpiration in arid and semi-arid is likely to increase salinity of shallow groundwater (Kundzewicz et al, 2007). Melting of glaciers following

rise in temperature attributable to climate change, would lead to initial flooding and heavy flows, and eventually low flows in summers. In several parts of the world, glaciers act as water repositories feeding into channels that are directly related to the social and economic development of the downstream populations. This would have severe implications for seasonal rivers dependent on inflows from glacier-melt, and consequently for freshwater availability (Box 2). Given that many rivers drain into seas, glacial melt would also have implications on the sea level. Rapid melting of glaciers can lead to the flooding of rivers and the formation of glacial melt-water lakes, which may pose a serious threat of outburst floods. Glacial Lake Outburst Floods (GLOF) can impact downstream populations and hydropower generation; countries falling within the Himalayan range are particularly susceptible to GLOFs.

Intense precipitation can destabilize the slopes in mountainous regions and cause landslides and soil erosion (Kundzewicz et al, 2007), endangering human settlements and affecting agricultural productivity due to the loss of fertile topsoil. Washing away of sediments can also raise the level of the river-bed and result in flooding and inundation of low-lying areas, with resultant livelihoods impacts. Increase in precipitation intensity can lead to a deterioration of water quality due to enhanced

Box 2 The retreat of glaciers

- Many small glaciers in Bolivia, Ecuador and Peru will disappear within the next few decades.
- Water supply in areas fed by glacial melt-water from the Hindu Kush and Himalayas, on which hundreds of millions of people in China and India depend, will be adversely affected.
- The glaciers of the Himalayas and Tibet alone feed seven of the world's greatest rivers—Brahmaputra, the Ganges, Indus, Irrawady, Mekong, Salween and Yangtze and endow more than 2 billion people with water.
- With more than 20 glacial lakes, Nepal is under particular threat from GLOFs.
- Most of Central Asia falls under the arid and semi-arid zone and majority of the fresh water originates from permanent snowfields and glaciers in the mountains of Kyrgyzstan and Tajikistan. Water from melting glaciers supports approximately 22 million livelihoods in Tajikistan, Turkmenistan and Uzbekistan.
- In China, almost all glaciers have already shown substantial melting. In Tibet most of the glaciers could disappear completely by 2100.
- Glaciers originating in the Andes are the main source of drinking and irrigation water for downstream population in the dry season. These glaciers however are retreating rapidly, with certain projections indicating the complete disappearance of some small and medium-size glaciers by 2010. In Peru glacial coverage has fallen by about one-fourths in the past 30 years.

Source (Kundzewicz et al, 2007), (UNDP, 2006)

transport of pathogens, agricultural runoff and other dissolved pollutants (e.g. pesticides) to surface waters and groundwater; and in increased erosion, which in turn leads to the mobilization of adsorbed pollutants such as phosphorus and heavy metals. Areas with declining water quality coupled with occurrence of droughts will be at a higher risk to diarrhoeal diseases, a major cause of mortality of children under-five in South Asia (WHO, 2003). In developing countries, children under 5 years of age comprise the majority of deaths among the three million people who die due to water-borne diseases annually (UNEP 2007). Nations that lack adequate fiscal resources and institutional

frameworks to bolster public healthcare services would be further burdened under rising mortality and morbidity patterns under a changing climate scenario. Apart from direct mortality, extreme events can change the virulence patterns of disease agents and promote favorable conditions for the growth and propagation of pathogens leading to vector-borne and water-borne diseases (Tearfund, 2006).

Variations in the temperature of water bodies due to increases in atmospheric temperature can also affect the self-purification capacity of water bodies and the level of dissolved oxygen essential for sustaining marine life. Degradation of freshwater ecosystems can threaten the

survival of freshwater species and affect human health, ecosystems, and water use. With feedbacks from rising temperature patterns and glacial melt, global mean sea level has been rising and the IPCC AR 4 estimates a projected sea level rise (SLR) of 0.18 to 0.59 m by 2100. Apart from leading to salt-water intrusion in coastal aquifers, coastal extreme events such as flooding, cyclones and storm surges can expose millions of coastal communities to risk. Large river delta systems, low-lying areas in countries such as Bangladesh, Egypt and Thailand, and Small Island Developing States such as Maldives would be affected (UNDP 2006). Also, coastal cities like Dhaka, Karachi, and Mumbai in Asia face the risk of inundation due to sea level rise. Complications arise with the displacement of populations, impacts on fresh water reservoirs, fisheries sector, direct and indirect impacts on health and tourism. The very existence of small island states is threatened by rising sea levels; Maldives is particularly vulnerable as over 80% of the land area of the islands in the country are less than a meter above mean sea level.

The social outcomes of extreme events can also manifest themselves in the form of lesser economic power of the vulnerable communities. Arise in school-dropout rates is often seen following extreme events like droughts and floods either due to a decline in the health status of children or the need to



engage them in work to supplement household incomes. Direct dependence on climate-sensitive sectors can also lead to loss of livelihoods and sharp decline in incomes drawn from these sectors. At particular risk are the farming, forest-based and coastal communities. Extreme events also pose an opportunity cost in terms of loss of man-days due to decline in health. Recurring extreme events with the likelihood of intensification can lead to a mass migration of people to areas with greater water security (Tearfund, 2006).

The way ahead

The absolute necessity of water for survival and growing concerns on its dwindling supply and quality exacerbated by climatic factors makes it essential to adopt adaptation and mitigation measures to counter the threats of climate change. Adaptation strategies in the water sector can either directly address climatic risks such as sea level rise, droughts, floods by land-use changes (afforestation, dikes, levees, drainage channels, sewer design standards, better urban planning) and other structural and non-structural measures. Also, adaptation options can promote 'win-win' strategies that enhance overall climate-resilience of the water sector by better management of available surface and groundwater resources. Such strategies include demand side management, water conservation and IWRM

(Integrated Water Resources Management). IWRM includes reshaping planning processes, incorporating community perspectives, linking land and water resources management, recognizing water quantity and quality linkages, connective use of surface water and groundwater, protecting and restoring wetlands and assessing barriers to information flow. The existing stocks of water supplies can be improved through water recycling and re-use, desalinization of sea water, artificial recharge, rainwater harvesting, and enhancing water storage capacities (dams, watershed management, groundwater management) to buffer against climatic shocks and stresses (Biemans et al, 2006). As irrigation forms a major source of water withdrawal, efforts should also be directed towards developing efficient irrigation systems (drip, sprinkler irrigation), and practicing 'more crop per drop' i.e. maximizing greater productivity from irrigation waters (UN, 2006). Apart from R and D investments in efficient irrigation technologies, there is a need to develop cultivable crop varieties that are tolerant to droughts, floods and salinity. In addition to the above, there is a need to enhance the generation of energy from water resources in order to decrease the extent of dependency on carbon-based energy sources, and thus reduce the intensity of greenhouse gas emissions from the energy sector. Currently, developed nations are utilizing

about 70 percent of their electricity potential, while the figure for developing countries is only 15 percent (UN, 2003).

Governance has a crucial role to play in identifying intervention measures, and facilitating the coping capacities of the vulnerable, especially those exposed to the manifestations of climate change, like extreme weather conditions (UNDP, 2007). Appropriate actions can be propelled at all levels by the sharing of best practices via technology transfer, institutional coordination and networking, and capacity building initiatives that foster multi-stakeholder interactions. There is also a need to facilitate adaptation to the impacts of climate variability and change on the water sector through policy initiatives like Coastal Zone Management Plans, Water Resource Management Plans, and Watershed Plans. For the above, it is essential that the projections of future trends in water availability and use, flow patterns and changes in climatic variables form crucial inputs into the planning process (Kabat et al, 2003). It is also important to develop a spatial and temporal database for surface and groundwater quality surveillance, conduct community-based risk assessment in vulnerable areas to identify 'vulnerability hotspots', and to incorporate climate change considerations in the urban planning process.

The year 2009 forms a point for review on the progress



achieved on several water related efforts made at international forums that include Agenda 21 at the 1992 Rio Conference, the 2002 Johannesburg Plan of Implementation and the UN Millennium Development Goals. 2009 also marks the mid-point of the 2005-2015 UN Decade of Water for Life. The 5th World Water Forum under the theme 'bridging divides for water' succinctly covers the barriers prevalent in the water sector: barriers between the rich and the poor, and between developed and developing nations. Against the above background, the impending uncertainties related to climate change and water should not defer necessary action towards this global emergency and immediate attention is called for, in order to be best prepared for a host of anticipated and unanticipated outcomes. In conclusion, the water crisis exacerbated by short-term and long-term changes in climatic patterns is a looming threat to human and ecological security, pervading all domains essential for human development. ■

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Feature

Issues related to human health and sustenance in developing countries in the context of climate-induced water stresses

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Changes in weather and climate heavily affect freshwater sources and its supply, especially in developing countries. Global warming, as well as changes in the intensity of the monsoon, not only affects drinking water supply and sanitation but also directly impacts agriculture, economy, and market of developing countries especially in the tropical climate. For example, the Indo-Gangetic plain is fed with water from the Himalayas and perennial rivers, like Ganga, are directly dependent on the glaciers melting and receding. According to one school of thought climate changes will increase the volume of water flow in Ganga by almost 42% but the other school predicts the lesser water in the basin. In either case, fluctuation on water supply will be highly unpredictable with variations in glacier melt, fluctuating rates of precipitation and evaporation. Floods as well as droughts will frequent the same place in short intervals. This will have a far-

reaching impact on the livelihood of the poor living in areas like the Ganga-Brahmaputra plain. In Africa, there is already a visible impact of climatic changes in the river flows; the drier areas will face increased water scarcity in future.

With climatic changes, seawater level will increase, effecting freshwater along the shoreline, and resulting in more salinity ingress which will further disturb the fragile balance of the brackish and sweet-water interphase. Sea level rise will cover more areas with brackish water that is unfit for agriculture and drinking water. This in turn will increase the cost of drinking-water supply as well as impact the availability and use of water in agriculture and industry all along the coastal belt. Sea water ingress can stretch inland to almost 10 km from the shoreline.

Therefore, livelihoods as well as basic quality of life of millions of poor will be affected. Even large urban population will face problems due to reduction of

water flow in rivers. The standard technology of wastewater disposal will be unable to function effectively and as a result, pollution will increase and general health conditions will deteriorate. This then demands introduction of a different standard of technology for wastewater treatment or a novel disposal system. This is because globally:

- there will be increased precipitation in some areas but a decline in others;
- drier and more fragile geo-hydrological areas will be vulnerable;
- more run-off in high altitude but also more flood and dry periods in low floodplains,
- reservoirs and wells will be affected which will have an impact on small irrigation and drinking water supply;
- ecosystems will be affected due to change of weather and climate; coastal freshwater system will be affected with salinity ingress and rising sea levels. Cities like New York, Bangkok, and Dhaka are vulnerable;
- conflicts may take place due to competing demands of urban and rural areas ; agriculture, drinking water and industry
- small industries, coastal agriculture and chemical industries in the coastal areas will be highly vulnerable;
- there will be a general deterioration of health in water scarce developing countries, in

- arid and semi-arid regions of the world; and
- high growth countries like China, India, and Brazil will face demand and supply problem unless they plan right now for a holistic approach towards a total water resource management including investment in the sector for the years ahead.

The lack of capacity in developing countries to recycle wastewater safely and failure in safe disposal of solid wastes will cause more water-borne diseases and malnutrition for children and will adversely affect the health of pregnant mothers. The good work done in the last two decades for increased access to safe drinking water will be negated unless developing countries shift their paradigm, introduce new technologies to a more sustainable source of supply, take positive actions for prevention of pollution, and arrest the deteriorating quality of groundwater. Otherwise, there will be a visible increase of skin problems and diseases related to drinking of water with more chemical contamination.

Developing countries are not only unprepared currently but are not even thinking to start planning and organising themselves for the future. The situation is hopelessly out of control and these countries need to take initiative now. They need expertise and support from international agencies, research organizations as well as partnership with private sector. India which has almost no

regulatory control on the use of water and no water basin management approach introduced, will face a serious situation especially with its increasing demand on freshwater due to urbanization and fast economic growth. The impact will increase the cost of supply of drinking water to poor rural areas too. The solutions will lie on a dynamic partnership approach between the Government, civil society and private sector in:

- introduction of improved water management (focus on river basins) and regulatory controls for both surface and ground water;
- introduction of stringent pollution control system and technologies;
- introduction of water saving technologies in agriculture, drinking water supply, and sanitation and industries;
- recognition of wastewater as a major resource and encourage recycling or recharging of groundwater with wastewater through natural water bodies;
- development of new water reservoirs and new schemes for shifting water resources between basins;
- recognition of the socio-economic cost of water in all panning and distribution system;
- introduction of proper forecasting and modelling for all vulnerable areas and plan in advance the remedies.
- improved water management system, people participation, and introduction of new technologies through private sector.

To introduce these changes, there is an urgent need for a major paradigm shift from a central-ministry managed water-resources-management concept to a new multi-disciplinary entity with full involvement of civil society and private sector. It may be remembered that the poor can take a leap jump in adaptation of technologies if introduced properly. Rich or poor, all take decision in their own interest if made aware, and options are laid out for them. Government departments unfortunately do not keep track with the latest research and technologies; and current knowledge base lies with private sectors and national and international research institutions. There is a need to introduce a mission approach through a new institutional structure, to fully involve the private sector for research and introduction of technologies in all water-related sectors in the country. The river basin-based water management approach will help involve private sectors in water management and distribution system with the community taking regulatory role as in some countries in Europe. Private sectors will play a major role even in flood control, disaster management, and forecasting.

There is time to plan, organize, and act before it is too late. Water will be the most predictable deterrent in economic growth if remedial actions are not taken immediately. It can easily pull down the rising curve of economic growth. Therefore, policy planners in the developing countries must wake up. ■

Water and Climate Change: issues for India

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The IPCC AR4 (Intergovernmental Panel on Climate Change, Fourth Assessment Report) has made several projections of impacts of anthropogenic climate change on global and regional water resources. Very briefly:

- By mid-21st Century, average runoff may increase by 10-40% at high latitudes and some wet tropical areas, and decrease by 10-30% in some regions at mid-latitudes and tropics, some of which are already facing water stress (Confidence level: High)¹
- Increase in drought and flood-affected areas due to extreme changes in precipitation (Confidence level: High)
- By 2100, water supplies stored in glaciers and snow covers may decline, reducing water availability for downstream population. (Confidence level: High)

The observed trends are: Precipitation, both rain and snow, has been found to be more variable with tendencies of concentration towards extremes (heat waves, droughts, heavy

precipitation events and floods). More intense and longer droughts have been observed over wider areas since the 1970s, particularly the tropics and sub-tropics.

India's NATCOM I (National Communication) to the UNFCCC (United Nations

Framework Convention on Climate Change) has assessed the impacts of climate change across 12 major river basins. A decline in total run-off for all river basins, except Narmada and Tapi, is projected (Figure 1). A decline in run-off by more than two-thirds is projected for the Sabarmati and Luni basins. Projections were also made with respect to the intensity of drought weeks over the next 20 years in each sub-basin in India (Figure 2).

Inter state and intra state conflicts on water issues would be a severe impact as a

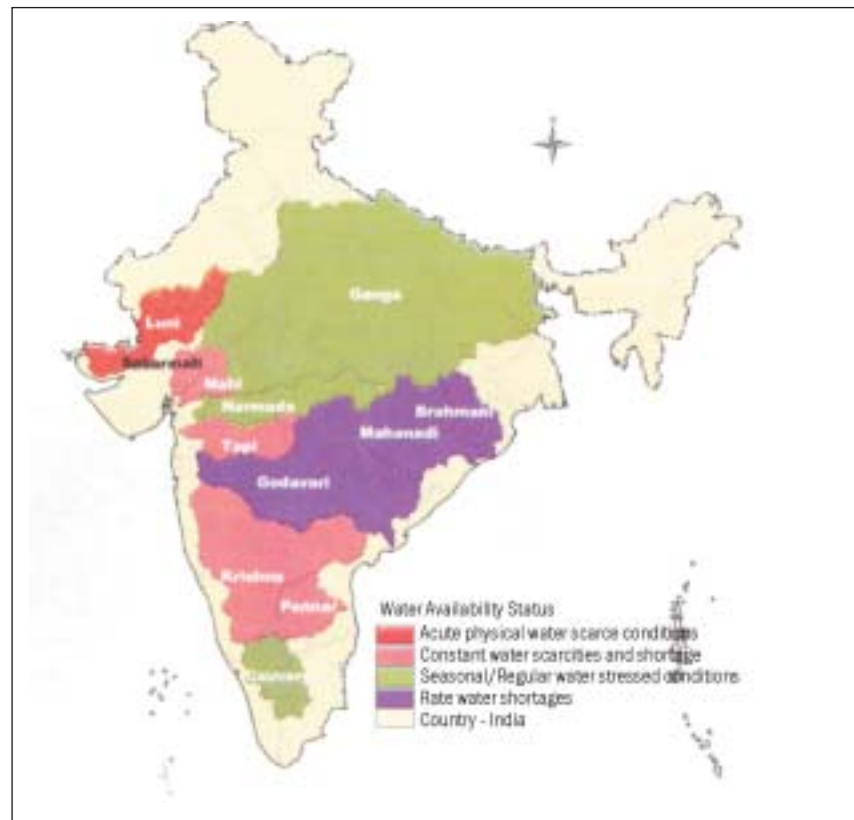


Figure 1 Regions vulnerable to changes in water availability due to projected climate change.

Source NATCOM, 2004

¹ Very high confidence: At least 9 out of 10 chances in being correct; High confidence: At least 8 out of 10 chances in being correct; Medium confidence: At least 5 out of 10 chances in being correct; Low confidence: At least 2 out of 10 chances in being correct; Very low confidence: Less than 1 out of 10 chances in being correct

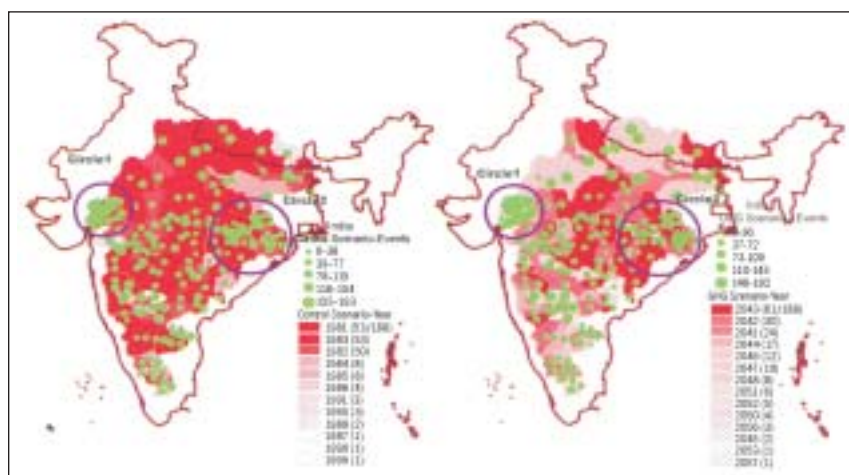


Figure 2 Spatial and temporal distribution of drought conditions

Source: Natcom 2004

consequence of transpiring flood and drought situations with extreme events predicted to be much higher both in frequencies and intensities.

What are the feasible and affordable policy-options to address the increased water stress? It is important to underscore that confidence in regional projections of climate change, in particular over the tropical regions, is still low. Accordingly, the options must ensure that benefits are obtained in the near-term from the interventions, as well as they are of acceptable net benefit, even if the actual climate change impacts are significantly different at the regional level from those currently projected. The decision rule may be termed as “maximin”, i.e. to maximize the net benefits under the worst *plausible* scenarios.

Some possible interventions, which intuitively, may meet these criteria, are as follows:

- Reduce vulnerability of cropping to greater intensity and frequency of droughts by development on high-yielding,

but drought resistant varieties of crops. Such crops may also be imparted nitrogen fixing properties (like legumes). R&D on such crops would be a significant challenge in crop biotechnology. Once developed and proven in field trials, they must be widely disseminated in vulnerable regions.

- In a step-by step approach, link the irrigation and flood control systems of surplus and deficit river systems. Apart from the challenges of ensuring that the environmental impacts of such linkages are properly identified and managed, it is necessary, both from the perspective of financial viability of the projects, as well as to promote water conservation, that the regime of irrigation tariffs is reformed, and administered by an independent, professional regulator.
- Conservation of ground-water resources is essential, both through removal of

perverse incentives to exploit ground-water beyond the annual recharges, as well as enhance recharges. These may be accomplished by first, electricity pricing reform so that non-metered electricity supply to pump-sets is discontinued, and later, full long-term average costs of supply are recovered.

Second, by conferring legal powers to gram panchayats or water users bodies at the village level, to apportion and monitor ground-water extraction entitlement to farmers, taking note of the annual recharge.

- In respect of drinking water supply to urban areas, it is essential in arid and semi-arid regions, to mandate rain-water harvesting in all buildings, including retrofits in existing buildings. Further, to require all new structures to reuse and recycle gray water from buildings (i.e. sewage other than from toilets) after in-situ primary treatment.

Such measures would help the present day imperatives of management of water availability, no less than future climate change challenges. ■

Reference

Government of India, 2004
India's Initial National Communication to the United Nations Framework Convention on Climate Change
Ministry of Environment and Forests, Government of India, New Delhi, Pp. 268

Climate Change and Water: the way forward

Ashok Jaitly

Distinguished Fellow, TERI

It is no longer in dispute that water as a burning issue has come to the top of the international agenda. In fact, now, the perspective in which this critical natural resource is viewed is a matter of debate. On the one hand, 'water promises to be to the 21st century what oil was to the 20th century: the precious commodity that determines the wealth of nations'¹, while the contrary take is that 'future wars will be fought not over oil but water'². A more recent note of caution was put across by Dr R K Pachauri, Chairman IPCC (Intergovernmental Panel on Climate Change), in his acceptance speech at the Nobel Peace Prize award ceremony (10 December 2007) when he said, 'peace can be defined as security and the secure access to resources that are essential for living. A disruption in such access could prove disruptive of peace.... Climate change will have an adverse impact on access to clean water... (and) is expected to exacerbate current stresses on water resources.'

According to the technical assessment conducted by the IPCC scientists, 'freshwater sources are among the systems and sectors that are vulnerable and have the potential to be

gravely affected by climate change. There is ample evidence supporting this statement in both observational records and climate projections.'

Some of the main observed and projected impacts of climate change on water resources include the following.

- Decline in mountain glaciers and snow cover in both hemispheres (the Hindukush, Himalayan, and Andes mountain ranges), which are expected to accelerate in the future, reducing water availability; hydropower potential; and changes in surface flows.
- Rise in sea levels (1.8 mm/year between 1961 to 2003), inundating coastal areas and extending areas of salinization of groundwater and estuaries, adversely affecting freshwater supply.
- Change in run-offs and available surface flows would cause changes in the infiltration rate of water in soils with serious consequences for agriculture and food production.
- Increase in precipitation and changing flow in some regions and reduction in others, with wetter areas becoming wetter and drier ones getting drier. While the

former is likely to increase flood risk; the latter could result in expansion of drought-affected areas.

Clearly, the prospective global water scenario is not very encouraging as can be seen from Figure 1.

The impact of climate change is being felt with varying degrees of intensity and different implications in various regions of the world. But the hard fact is that no region is insulated and the call for effective action, which is being heard at every international forum, is beginning to have a desperate edge, often verging towards panic stations. It is more than obvious that the 'business as usual' approach is no longer acceptable with growing awareness amongst large sections of society. Sadly, governments for most part continue to demonstrate either a belligerent refusal to accept reality or lazy complacency that somehow things will work out.

Adaptation to changing conditions of availability and demand is not new to water managers but the context has drastically changed. For long, water management has meant meeting increasing demands from all users and protecting people from disasters such as floods and drought. This has essentially been based upon the assumption of the existence of a perpetual natural-resource base. Climate change poses a fundamental challenge to these assumptions by impacting on

¹ Fortune magazine May 2000

² Ismail Serageldin, former Chairman, Global Water Partnership

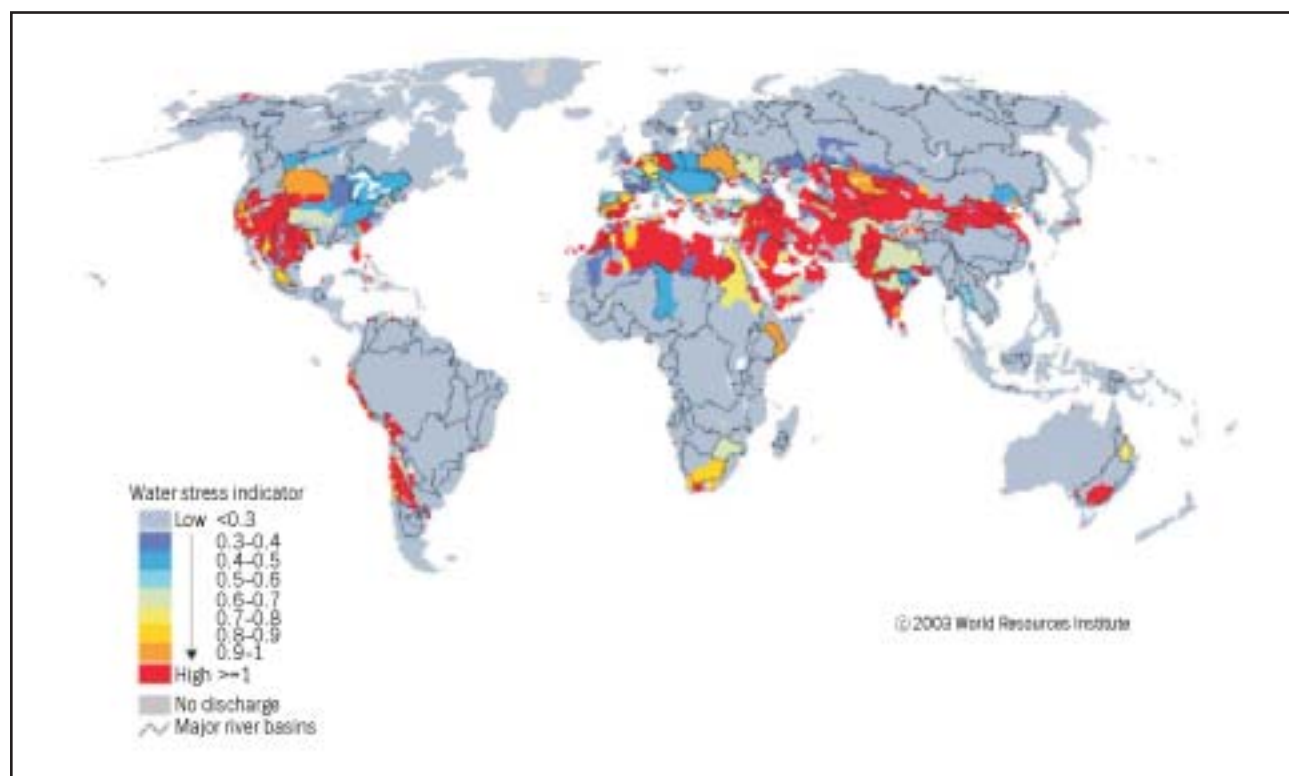


Figure 1 Environmental water scarcity index by basin

Source: Water Resources eAtlas

the sustainability of the very sources of freshwater supplies including precipitation, water storages (glaciers and deep aquifers), and flows. The natural-resource base itself has come under severe threat. Consequently, long-term sustainable adaptation strategies must deal with root causes even while providing short-term pacifiers. Thus, addressing the basic issues of greenhouse emissions and global warming are inextricably related to finding realistic and sustainable solutions to the water crisis.

At the same time, it is equally necessary to underscore the possible duality in the relationship between climate change mitigation and sustainable water resource management. For instance,

depending upon the species planted, afforestation could actually use more water than crop production particularly in drier regions. On the other hand, it could have beneficial hydrological effects by reducing water run-off and enhancing conservation. Similarly, substitution of fossil fuels by hydro sources for electricity generation may have adverse ecological impacts on existing river ecosystems and water availability, apart from causing social disruption. These potential conflicts and trade-offs between mitigation and adaptation have to be kept in mind and evaluated while designing inter-sectoral strategies for sustainable development. In fact, this re-confirms the need to adopt an

integrated river basin and watershed approach in order to ensure optimal allocation of scarce natural resources like land and water.

Similarly, while addressing those issues that fall directly within the water sector, there is an urgent need to shift the fundamental emphasis in water management from the existing supply-side approach to a demand led strategy; from the erstwhile technocratically oriented uni-dimensional mindset to much more multi-disciplinary and holistic solutions. In order to bring about such a change, governments need to adopt a suitable policy framework to regulate and direct land and water use. In many parts of the world, including developing



countries, policies and regulations actually encourage agricultural patterns and practices that result in a wasteful use of scarce water resources. Thus, huge subsidies of various kinds (on energy, inputs, equipment, and commodity prices), which protect narrow farming interests at the cost of consumers and the ecosystem, need to be revisited with the wider perspective in view. Undoubtedly, this is a highly evocative political issue (Western Europe, USA, China, India) which provides all the more justification for an attitudinal change that can forge a broader consensus at both domestic and international levels.

Technologies for more effective water use in agriculture and industry are being developed and successfully applied in many places. This could be considerably accelerated, again with a more conducive policy and fiscal environment. It would seem that the need for water conservation has not permeated deeply enough into the commercial consciousness, not only in the larger interest of sustainable development but also as good business. It is only too evident that excessive water withdrawal by agriculture and industry is not only creating adverse social and environmental conditions but also means higher costs of production. Thus, where water was once a relatively small percentage in the overall cost of production it can now be expected to become as significant an element as energy

in the future. Apart from appropriate policies that provide incentives for adopting water-efficient technologies, governments and businesses have a responsibility to strengthen institutional and regulatory arrangements that can bring about improvements in water management operations. This would include reduction in water pollution; restoration of water bodies (river channels, lakes, and wetlands); maintenance of flood plains; and protection of forests.

At the societal level, there is conclusive evidence to establish that present day patterns of water use by richer sections of human society do not only reduce the amount of water available for agricultural and industrial development but also deny equal access to the fundamental human rights of drinking water and sanitation to about two billion of the underprivileged citizens of our planet. This needs to change and indeed there is a growing body of world opinion that is out lobbying strongly for this change and even succeeding, albeit in a limited way. While every effort to strengthen the movement to generate global awareness must be lauded, it is equally necessary to back it with realistic regulatory and fiscal measures to discourage wasteful water consumption and promote best practices in water conservation. In many parts of the world, particularly in developing countries there is great resistance to the introduction of reforms in the water sector. For instance, economic pricing of water is a

highly contentious issue and induction of private enterprise is often found objectionable. However, well-meaning activism also needs to see the writing on the wall with an open mind because, clearly, water has got to be viewed as a scarce and valuable resource. At the same time, the encouraging spread of rainwater harvesting techniques and water-saving devices could be accelerated and extended with appropriate incentives.

That climate change is impacting heavily on the planet's water regime is obvious. That this impact will continue to be felt, indeed with greater intensity, in the future is equally evident. That the reverberations are being heard in all parts of the world is also a reality. However, clarity in the way forward to meet the challenge is yet to emerge, both at national and international levels. The IPCC has emphasized the need to deepen our understanding of what might lie ahead through more and more scientific inquiry. Indeed, this is one essential requirement because there are still many questions of uncertainty. This calls for concerted efforts of the scientific community, governments, and civil society. At the same time, the knowledge already available needs to be acted upon without loss of any more time. The issues are not just technical. There are serious economic and political nuances that can be addressed only through dialogue and interaction which are imbued with determination and goodwill. ■



Patrons and Advisors speak...

Patrons

“Ensuring safe and adequate water based on effective management of water resources is central to development efforts. Global climate change magnifies this challenge in ways that demand immediate attention. The world needs a coordinated scale-up of existing efforts to provide water to the poor and vulnerable. It also needs major new efforts to help them both adapt to decreases in water quality and availability, and be more resilient to increased flood and landslide risks. It is our collective duty to help the poorest and vulnerable adapt. They have contributed the least to climate change, yet are amongst the worst affected. Let us seize the initiative to assist them.”

Mr Kofi Annan

Former Secretary General, United Nations; President, Global Humanitarian Forum, Geneva

High risk of violent conflict

“Water is the keyword for the climate change that will cause most displacement of people in the future. Too much or too little water, at the wrong time or never. A report by International Alert identifies 46 countries, home to 2.7 billion people, where climate change and water-related crises create a high risk of violent conflict. This is not an issue of rich or poor, North or South since there are water problems in China, the United States, Spain, India, Pakistan, Bangladesh and the Republic of Korea. Water resources must be protected. There is still enough water for all of us – but only as long as we keep it clean, use it more wisely, and share it fairly.”

HE Mr Kjell Magne Bondevik

Former Prime Minister of Norway; President, Oslo Centre for Peace and Human Rights; Special Humanitarian Envoy for the Horn of Africa, United Nations

“Climate change poses serious threats to the earth’s ecosystem, including disruption of the global hydrological cycle. IPCC (Intergovernmental Panel on Climate Change), in its Fourth Assessment Report, warns that if anthropogenic GHG emissions continue to increase at their present rate, mean annual precipitation for subtropical regions will decrease by 20%, which will increase the likelihood of droughts. Business and industry must take these threats to humanity seriously, and participate in broad-based initiatives to tackle climate change, through technological advancement and innovation much like they did in helping overcome environmental pollution faced during the 1970s.”

Dr. Shoichiro Toyoda

*Honorary Chairman, Member of the Board
Toyota Motor Corporation*

Advisors

“Given India’s unprecedented economic growth and political stature, the country is in a strong position to promote adaptation to climate change for all of society, from the booming cities to the rural hinterland. In no other way does climate change impact people more than through water resources. While water in India sustains agriculture, quenches the nation’s thirst, generates power, and turns the wheels of industry, it all too often wreaks havoc through devastating floods and droughts. A changing climate will only aggravate these shocks. India can seize the opportunity to transform the way its water resources are managed, thereby meeting multiple demands equitably and efficiently across its many river basins, and ensuring sufficient quantity and quality of both surface and groundwater for future generations. Achieving this, India will be well placed to face the threat of climate change to growth and poverty eradication.”

Ms Isabel M. Guerrero

Country Director, The World Bank – India

“Water is one of the main issues, if not the most important, of the climate change. Bibliography in this subject has become abundant and more and more scientists, policy makers and think tank experts invest themselves in order to shed light to its multiple aspects. The list of the water-and-climate-change subchapters is almost inexhaustible: fresh water resources, clean drinking water availability, floods and droughts, groundwater-surface water interactions, water quality, seasonal runoff regimes, ice melting, evaporation and precipitation patterns... Besides and beyond this complexity, water interferes with almost every other significant issue of the global warming: food, health, infrastructures, energy, industrial activities, economy, demography and politics. Eventually, peace and human development will be at stake. The water-and-climate-change problem is challenging the world institutions.”

Mr Georges Valentis

*Managing Director, The Institut Veolia Environnement,
France*

“ADB’s strategy for climate change adaptation is to help clients in national adaptation planning, project-level climate proofing, and adaptation investments to reduce the risks from likely impacts. Whereas mitigation is largely “in the air”, adaptation is mostly about water. ADB supports integrated water resources management (IWRM), which offers a sensible framework for adapting to climate change. As the likely impacts, knowledge and capacity for adaptation vary significantly across countries, a differentiated approach is needed, with early priority for downscaling of models for better predictions, increasing awareness and knowledge, and climate proofing of new investments for assets with a long life.”

Mr Xianbin Yao

*Acting Director General, Regional Sustainable Development
Department, Asian Development Bank*



Resources

Initiatives and agreement

United Nations Climate Change Conference

*Bali, Indonesia
3–14 December 2007*

The Bali roadmap, adopted at the conference, charts the course for a new negotiating process to be concluded by 2009 that will ultimately lead to a post-2012 international agreement on climate change.

http://unfccc.int/meetings/cop_13/items/4049.php

IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report (AR4)

The IPCC AR4 reports were released in the course of 2007.

The final part of “Climate Change 2007”, “The Synthesis Report” was released in Valencia, Spain, on 17 November 2007
<http://www.ipcc.ch/#>

International Carbon Action Partnership

On 29 October 2007, leaders of more than 15 governments met in Lisbon, Portugal to launch the establishment of the International Carbon Action Partnership
<http://www.icapcarbonaction.com/>

Asia-Pacific Partnership (APP) on Clean Development and Climate

Second Ministerial Meeting, New Delhi, 14–15 October 2007

APP partners Australia, Canada, China, India, Japan, Republic of Korea, and the United States reiterated their resolve to work together and with private sector partners to meet goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction.

[http://](http://www.asiapacificpartnership.org/)

www.asiapacificpartnership.org/charter.pdf; [http://](http://www.asiapacificpartnership.org/)

www.asiapacificpartnership.org/

Forthcoming events

London, UK

12–13 February 2008

The Climate Change Summit 2008

Web site [http://](http://www.ethicalcorp.com/climate/)

www.ethicalcorp.com/climate/

Berlin, Germany

22–23 February 2008

2008 Berlin Conference on the Human Dimensions of Global Environmental Change

Email bc2008@zedat.fu-berlin.de

Hanoi, Vietnam

7–11 April 2008

4th Global Conference on Oceans, Coasts, and Islands: Advancing Ecosystem Management and Integrated Coastal and Ocean Management by 2010 in the Context of Climate Change

Web site [http://](http://www.globaloceans.org/globalconferences/2008/index.html)

www.globaloceans.org/globalconferences/2008/index.html

Alexandria, Egypt

10–13 May 2008

International GEF Workshop on Evaluating Climate Change and Development: Results, Methods and Capacities

Secretariat of the International Workshop on Evaluation Office of the Global Environment Facility

Web site [http://](http://www.esdevaluation.org/)

www.esdevaluation.org/

Honolulu, Hawaii

12–16 May 2008

World Environmental & Water Resources Congress 2008

ASCE World Headquarters, 1801 Alexander Bell Drive Reston,

Virginia 20191-4400, USA

Web site <http://content.asce.org/conferences/ewri2008/>

Kampala, Uganda

25–8 June 2008

International Conference on Groundwater and Climate in Africa

Web site <http://www.gwclim.org/>

Poznań, Poland

1–12 December 2008

COP 14, CMP 4 Conference of the Parties (COP), Fourteenth session and Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP), Fourth session

Website http://unfccc.int/meetings/unfccc_calendar/items/2655.php

Lighting a Billion Lives Campaign

The Lighting a Billion Lives (LABL) Campaign is a global programme initiated by TERI to provide clean lighting through the use of solar technology to people without illumination, specifically those not connected to the centralized power grid in rural regions.

Globally, 1.6 billion people lack access to electricity; this includes 77 million rural households in India alone. Thus this commitment is aimed to enhance the welfare and livelihoods opportunities of households and communities that have until now been dependent on traditional resources for their lighting (e.g. biomass, kerosene, and paraffin). The LABL campaign will not only illuminate lives but also provide for development that can be sustained by positively influencing the building of human capital and reducing negative impacts on the environment. The above would be facilitated through enhanced potential for literacy and increased primary health care benefits in the poorest regions of the world, as well as a reduction in local carbon emissions

The LABL campaign brings alive the central message of the World Sustainable Development Forum (WSDF) - 'to enhance human well-being in the present and create conditions for a sustainable future'. As sustainable development is about achieving actual improvements in the quality of peoples' lives and the environment, WSDF proposes to facilitate the LABL campaign of disseminating 200 million solar lanterns to a billion people, and thereby mitigate approximately 300 million tonnes of CO₂.



World Sustainable Development Forum

The World Sustainable Development Forum (WSDF), established by TERI, provides a platform to identify, analyse, and disseminate policy interventions to enhance human wellbeing in the present, and create conditions for a sustainable future. In its endeavours, the Forum is supported by highly distinguished patrons and advisory committee members who are global leaders in government, industry, and academia, as well as opinion-makers in a world characterized by locale specific socio-economic and environmental priorities. Given the diverse developmental imperatives across regions, WSDF activities and events seek to spread the key messages emerging from the annual Delhi Sustainable Development Summit (DSDS) and the Regional Sustainable Development Summits (RSDS), collate information, monitor developments, and report on the progress of MDGs, apart from understanding and disseminating information on the issues of sustainable development in varied contexts.

Towards this end, a biannual newsletter series "*Tackling Tomorrow's Challenges Today*", published by the Forum seeks to discuss development prerogatives, debates and discourses with the aim of highlighting challenges to the attainment of development that is sustainable worldwide. Given overriding global concerns on the subject, this first issue brings to focus the key issues pertaining to Climate Change and Water.

Acknowledgement

The WSDF solicits support from governments, institutions, organizations, and corporate houses in bringing together the finest minds and leading thinkers of the world to focus on the global challenge of sustainable development

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